

**Faculty of Health Sciences
School of Public Health**

**Can diagnosis-based capital allocation facilitate more appropriate,
sustainable and innovative acute care?**

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**This thesis is presented for the degree of
Doctor of Philosophy
of
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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Rhonda Ann Kerr

October 2019

Abstract

Economic sustainability for Australian public hospitals is sought by the community, clinicians and governments. National diagnosis-related hospital funding has successfully adjusted the focus from funding institutions to resourcing effective patient care. Changing the method of funding to focus on the patient diagnosis combined with an emphasis on hospital efficiency has resulted in more financially sustainable public hospitals.

Sustainable clinical care increasingly relies on technologically appropriate hospitals. However, Australia has a traditional prioritised approach for allocating capital funding hospitals and technology. Capital resources are of growing importance in delivering technologically sophisticated services for the next generation of advances in diagnosis and treatment. Unlike hospital recurrent funding, resources required for effective clinical care are not equally available for all patients.

In this thesis it is argued that the purpose of capital investment in hospitals is *to fund patient access to appropriate care in efficient hospitals*. However, capital invested to facilitate acute care in Australia has not previously been aligned with services or standards, accurately measured or reported. The vision for the work undertaken in this doctoral thesis is to establish a system to effectively fund equitable access to appropriate services for patients and to provide access to the necessary tools for clinicians in a manner that enhances hospital efficiency.

The research question “*Can diagnosis-related capital facilitate more appropriate, sustainable and innovative acute care?*” has been considered in three main objectives;

1. assessing prevailing systems for capital invested in hospitals within Australia and in comparable OECD nations (considered quantitatively and qualitatively),
2. developing a clinically-based model to cost capital for patient diagnosis groups and testing the model for one third of Australian patients in high patient volume Diagnosis Related Groups (DRGs), and
3. conducting a comparative evaluation of the new model and the current system for capital investment in hospitals based on the Australian government performance framework for public hospitals.

Methodology

Adopting an Exploratory Sequential Mixed Methods approach, capital allocation systems within Australia were assessed through literature reviews and interviews with senior officials involved in capital allocation across Australia. International capital allocation information was drawn from literature reviews, WHO and OECD reports. Model development (Objective 2) for the capital amount required for each patient episode adopted a modified Time-Driven Activity-Based Costing method for the development of the model using three data sources:

- authorised clinical guidelines identified through literature review, and government standards and targeted searches of official websites,
- Australasian Health Facility Guidelines, and
- interviews with professorial-level clinicians (or those recommended by clinical professors) and experts from across Australia.

Testing of the model and the prevailing system of capital allocation (Objective 3) used the National Public Hospitals Performance Indicator Framework adapted for capital measures from the annual national report on government services drawing on data identified from government and other sources based on literature searches and ongoing surveillance.

Results

Developing a model of capital cost estimation has proven possible for a range of DRGs relevant to a significant portion of Australian public hospital patients. Australia has robust evidence-based mechanisms that have informed the model to transparently support capital allocation by DRG to align with recurrent DRG funding. Medical equipment, information and communications technologies (ICT) and facilities were independently identified and costed for each DRG based on clinical pathways and guidelines. A prime quality of the model is that it creates a link between patients, clinical practice and technologies for diagnosis and treatment and capital costs, to determine the appropriate level of investment.

Technologies, patient numbers and clinical care continue to change. Appropriate capital investment for the systems, equipment and facilities patients require has been found to activate clinical innovation for improved clinical effectiveness, productivity and safety

The values expected of Australian public hospitals are equity of access, effectiveness, appropriateness, quality of services including safety, responsiveness and continuity, and

sustainability incorporating environmental and economic sustainability and efficiency. These are codified in the Australian Public Hospital Performance Indicator Framework and have been used to evaluate the current system of capital allocation and the new model for capital. Of 35 measures adopted to evaluate relative performance the Model system met 33 measures, with the current system achieving only three of the 35 standards expected for Australian hospitals.

Conclusions

The existing Australian system of capital allocation for acute care has been found to be inequitable, to limit patient access, not to universally fund appropriate quality care, to be unresponsive to clinical and patient requirements and to be environmentally and economically unsustainable. Moreover, the existing system for funding future services is not funding medical equipment, hospital information and communications systems and facilities for equitable access to contemporary standards of care in Australian hospitals or to facilitate an equitable future.

Evaluation of the existing system and the proposed diagnosis-based based model of funding capital for acute care in public hospitals has illustrated how the new model addresses many of the shortcomings of the existing model. Additionally, the diagnosis-based model of capital funding aligns with the activity-based model of funding recurrent costs. While issues involved in transitioning to a new system of capital funding of public hospitals need to be addressed, the proposed model is recommended as a system that will more effectively fund equitable access to appropriate services for patients and provide access to the necessary tools for clinicians in a manner that enhances efficiency

It is proposed that a national system of capital funding for acute care is adopted to align with the shared Commonwealth-state funding for acute care, based on the Model created in this thesis.

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Publications

Articles written and published during the preparation of this thesis are to be found at Appendices H-K. They abbreviate the research questions, methods and findings of:

1. Chapter 4 - Investing in acute health services: Is it time to change the paradigm?(Kerr, Hendrie and Moorin 2014)
(Appendix H)
2. Chapters 5 and 6 - Is capital investment in Australian hospitals effectively funding patient access to efficient public hospital care?(Kerr and Hendrie 2018)
(Appendix I)
3. Chapters 7-8 Cost assessment for new public hospital services (Kerr 2019)
(Appendix J)
4. One publication addressed concerns about the range and quality of national data on capital for hospitals. (Concerns about the Australian Institute of Health and Welfare's information on capital investment for healthcare)(Chapter 4)
(Appendix K)

References

- Kerr, R. 2019. "Cost Assessment for New Public Hospital Services." *The Building Economist* June 2019.
- Kerr, R. , and D. V. Hendrie. 2018. "Is Capital Investment in Australian Hospitals Effectively Funding Patient Access to Efficient Public Hospital Care?" *Australian Health Review* 42 (5): 501-513. doi: <https://doi.org/10.1071/AH17231>.
- Kerr, R., D.V. Hendrie, and R.E Moorin. 2014. "Investing in Acute Health Services: Is It Time to Change the Paradigm?" *Australian Health Review* 38 (5): 533-40. doi: DOI: 10.1071/AH13226.
- Kerr, R. 2015. "Concerns About the Australian Institute of Health and Welfare's Information on Capital Investment for Healthcare." *Australian Health Review*: -. doi: <http://dx.doi.org/10.1071/AH14180>.

Contributors to Publications



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To whom it may concern,

I, Rhonda Ann Kerr, am a major contributor to the conceptualisation, coordination, and implementation of the research which resulted in the following papers:

Kerr, R., Hendrie, D.V., Moorin, R.E. (2014) Investing in acute health services: Is it time to change the paradigm? Australian Health Review, 38 (5) pages 533-40 DOI: 10.1071/AH13226

Kerr, Rhonda (2015) Concerns about the Australian Institute of Health and Welfare's information on capital for investment in healthcare. Australian Health Review, 39 pages 453-454
<http://dx.doi.org/10.1071/AH14180>

Kerr, Rhonda. Hendrie, Delia, V. (2018) Is capital investment in Australian hospitals effectively funding patient access to efficient public hospital care? Australian Health Review, 42(5) pages 501-513 doi: 10.1071/AH17231.

Kerr, Rhonda. (2019) Cost assessment for new public hospital services. The Building Economist. 8 June 2019

I am the primary contributor to the conceptualisation, data analysis, drafting, writing and editing of the papers listed above which are part of my PhD thesis. Accordingly, I am lead author on these publications.

Rhonda Kerr

I, as co-author, endorse that this level of contribution by the candidate indicated above is appropriate.

Delia Hendrie

Rachael Moorin

Conference Papers and Presentations

Peer-reviewed conference presentations

- 2015 Australasian College of Health Service Management and Australian Council on Healthcare Standards Joint Congress, 28-30 October. Sofitel Melbourne. *Health Economic methods in health planning* in 'Economics Methods and Applications - ABF, Health Services Delivery, Health Planning, Governments, Parliament' with Drs Kathryn Antioch, Priscilla Robinson and Zoe Bristow.
- 2016 Australasian College of Health Service Management and Australian Council of Healthcare Standards Congress, 26-28 October, Sofitel. Brisbane, *Capital - balancing innovation and risk*.
- 2017 Australasian College of Health Service Management Conference, 27-29 September, Sydney Hilton. *Building resilience into the changing environment for hospitals: Lessons for Australia from 18 OECD nations*.
- 2017 European Health Property Network, 20-22 November Turin, Italy. *Targeting capital investment for hospitals for sustainability and patient centred care: evidence from 18 nations*.
- 2018 European Health Design Congress, 11-13 June, Royal College of Physicians, London. *Enabling the future: funding health infrastructure for transformational change*.
- 2018 Australasian College of Health Service Management Conference, 19-21 September. Darwin Convention Centre. *Next Gen hospitals: Funding to deliver new models of care*.
- 2019 European Healthcare Design Congress, 17-19 June, Royal College of Physicians, London. *Transforming healthcare: Form follows finance*.
- 2019 International Union of Architects Public Health Group, 29-31 July, Christchurch Art Gallery, New Zealand. *Designing for evolving hospitals to frame clinical care*
- 2019 Asia-Pacific Health Leadership Congress of the Australasian College of Health Service Management, 9-11 October. Gold Coast. *Incorporating innovation -a key to financial sustainability*.
- 2019 Australian Health Design Council, 18 November National Meeting, Brisbane, *Funding patient access to efficient hospitals-directions in capital funding*.

Other presentations

- 2015 The Mark Liveris Health Sciences Research Student Seminar. *Where will your work? Hospitals for future healthcare.*
- 2019 The Mark Liveris Health Sciences Research Student Seminar *Next Gen hospitals: Funding new models of care.*
- 2018 W.A. Treasury Health Group 18 July. *DRG based capital for public hospitals- methods and mechanism.*

Submissions

- 2017 WA Health Sustainability Review. *Sustainable healthcare.* October 2017
- 2018 Australia's National Digital Health Strategy – Safe, Seamless and Secure Framework for Action. April 2018 *How Australia will deliver the benefits of digitally enabled healthcare?* Consultation Paper March 2018
- 2019 Steering Committee for the Review of Government Service Provision, Health Working Group. Report on Government Services 2019. Productivity Commission. *Public hospital efficiency measures.* 30 January 2019

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*“Pour ce qui est de l'avenir, il ne s'agit pas de le prévoir,
mais de le rendre possible.”*

“As for the future, your task is not to foresee it, but to make it possible.”

(Saint-Exupéry 1995)

Chapter 1 Introduction

1.1 Background

Australians prize access to good quality healthcare. The national Medicare funding system, guaranteeing universal access for patients to high quality care, is the most popular government program (Wade 2015). In the three decades since Medicare's inception in 1984 (*Health Legislation Amendment Act 1983*), average Australian life spans have increased significantly (by 7.5 years for men and 5.4 years for women) due to a range of public health factors including access to appropriate health services and medical and technological advances (AIHW 2017a). Two of the three pillars of Medicare are access to community-based primary and specialist medical care and subsidised pharmaceuticals. The third pillar funds free access to public hospitals.

Supporting those pillars Australian health expenditure by governments and patients represents 10.3% of our national economy, measured against Gross Domestic Product. Public hospital costs account for almost 32% of total annual health expenditure, slightly less than in 1984 (AIHW 2018d, 1994). The capital invested to sustain the Australian public hospital pillar however is unknown.

Public hospitals are highly valued as the technological flagships of the health sector by the community, governments and the medical profession (Council of Australian Governments (COAG) 2011c, 2018b; Australian Medical Association 2018). Hospitals support patients through some of the most important life events from births, life-saving treatments, and life-enhancing improvements to end-of-life. At times of threat, hospitals manage community risk (major trauma incidents, emergencies, infectious disease outbreaks). Technological developments since 1984 have been significant with increased technology in hospitals identified as a factor increasing health costs (Mangano M 2006; Fuchs 2010; Productivity Commission 2005; Sorenson 2013; Mangano 2006). However, the quality, value and distribution of significant technologies, including major medical equipment (MME) and information and communications technologies (ICT), in Australian public hospitals are not effectively valued and are poorly reported by governments (OECD 2018; Productivity Commission 2017b).

The sustainability of health and hospital costs are politically contentious issues causing all Australian governments to closely monitor annual public hospital expenditure to ensure

value for the tax-payer funds and minimise expenditure(Productivity Commission 2009e; Koff 2017; Kruk 2018; Daly 2018; National Health Information and Performance Principal Committee 2017; AIHW 2018f). Value is considered in terms of the costs, quality and outcomes of services, and processes, delivered to the Australian public (Mazzucato 2018).

Growth in public hospital costs has been effectively contained (to average less than two per cent per annum over four years) by the national implementation of activity based or casemix funding(AIHW 2018d; Biggs 2018) . Activity based funding (ABF) by patient diagnosis related group (DRG) in public hospitals funds medical, nursing, allied health salary costs, supplies and hotel costs per patient across Australia. Capital and depreciation of buildings and medical equipment are not included in payments to hospitals for patient care(IHPA 2017c). Capital funding for hospitals is the responsibility of state and territory governments within the national system(Council of Australian Governments(COAG) 2011c). This tradition predates ABF funding arrangements for joint funding of hospital services by the Commonwealth and the states.

Community expectations are for equitable access to continuously improving medical options and progressive technological advances to improve lives and reduce disability(Consumers Health Forum of Australia 2018). Clinicians expect to deliver high quality care utilising appropriate contemporary technologies(Productivity Commission 2005). The problem is how should new technologies and clinical innovations be valued and funded to cost-effectively deliver access, quality and value within Australia’s public hospital system?

Prevailing Australian systems for capital allocations for hospitals face challenges regarding access, equitable distribution, funding effectiveness, accountability, quality and information transparency (detailed in Chapters 2, 4, 5 and 9). Unlike recurrent costs for patient care, capital is not allocated on a per patient-basis but allocated to a relatively small number of institutions each year at a rate below replacement levels (identified in Chapter 9). Establishing the value of existing capital supporting clinical care in public hospitals is challenging with no national information published since 2013-14 due to accuracy concerns(AIHW 2015b, 2015c, 2016c, 2017f, 2018d; Productivity Commission 2009e, 2010; SCRGSP 2010, 2011, 2012, 2013, 2014, 2015, 2016; SCRGSP 2017; SCRGSP 2018; Kerr 2015). The absence of transparency and reporting systems for capital has sustained inaccuracy(AIHW 2018b; Productivity Commission 2009e; Kerr 2015; AIHW 2017f) and been tainted by corruption(WA Corruption and Crime Commission 2018;

Independent Commission Against Corruption 2011; Independent Broad-based Anti-corruption Commission 2017)

Deeble recognised problems with the varied methods of valuing capital in Australian hospitals. His seminal work costed capital, including medical equipment, at replacement costs relative to the service provided (Deeble 2002b). Building on his research, the work presented in this Ph.D. thesis costs capital for hospital buildings, medical equipment and ICT to also align with the service provided but, in this case, at the patient DRG-level rather than by hospital type (Deeble 2002a). Deeble's approach refined the valuation methods for existing hospital assets; this research goes further by aligning capital costs to the patient, the diagnosis and the treatment.

Current estimates for the value of hospital capital per patient made by the Productivity Commission rely on depreciated assets plus a factor for the cost of money (user cost of capital) (Productivity Commission 2009e, 2010). The estimated cost reflects an assessment of the hospital assets of each state divided by the number of inpatients. As a measure of capital required to support contemporary patient care it is problematic due to the primary focus on assets rather than patients or clinical standards. Also, there are concerning assumptions that all hospitals have the same equipment and that DRG weightings are equally applicable to capital; assumptions not supported by the research (Deeble 2002a; SCRGSP 2018; IHPA 2018b). The quality of assets is also assumed to be perfect for all patients. Depreciation-based capital reimbursements are used in Europe based on the value of existing capital assets in each hospital. However some problems in relation to outcomes, asset imbalances and valuations have been identified in this approach (Vogl 2014; Dodswell 2009; Rechel 2009b).

Like these approaches, the research undertaken in this Ph.D. thesis sought to create a patient-based system for capital allocation. However, as capital is allocated for future service delivery, this research intends to counter the backward-looking depreciation-based methods of capital valuation, aiming to create a model that provides value for acute care and can incorporate evidence-based clinical innovation and technological improvements. The model for capital allocation was designed to support access to appropriate care in efficient hospitals using government standards, clinical guidelines and clinical pathways to cost the capital required for contemporary DRGs. The model method costs each DRG individually based on government standards for appropriate, sustainable care and clinical standards. It seeks to identify the quality of resources required for appropriate and efficient clinical care.

Australia has multiple state-based adapted systems of capital allocation for hospitals that have not previously been researched. Internationally capital allocation systems for hospitals are rarely researched but are crucial to effective delivery of acute services for patients. As technology and clinical models are changing in the 21st century it is imperative to consider how capital for future clinical services will be funded to achieve the standards Australians expect.

Determining the value of the national capital investment for Australian public hospitals is the focus of this research.

1.2 Purpose and motivation for the study

There are three significant contexts for funding public hospital services. Technological and clinical innovations are providing new modes of diagnosis and treatment redefining what is clinically ‘appropriate’ for hospital facilities, systems and equipment. Secondly, in 2013, the method of funding the recurrent costs of Australian hospitals changed to focus on the patient, their diagnosis and their treatment through activity-based funding (ABF) at an efficient price. Patient-based standards for health care effectiveness were embedded in the Australian system with reporting processes and institutions for monitoring those standards and improved financial sustainability. Thirdly, capital investment in hospitals is intrinsically about future patient health services so capital allocation systems need to also be evaluated for their capacity to respond to dynamic factors including changing patient, technological, clinical and economic circumstance.

This thesis argues that the purpose of capital investment in hospitals is *to fund patient access to appropriate care in efficient hospitals*. However, capital invested to facilitate acute care has not previously been aligned with services or standards, accurately measured or reported. The vision for the work undertaken in this Ph.D. thesis is to establish a system to effectively fund equitable access to appropriate services for patients and to provide access to the necessary tools for clinicians in a manner that enhances efficiency.

1.3 Research question

Capital allocation for public hospitals has been addressed by investigating the prevailing system of capital allocation and comparing it with Australian standards, and then developing a new diagnosis-based model for capital allocation for comparison with Australian standards. The research question “*Can diagnosis-related capital facilitate*

more appropriate, sustainable and innovative acute care?” has been considered in three main areas;

- assessing prevailing systems for investing in hospitals (considered quantitatively and qualitatively),
- developing a clinically-based model to assign capital to patient diagnosis groups and testing the model on high patient volume DRGs, and
- a comparative evaluation of the new model and the current system for investment in hospitals based on the Australian government performance framework (AIHW 2018b) for public hospitals.

Design of the work drew from Australia’s patient-focussed recurrent funding model and government standards for public hospital performance, economic aspects of effective capital funding and the international experience of investment in hospitals (Kerr and Hendrie 2018). The research question was formed to address distributional issues arising from capital allocation in Australia (Kerr, Hendrie and Moorin 2014; Australian Senate Community Affairs and References Committee 2018; Australian and New Zealand Intensive Care Society 2017; Australasian College for Emergency Medicine 2018; Australian Medical Association 2018).

This study creates a model with explicit assumptions and variables informed by a series of literature reviews systematically conducted and designed to fit the decision-making context. Evidence is drawn from health service, health planning, clinical and architectural practice and research. It is a methodological study of funding for hospitals to determine an effective process (in Chapters 5 and 7) and amount for capital funding (in Chapters 4 and 8) for acute hospital services.

Data collection to examine the process and basis for Australian capital allocation systems (Objective 1) drew on literature reviews including targeted searches of official or ‘grey’ literature and interviews with senior officials from each state and territory (collectively referred to as ‘states’ in this thesis) and members of the Australasian Health Infrastructure Alliance reporting to the Australian Health Ministers’ Advisory Council (Australasian Health Infrastructure Alliance 2016). International capital allocation information was drawn from literature reviews, WHO and OECD reports.

Model development (Objective 2) for the capital amount required for each patient episode drew on three sources:

- authorised clinical guidelines identified through literature review, and government standards and targeted searches of official websites,
- Australasian Health Facility Guidelines, and
- interviews with professorial-level clinicians (or those recommended by clinical professors) and experts from across Australia.

Testing of the model and the prevailing system of capital allocation (Objective 3) used the National Public Hospitals Performance Indicator Framework adapted for capital measures from the annual national report on government services (SCRGSP 2018) drawing on data identified from government and other sources based on literature searches and ongoing surveillance. Due to the complexity of this research significant elements of connection in this PH.D. thesis are referenced as (Ch.number.number) to aid connectivity and minimise repetition.

Execution of the three objectives is summarised in the outline of the subsequent thesis chapters and the significance of this research is discussed.

1.4 Thesis structure

Chapter 2 presents the literature review of capital allocation systems, their outcomes and context within health systems. The key themes of capital funding effectiveness, appropriateness, sustainability and innovation are examined. Appendix A expands on these terms and provides a glossary.

Chapter 3 outlines the methodology used to address the research question and the overarching strategy and processes. It links to the more detailed methodological objectives and tasks that preface subsequent chapters. Similarly, discussion of the design, data, and methods used to calculate capital and address the objectives are located at the beginning of each chapter.

Chapter 4 examines the value of capital investment for hospitals services in Australia from 2000-1 to 2018 and assesses the appropriateness and sustainability of funds allocated by states based on the literature and the assessments of national and state health service reviews. An earlier version of this chapter has been published in a peer-reviewed journal (Kerr, Hendrie and Moorin 2014).

Chapter 5 identifies the decision-making processes of capital allocation in Australia, discovering the approaches used in each state for investment in hospitals, medical equipment and ITC. It examines if capital allocations are appropriate, sustainable and supportive of innovation. Appendix B is the questionnaire used for interviews with officials. Appendix C assesses Deeble's finding of the importance of inheritance for hospitals in capital allocation by identifying the origins of prevailing system of capital allocation through a history of capital allocation for hospitals in Australia summarised in Ch.5.3.1. Appendix D contains the responses given by officials to the questions in Appendix B.

Chapter 6 compares approaches to capital funding and distribution between Australia and 17 comparable OECD jurisdictions, analysing which funding systems effectively fund patient access to efficient acute care. Major medical equipment allocation systems are evaluated from evidence for 24 national systems. The capital funding methods, data and results of Chapters 5 and 6 have been published (Kerr and Hendrie 2018). Appendix E contains the methods and data used for the comparative scoring of national capital allocation systems (Ch.6.4.4)

Chapter 7 develops a capital allocation system for Australian public hospitals to meet contemporary health system objectives. A formula for capital estimation and costing was developed. Clinical pathways were capitalised based on clinical and facility guidelines. Semi-structured interviews with medical, nursing and allied health professors from across Australia informed the capital elements required for patient clinical pathways and to support clinical services in the model. From the formula a diagnosis-based model for capital funding based on Australian government and clinical standards was established. The model used to allocate costs to each of the selected DRGs is presented with evidence for the allocations for specialist treatment and investigation areas, various forms of patient accommodation, medical equipment and ICT. Appendix E contains the questionnaires for obstetricians, midwives, orthopaedic surgeons, nurses, physiotherapists, other clinicians and support staff.

Chapter 8 identifies the capital required for clinical pathways for high volume diagnosis groups representing more than one third of Australian patients. The model was tested for proof-of-concept for seven DRGs drawing on the relevant guidelines, standards and literature, expert interviews, and building standards specific to the DRG. A capital cost per patient episode was determined for each DRG based on interview and quantitative evidence for the apportionment of costs. Sensitivity analysis was conducted for each DRG. The relationship between recurrent and capital costs per DRG was assessed. Chapter 8

concludes by outlining how the model could be implemented in Australia using existing governance structures aligned to ABF. Appendix G contains information on additional professorial level experts consulted for verification of information.

Chapter 9 evaluates the effectiveness of the current system and the new model of capital allocation for acute care in Australia. The models are assessed using the standards of the national Public Hospitals Performance Indicator Framework(SCRGSP 2018) adapted for capital allocation. Each system was assessed for equity of access, appropriateness, efficiency, effectiveness, quality, responsiveness to patient requirements, innovation and sustainability. These qualities informed the assessment of the key standards for capital allocation- appropriate, sustainable and innovative funding systems.

Chapter 10 provides the discussion, addressing the broader implications of the research for future acute service funding and delivery and limitations of the research. Recognising the changing technological environment for acute service delivery, implementation and transitional arrangements for the model approach are discussed. The thesis concludes recommending shared Commonwealth-state funding for capital for acute care.

1.5 Significance

Capital funding for acute health services is not well understood(Kerr, Hendrie and Moorin 2014). Public debates have focussed on hospital bed numbers without clear measures of the appropriate investment to achieve the standards expected by Australians and their governments. This study is the first to examine Australian capital allocation for acute care qualitatively and quantitatively¹. Uniquely, it delineates the requirements of a national system for effective acute care capital funding for Australia. It also provides an original design for a purpose-built, evidence-based capital allocation system for Australia. Additionally, this research uses Australian patient diagnosis groups (DRG) and government standards to identify the capital required to support contemporary standards of clinical care per patient. By aligning with ABF funding system, this research has described and defined a comprehensive resource investment for appropriate acute care at the prevailing standard (patient diagnosis group) previously not possible.

Additional original contributions identified for this study relate to governance, quality, patient access, efficiency, innovation and sustainability.

¹ Deebles research did not include NSW hospitals that were 31% of Australian hospitals. He extrapolated from Victorian data.(Deeble 2002a)

Governance: This research has developed a new dynamic and, arguably, universal definition for the role of capital funding namely '*to effectively fund patient access to appropriate and efficient acute care*'. Regular hospital beds no longer encompass the full range of acute clinical care diagnosis and treatment options (Koff 2017). A formula has been developed to identify and include each element of capital required to deliver care. A virtue of the system developed is that it is designed to integrate with existing acute care funding mechanisms including the National Hospital Cost Data Collection(IHPA 2018b)

The model developed in this research offers a new, readily comparable and transparent dollar value for each of the elements that constitute public hospital capital (buildings, MME and ICT). This research permits a system of national governance for capital allocation involving timely, regular, quality-based reporting, national benchmarking and transparency for the first time in Australia. Using standards and clinical evidence as the basis for assessing health capital investment is an original contribution of this research.

Quality: Clinical pathways and guidelines have been identified as mechanisms to reduce clinical error and waste(Quaseem 2012; Australian Commission on Safety and Quality in Health Care 2018b; Gooch 2009; Guerrero 2009; OECD Health Ministerial Meeting 2017). Alignment of capital funding to the DRG provides an original method for the comprehensive implementation of best-practice clinical pathways throughout Australia. Adaption to changing clinical standards is made possible through the alignment of patient-based capital allocations with clinical guidelines, clinical pathways and ABF funding approval mechanisms. Investment would facilitate a suite of recommended resource deployments encouraging appropriate investment but also disinvestment of outmoded models of care, facilities and equipment by defunding obsolescence which has not previously been possible in a depreciation-based system. Changing the emphasis from the heritage of inert buildings to active systems and enabling equipment offers a new funding mechanism for change in the delivery of acute care, including locational change for acute care. Specifying capital resources through government and clinical guidelines by DRG permits monitoring of the quality of investment in clinical equipment, systems and facilities for appropriate patient care for the first time.

The model for capital allocation specifies each of the capital components required to deliver appropriate and sustainable care. This is the first time capital elements have been considered in a linked manner to deliver specific care objectives.

Equitable Access: As a patient-based funding model aligned with ABF this research has developed a mechanism for funding to follow the patient and align to the optimal treatment situation for that patient. Capital funds would support care for patients receiving at-home care and for rural and remote patients.

Australian policy is for universal access for patients to quality care and, for recurrent funds, the Commonwealth and States share in funding that commitment. But for facilities, MME and ICT the responsibility, financial and operational risks are devolved to the states with differing funding capacities. Aligning capital allocation with the successful recurrent cost model permits some problematic acute funding silos to be removed (Kerr, Hendrie and Moorin 2014; Productivity Commission 2017b). This research has developed a new system to deliver shared Commonwealth-state funding responsibility to achieve stated national objectives for patient access. Furthermore, it defines effective investment in terms of the objectives of Australian public hospitals (AIHW 2018b).

The model approach has application in Australia and other nations to enable their defined standards of care to be funded. Similarly, the model and formula can be adapted to estimate capital for specialist hospitals, mental health, emergency care, outpatients, sub-acute and aged care.

Efficiency: The efficiency of traditional arrangements for hospital capital funding has been questioned (Duckett 1995; Deeble 2002a; Garling 2008b; Productivity Commission 2015, 2017b) This study is unique in interrogating acute care capital allocation systems for efficiency and for purposefully researching and consequently designing a system based on the national and international evidence for allocative efficiency.

It has not been possible to determine the technical efficiency of Australian public hospitals or individual hospitals due to inaccurate capital information (Productivity Commission 2009e, 2010, 2015; SCRGSP 2018). So this model does not aim to reimburse existing capital costs. This model provides an opportunity to align the cost of capital required for patients with recurrent costs at the patient, diagnosis, hospital, state and national levels. Analysis of productive efficiency can be achieved with appropriate capital information (Karmann 2017).

Australian access to electronic medical records (EMR) is poor by international standards with higher rates of unnecessary tests and medical errors (Productivity Commission 2017b) This research provides, for the first time, a mechanism to fund the infrastructure for electronic medical records across Australian public hospitals.

Sustainability: Energy and carbon costs for acute care have been considered in this research and can be addressed using the model when suitably robust costing tools are available. Further development of green and life cycle costing data bases has been simulated by this research(Kerr 2019). Systemwide investment in life-cycle costing, waste reduction and energy management are facilitated through this model.

Hospital investment has traditionally been ‘lumpy’ and unpredictable with large infrequent building developments(Deeble 2002a; AIHW 2018d). This model for the first time identifies a steady capital funding system permitting budgeting for progressive continuous improvement based on patient requirement rather than uneven, unequal institutional funding for hospitals (Kerr, Hendrie and Moorin 2014).

Innovation: In the 21st century acute clinical care is expected to continue to expand from the acute hospital throughout the community utilizing a wider range of technologies to achieve health objectives. Hospitals will also be expected to fund and support larger ICT systems and data bases and more technologically-advanced diagnostic, surgical and monitoring equipment with optimum patient security(CSIRO 2018; Williamson 2018; Productivity Commission 2017b; ENISA 2016; Ghafur 2019).A retrospective bed-based system of capital (AIHW 2017f)is not aligned with these requirements. Calls for clinically and technologically appropriate care cite funding challenges (CSIRO 2018; Williamson 2018; Productivity Commission 2017b; Lancet Editorial 2018). This research has addressed these issues and provided a new evidence-based funding mechanism for technological adaption in public hospitals.

This research initiates patient-centred capital costing by DRG for acute care. The tools and model developed for capital funding in this research addresses the challenge of funding appropriate, sustainable and innovative acute care for the future. Chapter 2 examines these concepts and the literature on effective capital funding for public hospitals.

Chapter 2 Literature Review

2.1 Introduction and rationale

Hospitals fund highly-skilled medical specialist, nursing, clinical and technical staff in intricately designed, technology-rich environments. Billions of dollars are invested in public hospital facilities each year to provide treatment spaces for patients, but the total value of the investment is unreported and perhaps unknown in Australia. This research seeks to identify the characteristics of effective capital allocation for hospitals and establish a verifiable capital value to enable the clinical requirements for patient services.

Patients expect access to high quality contemporary care incorporating innovations in technology and clinical care adaption while governments seek to manage costs within economically sustainable levels(Braithwaite 2017).

Effectively funding the facilities, equipment and systems of hospitals involves ensuring funding is appropriate, sustainable and supports proven innovations in clinical care. Within the concept of the effectiveness of capital allocation, three key themes examined are supporting appropriate care, efficiency and innovation(SCRGSP 2018).

2.2 Definitions

Clarifying the meanings of these concepts in relation to capital for acute care:

Capital for this research is defined as dollars *invested to fund patient access to appropriate and efficient acute care*. This definition aims to create a dynamic measure for capital cognisant of contemporary health standards and funding objective. The definition builds from Deeble's definition of capital for hospitals as "the stock of durable goods used in the provision of hospital services (buildings, equipment, etc). 'Investment' is the creation of these goods."(Deeble 2002a) Page 45) Primarily capital expenditure in acute health care is funds provided for items not consumed in the delivery of health services in a year which results in the creation or acquisition of fixed assets (new or second hand)(AIHW 2013b). Typically acute health care is provided in hospitals supported by investment in major medical equipment, building equipment, offices, clinics, parking facilities, landscaping, information technology, communications systems and vehicles. Gross Capital expenditure under accrual accounting principles includes land (AIHW 2005)for healthcare buildings but in this study excludes land and land values in data and analysis in line with prevailing standards. (Productivity Commission 2010; SCRGSP 2013; Productivity Commission

2009e) The IHPA discusses capital to be costed for diagnosis groups as including all assets on the Fixed Asset Registers of hospitals including leased and donated assets but not including unused buildings, teaching, training and research facilities or buildings used for producing products not relevant to patients. (IHPA 2014a)”

More detailed inclusions and exclusions of the definition are detailed in Appendix A Glossary.

Effective identifies whether the outputs of the service or process achieve the stated objectives of the service or process in terms of access, quality and appropriateness(SCRGSP 2018).For capital allocation the outputs are funding patient access to appropriate and efficient patient care.

Appropriate measures how well services meet patient needs(SCRGSP 2018). For Australian public hospitals determination of the appropriate standard derives from government agreements and Australian standards (Council of Australian Governments(COAG) 2011b) (Australian Commission on Safety and Quality in Health Care 2009; Australasian Health Infrastructure Alliance 2004-2018). National standards for appropriate healthcare affirm that all Australians are entitled to equitably access safe, high quality care.(Australian Commission on Safety and Quality in Health Care 2009) Quality of service and contemporary clinical standards are contained within the concept of ‘appropriate.’

Accreditation describes appropriate hospital processes but does not contain measures for facilities (Australian Commission on Safety and Quality in Health Care 2017a).In physical terms the appropriateness of hospital facilities is defined by the Australasian Health Facility Guidelines(Australasian Health Infrastructure Alliance 2004-2018) which are the prevailing standard for construction. There are no other measures of the appropriateness or quality of capital assets (facilities, equipment and information and communications technology) for patient care.

Acute care is used in this thesis to cover inpatient hospital care and acute services provided from hospitals to patient’s homes.

Sustainability is development and activity “that meets the needs of the present without compromising the ability of future generations to meet their own needs.”(Brundtland 1987) Encompassing economic growth, social responsibility and environmental protection the Brundtland definition aims to ensure sustainable development. Within the complex adaptive acute health system, sustainability is aligned with positive patient

outcomes and represented by economic efficiency and environmental sustainability(Asheim 1994; Braithwaite 2017)(Chapter 9.3.5,9.5.7, 9.6.6). In this thesis sustainability is considered for the key phases of acute care capital (capital allocation, facility development and facility management).

Efficiency includes allocative, productive and dynamic efficiency(Productivity Commission 2009e). The capacity of the hospital system to sustain infrastructure, to innovate and respond to emerging needs (AIHW 2018f) in terms of maintenance, renewal and efficiency are established within the national Health System Performance Logic Model(AIHW 2018a).

Innovation in this study means approved evidence-based advances in clinical care to improve patient outcomes, efficiency and costs. (Further definitions of terms used in the research are in Appendix A Glossary.)

2.2.1 Aim

This chapter aims to review the literature on capital funding for acute health facilities for Australia for the central themes of:

1. Effectiveness of capital allocation
2. Capital for appropriate acute care
3. Capital for sustainable costs through efficient acute care
4. Capital for the adoption of innovation in acute care.

2.3 Methodology

As capital funding for public hospitals is usually a government issue, a dual strategy was adopted to (i) systematically review the literature on investment in, or capital allocations for hospitals, supplemented by a (ii) targeted examination of grey literature including government sites and publications, international health organisations, universities and health institutes. Adoption of this strategy aimed to address the scarcity of information on capital funding.

For all chapters searches were in the English language for full-text publications from January 2000 to November 2018 for Chapters 3, 6-10. To address the issue of asset formation and allocation processes in Australia, the literature reviewed for Chapters 2, 4 and 5 were searched for a longer period from 1830 to November 2018. All were searched

using data bases Emerald, Informit, and Medline. These databases were selected due to the specific range of health system literature covered including health planning, health economics, clinical sciences, health architecture and engineering. Initial searches were by title and abstract.

Inclusion criteria for the peer-reviewed literature review were published reports, books and articles published in the peer-reviewed literature on the effectiveness of capital allocation for acute care searching for system-wide approaches to capital funding.

Articles were identified using the search terms:

- ‘capital allocat*’ with ‘hospital*’; ‘capital’ and ‘hospital’, OR
- ‘capital’ and ‘diagnosis related group’, ‘hospital’ and ‘invest*’ OR
- ‘public hospital investment process,’ OR
- “hospital” and “sustain*”, OR
- ‘hospital’ and ‘innovation’ and variants thereof in the electronic databases.

Grey literature searches for the terms –‘invest’, ‘investment’, ‘capital’, ‘effectiveness’, ‘sustain*’, ‘sustainability’, and ‘innovation’ with ‘hospital’ for:

- international organisations including the OECD, WHO, the Commonwealth Fund, the European Health Property Network, the Kings Fund, the Henry Kaiser Family Foundation, and the World Bank.
- university sites examined included, Universities of Sydney, NSW, Queensland, Melbourne, Western Australia, Wollongong, Tasmania, the University of Technology Sydney, Curtin, Monash, Macquarie, ANU, Griffith and Queensland University of Technology. Universities at York, University College London, London School of Economics, London School of Hygiene and Tropical Medicine, Harvard, Yale and McMaster University websites were also examined.
- Institute sites searched were the Grattan, Deeble, Sax Institutes, and the Menzies Centres
- Government websites including the Australian Institute of Health and Welfare (AIHW), Australian Bureau of Statistics, the Productivity Commission, Commonwealth and state health departments and agencies (including the NHMRC, Australian Commission on Safety and Quality in Health Care, the National Health Funding Body, the Independent Health Pricing Authority), the Council of Australian Governments (COAG), the Australasian Health Infrastructure Alliance, the Steering

Committee for the Review of Government Service Provision(SCRGSP), Commonwealth and state parliament sites and auditors-general from the Commonwealth and each state. Australian hospital standards were searched through Commonwealth and state health websites.

- Hospital asset formation and the process for capital allocation before 2000 were searched through the National Library of Australia and the Trove collection, Commonwealth and state parliamentary libraries and websites and hospital libraries and archives.
- The grey literature review found 98 relevant reports and articles for inclusion in the review. The peer-reviewed literature was examined (Figure 2.1) with:
- **Exclusion** criteria were for articles not using capital in terms of the definition: articles on hospitals in capital cities, social capital, intellectual capital or ethical capital in hospitals.
- **Identified** studies were reviewed based on title and abstract (n=869).
- **Screening** of studies had duplicates excluded (n=173). Studies excluded for relevance (n=115) relating to limitations of scope and relevance to Australian health system. These were articles on investment in specialist portions of hospitals. For comparison of acute care high income countries were preference so articles on hospitals in developing nations were examined but were excluded where clinical services were not comparable to Australian hospitals. The range of services for Australia was defined by government standards(NSW Health 2016c; Health Department of Western Australia 2009)
- **Eligibility**- As the aim was to identify studies on capital funding systems for public hospitals, full text articles were reviewed and excluded if only one hospital was discussed, the study related to for-profit hospitals, hospital ownership or private financing, or the studies were focused on portfolio investment strategies (n=419). The reference lists of each item reviewed were also searched for potentially relevant articles.

In total 162 studies were included.

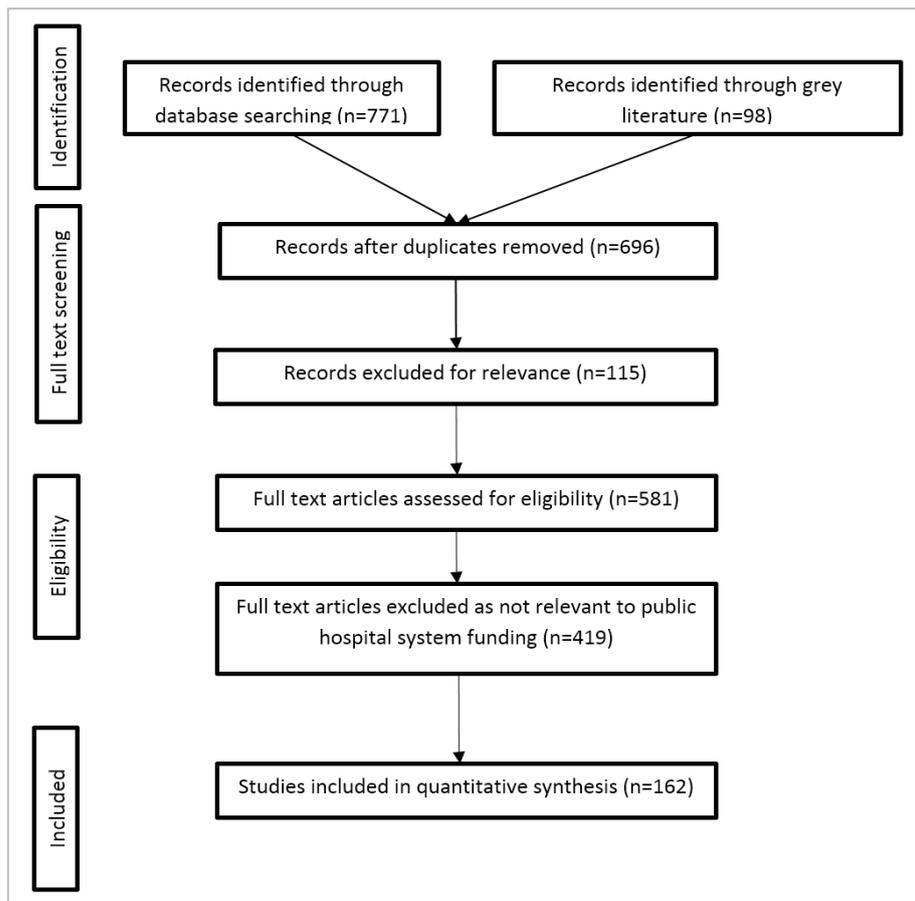


Figure 2.1 PRISMA diagram
(Moher 2009)

In subsequent chapters these parameters are continued for focussed reviews of literature for information and data on:

- the methods for capital allocation in Australia (Chapter 4.3)
- the historic background to Australian systems of capital allocation (Chapter 5.3)
- capital allocation methods of comparable OECD nations (Chapter 6.3)
- model design, clinical standards for specific DRGs and costing indices (Chapter 7.5).

These chapters aim to develop a model for acute care capital allocation with assumptions and variables informed by systematic review and tailored to fit the decision-making context discussed in Chapter 1.

The results of the literature review are presented through the themes of effectiveness of capital allocations (Ch.2.6), appropriate and equitable capital (Ch.2.7), sustainable capital (Ch.2.8) and capital for innovation (Ch.2.9) with the discussion of the key determinants and the impetus for change (Ch.2.10) concluding with a way forward for capital allocation

(Ch2.11). But first some background to the current system (Ch.2.4) and the literature on how capital allocation is assessed (Ch2.5) are presented.

2.4 Background

In the advanced technology environment of hospitals expectations of patients, taxpayers and governments are for the effective delivery of complex services through appropriately funded systems. Australian governments have standards for the performance of hospitals to report on these expectations. The major themes of Effectiveness, Equity of Access and Efficiency are used to evaluate public hospital services(SCRGSP 2018) but not the capital for hospitals. The imbalance of transparency between recurrent and capital funding for patient care dates back 25 years.

Prior to 1993 capital and recurrent funding for hospitals were negotiated between hospitals and state governments. The introduction of casemix funding permitted State Governments to remove their close supervision of inputs and devolve responsibility for most resourcing to the hospitals (Duckett S 1994d). Both Duckett and Deeble argued that rational management of hospitals required them to have the ability to manage their own capital stocks.(Duckett S 1994b; Deeble J 2002a)

Australia continued the change from funding institutions to funding patients by setting the standards, roles, funding and monitoring institutions for Australian hospitals through the National Healthcare Reform Agreement(Council of Australian Governments(COAG) 2011c, 2011a).However capital funding remained a state responsibility, briefly supplemented by a Commonwealth fund for hospital infrastructure (the national Health and Hospitals Fund (2009-2014))(Australian Department of Finance 2013; Australian Department of Health 2012; Australian National Audit Office 2012).

2.5 Assessing capital allocation

Evaluation of capital allocation effectiveness has not matched the scrutiny of recurrent hospital funding through the progress to a patient-based health system. The annual Report on Government Services measures 'Effectiveness' in public hospital services in terms of patient access, appropriateness, service quality and sustainability(SCRGSP 2019). This review of the literature follows that approach examining the effectiveness of capital allocation for patients through parallel themes of effectiveness, equity, appropriateness and sustainability. An additional theme of innovation is included as capital is inherently funding for future patient services(SCRGSP 2018)Figure 9.2).

Effectiveness is reviewed from theoretical, quantitative and qualitative perspectives closing with the attributes of effective capital allocation (Chapter 2.6). The following section draws from the three studies of Australian hospital capital funding, and then considers evidence on the qualities of an effective system of capital allocation from Australian and European studies of capital allocation for hospitals.

2.6 Effectiveness for capital allocation for hospitals

The effectiveness of Australia's system of capital allocation, as a mechanism to fund equitable patient access to appropriate and efficient acute care, has been challenged. Three studies observed a capital allocation system based on political decisions with little reference to economic considerations or operational efficiencies (Duckett 1995; Deeble 2002a; Bridges 2001). Identifying the problems of the system for allocative, productive and dynamic efficiency respectively:

- Duckett found “this has impeded the rational assessment of capital needs.”(Duckett 1995)
- Deeble identified “many health administrators see capital allocation, namely as a competition for funds whose total is fixed by some unfathomable budget process in which political sensitivity, historical precedent and rules of thumb are as important as demonstrated need.”(Deeble J 2002b)
- Bridges queried the capacity of the system to respond to population and technological change(Bridges 2001).

In an institutionally-based system the influence of existing assets on health service development caused Deeble to question the allocative efficiency, equity and effectiveness of capital distribution systems that result in significant investment inequalities favouring major urban hospitals over metropolitan and rural facilities treating similar patients(Deeble J 2002c). He judged capital expenditure to be largely replacement of assets with little funding for new patient services or technological improvement (Deeble 2002a). (Deeble's ground-breaking study is further discussed in Ch.2.5.2) Political risks are associated with capital fund raising and determining appropriate investment (Bridges 2001). However the challenges from ineffective or short-term capital funding relating to efficiency, functionality and flexibility are managed by individual hospitals(Samset 2009).

Duckett argued effective capital allocation would ensure equitable distribution of capital for the same types of patients, maintenance of assets at an appropriate standard and would support the pursuit of efficiency by hospital management (Duckett 1995; Deeble 2002a).

Deeble also championed decentralised decision making for major medical equipment (MME) to enhance efficiency.(Deeble J 2002e) Responsibility for capital was recommended to be at hospital management level rather than the political level. (Duckett 1995; Deeble 2002a; Bridges 2001)

Effective capital funding requires allocative efficiency of capital distribution, operational cost-effectiveness and flexibility to permit dynamic efficiency.(Additionally evaluations of operational cost-effectiveness and flexibility of private finance initiative (PFI) hospitals in the UK identified the affordability of capital as significant(Shaoul 2011; Barlow 2008; Barlow 2010; Hellowell 2012b).

In Europe effective capital allocation has been identified as funding at the hospital level that is:

- timely, flexible and readily available (Hellowell 2012b)
- regular in funding and fairness of distribution (Murray 2001) and
- affordable capital incorporating the cost of capital and the repayment costs over time(Shaoul 2011)

Reviewing the effectiveness of capital allocation in Australia involves assessment of the quantitative capital inputs (2.6.1-2) with a qualitative examination of the outputs (2.6.3) of the prevailing process for the qualities listed above.

“What we measure affects what we do; if our measurements are flawed, decisions may be distorted.” (Stiglitz 2010)

2.6.1 Measuring the effectiveness of capital for acute care

Evaluating the effectiveness of capital allocation in Australia is constrained by the paucity of data (Kerr 2015; Productivity Commission 2009a, 2010; AIHW 2018e)page49). Measures of capital allocations for hospitals were removed from the National Health Performance Framework in 2013 (AIHW 2018f) The publication of information on capital allocated for Australian public hospitals was ceased in 2015(AIHW 2015c).

Accurately measuring capital allocated for acute care is challenging(Deeble 2002a; Steering Committee for the Review of Government Service Provision 1997; SCRGSP 1998, 1999, 2000, 2001b, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016; SCRGSP 2017; SCRGSP 2018). The annual national Reports on Government Services express concern about the valuations of public hospital capital

described as “indicative”, difficult “and “unreliable”. (Steering Committee for the Review of Commonwealth/State Service Provision (SCRCSSP) 1997, 1998, 1999, 2001; (SCRGSP) 2002, 2003, 2004; (SCRGSP) 2005; (SCRGSP) 2006; Steering Committee for the Review of Government Service Provision (SCRGSP) 2007). The Productivity Commission (PC) affirmed NSW Health’s view that “nobody knows exactly how much capital is currently used by public hospitals” (Productivity Commission 2009e)page 303).

Traditionally hospital beds have been used as a surrogate for the value of capital investment in patient services(AIHW 2017f; OECD 2017). However ‘beds’ have diminished in relevance as a measure of investment for the diverse range of diagnostic and treatment services provided for inpatients (Koff 2017; Productivity Commission 2010)page 42) and are particular ineffective in describing the capital resources required for patients (Productivity Commission 2010)page 42) who have lengths of stay of hours rather than days. Similarly, bed numbers cannot reflect the value or nature of investment in enabling technologies such as ICT or MME.

As measurement of capital for acute care in Australia is unreliable, methods used for estimating the cost of capital consumed in acute patient care are reviewed to identify a measure to assess the effectiveness of capital allocation. The value of capital invested in acute care encompasses the inputs, the outputs and how capital is shared (distribution) for the creation of ‘public value’(Mazzucato 2018).

2.6.2 Estimating the value of capital for patient care

Ambivalence surrounds the valuation of capital for acute care. Estimates of the value of capital required for acute care in Australia have been made by Deeble and the Productivity Commission(PC) in conjunction with the annual Report on Government Services(SCRGSP 2018). Their methods for estimating the value of capital, the relationship to patient care, distribution and the reliability of the estimates are outlined in this section.

Deeble sought to create a rule for the cost of capital (as a percentage of recurrent costs) based on the value of contemporary, technologically relevant capital. He questioned if the methods for allocating capital provided sufficiently for maintenance of the functionality of assets, population growth and technological change. Significantly he stepped away from the conventional reliance on depreciated capital value to measure the residual value of hospital assets because the depreciation data is not sufficiently reliable and was meaningless for hospital management. He valued hospital capital elements at the

replacement cost of each element based on the type of hospital for the buildings, for equipment and an average cost per square metre for furnishings and fittings. He noted that based on the 141 hospitals he had reviewed buildings older than 50 years would continue to be used.(Deeble 2002c) Mechanical and electrical systems with furniture and fittings Deeble estimated “account for about 40% of total building cost.” He concluded that “overall the flat rate consumption of building capital was therefore estimated at just under 3% per annum- 2% for the main structures and about 4.3% for the remainder.”(Deeble 2002c)

Deeble’s method of using sample data averages and international standards provided a more effective measure of the cost of capital “annualising, in a regular way, some large and irregular outlays”.(Deeble 2002c) The strength of Deeble’s method is that he defined capital into its constituent and different parts, built up information from the best available hospital-based data sources and established a capital profile at the hospital level. For the first time capital was valued on the national scale in terms of its functional type rather than an estimated total value of purchase price less depreciation. Unequal distribution of capital was found across states and between states (Deeble J 2002c).

The vision and scale of Deeble’s work are valiant but time and the deficiencies of the data may to some extent limit the application of the findings. Deeble’s studies over the 1990s sampled from most States but do not include the Territories or NSW which had 35% of public hospital separations and 36% of public hospital beds at that time. (Deeble 2002c) (AIHW 1997) Also the intensity of technology in hospitals has changed in range, value and volume since Deeble’s seminal work, as has the lifespan of clinical facilities(Sun 2009; Schinko 2016),and the concept of a consistent percentage relationship for technology per weighted patient may not be a constant over time. Expenditure on medical equipment and ICT may have increased in value relative to buildings since the 1990’s.

The Productivity Commission (PC) was directed to analyse the cost of capital for patients in public and private hospitals (Productivity Commission 2009e). Capital costs for hospitals by DRG could not be directly identified ¹ (Steering Committee for the Review

¹ The PC concluded “are no consistent data available on capital costs, such as interest and depreciation for land, buildings and equipment, particularly for public hospitals. Capital costs were consequently not included in the dependent variable nor was a price of capital calculated. This is a problem experienced in other similar studies involving Australian hospitals (Wang, Zhao and Mahmood 2006; Yong and Harris 1999)” page 104(Productivity Commission 2010) (Productivity Commission 2009e). Similarly Gabbitas and Jeffs estimating the productivity frontier in the delivery of public hospital services in Australia found “the data used in this paper indicate substantial variation in the use of capital per casemix- adjusted separations across jurisdictions. Because of the difficulty in measuring capital stocks, it is unclear if these differences reflect actual differences in the use of capital inputs or statistical differences arising from estimation techniques. “ They acknowledge the accuracy of inputs is crucial to the quality of analysis and results.(Gabbitas O and C Jeffs 2008)

of Government Service Provision 1997)so the PC estimated public hospital capital costs based on total state-wide hospital depreciation (of buildings and medical equipment) by the user cost of capital(UCC) minus interest (Productivity Commission 2009e)page 301) The resulting figure was divided by the number of patients (measured as case-mix adjusted separations) and multiplied by an 'admitted-patient cost proportion' also known as the inpatient fraction. The UCC is estimated to be 8% of the value of assets discounted for the cost of interest payments(Productivity Commission 2009a). This estimate is used for the cost of capital per patient by state for the monetary value of public hospital capital for the annual national report on government services(SCRGSP 2018) Unable to trust the capital cost data developed in this method to model efficiency for the national review, the PC reluctantly then used beds as a surrogate for capital, acknowledging major limitations(Productivity Commission 2010)page 42).

Data quality for hospital depreciation is doubted by the Australian Institute for Health and Welfare (AIHW) preventing its publication (AIHW 2017f, 2015c, 2018e) and also by the PC (Productivity Commission 2010)page 104-5). The capital cost estimate used in the annual report to government may therefore be compromised by the quality of the source data. The cost of capital is required to assess the full cost of delivering patient care and as a measure of the efficiency of hospitals(SCRGSP 2018).

While national annual reports on public hospitals seek to estimate capital cost per patient (SCRGSP 2018)they are restricted in estimating the productive value of the capital supporting efficient patient care due to five issues relating to appropriateness. Firstly, patient care assessment is now aligned to DRGs while PC costing remains institutionally based. The DRG system is patient outcome and process focussed acknowledging there are different resource requirements for different DRGs. Secondly, hospital depreciation data is aggregated to the state level for buildings and medical equipment. While the PC acknowledges that different bed types have different capital inputs (Productivity Commission 2010)page 42) extending those costs to all patients in a hospital class (drawing on Deeble's approach), they were not able to assess individual hospital costs or patient services (Productivity Commission 2010; Deeble 2002a). Thirdly, the quality of the top-down costing estimate for capital for patient care does not align with the detailed costing used to inform the Efficient Price for acute care derived from the national Hospital Cost Data Collection(IHPA 2018b, 2017c). Fourthly, the measures do not allow for different levels of capital intensity or specificity for DRGs. Finally, the depreciation-based method assumes accuracy and the perfect distribution of assets between all patients and

that previous decisions about asset purchases remain clinically relevant over time. The results of the following qualitative studies (Ch.2.6.3) would not support this assumption.

2.6.3 Qualitative assessments of capital allocation effectiveness

Major health service reviews examining patient access, equity and quality issues have consistently identified the need for additional capital allocations to improve delivery of acute healthcare(Reid 2004; Forster 2005; Garling 2008b; Menadue 2003; Richardson 2004; Bansemer 2014; Travis 2015; NHHRC 2009). Capital allocation processes for hospitals have been criticised for not delivering capital aligned to contemporary patient care (Forster 2005; Garling 2008b; Australian National Audit Office 2012; Menadue 2003; Kerr and Hendrie 2018; Leggat 2008) Reviewers argued the stock of capital assets was not supporting the effective and efficient delivery of care² advising a greater alignment of investment in assets with the objectives of health service delivery was necessary (Forster 2005; Garling 2008b; Reid 2004; Menadue 2003; NHHRC 2009; Richardson 2004). Capital has not been a demand driven health expenditure and Deeble argued it has been capped at below replacement levels across the health system(Donato 1998; Deeble J 2002f) The state and national reviews consistently identified inadequacies in existing capital assets limiting the appropriateness of the depreciation method of estimating capital costs for contemporary patients(Bansemer 2014; Garling 2008b; Forster 2005; Menadue 2003; NHHRC 2009; Productivity Commission 2009e; Reid 2004; Richardson 2004; Travis 2015; Australasian College for Emergency Medicine 2018; Australian and New Zealand Intensive Care Society 2017; Australian Medical Association 2018).

If the Australian depreciation-based value for capital is not appropriately measuring the capital required for contemporary acute care per patient and reviews have persistently found capital allocation was not effectively supporting patient care, what does the literature recommend for capital allocation?

² “Many past capital investment decisions have been questionable, leading to health service facilities that are not fit-for-purpose or support efficiency in infrastructure and health service delivery”(Forster 2005)page xxi) “...it seems to come as something of a surprise when a piece of equipment needs replacement, whether it is because of changes in medical technology or the equipment can no longer be repaired or the equipment has become unreliable by reason of its antiquity. There does not appear to be any routine budgeting for equipment replacement. “(Garling 2008b)1.198)

2.6.4 Attributes of effective capital allocation

The literature delivers ten compatible objectives for effective capital funding for acute care including:

- Duckett's goals of *(i)* equitable distribution of capital for the same types of patients, *(ii)* maintenance of assets at an appropriate standard and *(iii)* supporting the pursuit of efficiency by hospital management(Duckett 1995).
- European research conclusions that capital should be *(iv)* timely, flexible and readily available (Hellowell 2012b), *(v)* regular in funding and fairness of distribution (Murray 2001) and *(vi)* affordable capital incorporating the cost of capital and the repayment costs over time(Shaoul 2011), and,
- Conclusions drawn from Australian reviews, research and reports for *(vii)* alignment with the contemporary Australian clinical standards *(viii)* based on verifiable data *(ix)* sustainable and *(x)* at the patient level(Productivity Commission 2009a, 2010; Forster 2005; Garling 2008b; NHHRC 2009)

An effective system of capital allocation for Australia would need to deliver capital for appropriate *(objectives i, ii, vii, viii, and x)*, sustainable *(objective iii, v, vi and ix)* and innovative services *(objective iv)*. The literature on role of capital in facilitating these themes is examined in the following sections.

2.7 Capital for appropriate healthcare

Connected to the unresolved issues of the value of capital for public hospital patient care is the expectation of Australian people, patients and governments, that capital funding is appropriate for contemporary clinical care.

Appropriate care has been defined within a universal entitlement to access safe, high quality care(Australian Commission on Safety and Quality in Health Care 2009; Council of Australian Governments(COAG) 2011b) National funding for the recurrent costs of appropriate care is through Activity-based Funding(ABF)by patient diagnosis group however there is no national funding to cover the capital cost of delivering appropriate care(IHPA 2017b).

Appropriate care is measured as effectiveness, equity, efficiency, responsiveness, access, quality, safety, continuity, capability and sustainability in National Health Performance Framework (AIHW 2018f; Duckett 2015; SCRGSP 2018). Public hospitals are also

expected to provide care that is timely, coordinated and equitable.(SCRGSP 2018)page 12.6) While recurrent expenditure for patient care is measured for these standards, capital investment is not measured. No research on the key dimensions of (timeliness, responsiveness, equitable distribution, continuity and efficiency) capital distribution relative to contemporary care in Australia was identified. Crucially the national Public Hospital Performance Indicator Framework has no measure to assess appropriateness for public hospitals (SCRGSP 2018).

Within the concept of capital appropriateness there is an expectation that all acute facilities and equipment are fit-for-purpose, safe and well maintained(Australian Commission on Safety and Quality in Health Care 2017b) Yet there is no measure for assessment of the fitness-for-purpose of capital invested in facilities, MME and ICT as accreditation no longer assess these assets(Australian Commission on Safety and Quality in Health Care 2017a). There is no national measure for the appropriateness or quality of assets for patient care after construction.

Building standards referenced as appropriate by the Australian Commission on Safety and Quality in Healthcare are for the Building Code of Australia (Australian Commission on Safety and Quality in Health Care 2017b) covering all Australian construction rather than the standards developed for Australian hospitals. The Australasian Health Facility Guidelines (AHFG) are supported by all states and referenced internationally(Australasian Health Infrastructure Alliance 2016l; Shafie 2009) .The AHFG as a peer-reviewed, clinically informed facility guideline is specific to appropriate hospital standards in Australasia.

The literature suggests that capital for appropriate clinical care is not measured, funded or assessed in Australia although National Health Performance Framework and the AHFG provide potential mechanism for scrutiny of appropriateness and ABF a potential method of funding.

2.7.1 Diagnosis Related Groups (DRGs) for appropriate funding

Appropriate acute care for patients in Australian hospitals has primarily been funded through diagnosis related groups since 2013. DRGs have been refined as tools for funding hospitals with the capacity to drive change at the clinical level (Eagar K 2008) to achieve efficiency(Duckett 2018a). The National Centre for Classification in Health (NCCH) specifies that the “AR-DRG Classification System needs to be developed with maximum

regard to the clinical needs of the patient”(Australian Consortium for Classification and Development 2016) The absence of capital funding in Australian DRGs means some clinical requirements (equipment, ICT and facilities) are unsatisfied by DRG funding(IHPA 2017c).

Capital payments aligned with DRGs have been studied in Europe. Busse, Schreyögg, and Smith describe the careful balance necessary in funding for clinical services to encourage efficient delivery of services and exclude unnecessary services. They argue DRG costing needs to be clinically and economically meaningful, align with social objectives and accurate (Busse 2006).

O’Reilly et al found that Finland, Ireland, France, England and Germany had similar objectives to improve patient services and efficiency in hospitals. They argue that excluding capital costs in Ireland and Germany, in the initial phases of ABF, was appropriate for hospitals to gain better control over their cost structures and particularly for the planning of new facilities and equipment. They note that in England, Finland and France capital costs have been included in ABF payments from their inception. (O’Reilly et al. 2012a)Examining the cost data definitions and the detail of pricing across nine EU members (Denmark, France, Germany, Hungary, Italy, the Netherlands, Poland, Spain and England), Schreyögg et al conclude that DRG systems need to take new technologies into account as part of their depreciation-based systems which would otherwise repel innovation acknowledging the vital importance of incentives for the adoption of new technologies.(Schreyögg J 2006) Germany subsequently developed DRG funding for capital costs linked to facilities management systems(Vogl 2014; Lennarts 2009) The adoption of DRG capital funding in Germany improved the quality and cost effectiveness of hospitals. Information on capital costs and technological progress have enabled detailed evaluations of individual hospitals and regional efficiency(Karman 2017).

However, effective capital funding and funding associated with DRGs may raise costs for governments prompting consideration of the sustainability of capital funding.

2.8 Capital for sustainable acute care

Sustainability is a significant issue for health care and there is strong focus on hospital costs and sustainability(Boxall 2011; Asheim 1994; Health and Human Services Tasmania 2015, 2016; Hockey 2014; Kaplan 2012; Kruk 2018; OECD Health Ministerial Meeting 2017; Thomson 2009; UK National Audit Office 2015; WHO Regional Office for Europe

2017; Victoria Health and Human Services 2018b). Drawing on the Brundtland definition (Chapter 1 Appendix A Glossary)(Brundtland 1987) sustainable care in this domain encompasses economic sustainability (allocative, productive or technical efficiency and dynamic efficiency) (Productivity Commission 2009e)and environmental sustainability. First asking is there a sustainable method of investment for public acute care (Ch.2.8.1), the literature on sustainability is presented for the capacity of capital to enhance operational effectiveness and efficiency (Ch.2.8.2). The literature on the constituent elements of efficiency, allocative (Ch2.8.3), technical or productive (Ch2.8.4) and dynamic efficiency (Ch2.8.5), are separately presented preceding the literature on capital and environmental sustainability (Ch2.8.6).

2.8.1 Investing in sustainable hospital services

Authorities note there is almost no research on investment systems for hospitals (Rechel 2009b; Ettelt 2008; Ettelt 2009). Identifying the current challenges of capital investment for acute service delivery the European Health Property Network raise the importance of connectedness and communications for hospitals within the health system, flexibility to align with functional changes within the changing context for hospitals. (Rechel 2009b) They identify that capital investment strategies continue to lag behind service delivery standards particularly for innovation, responsiveness and measurable value (Rechel 2009b)page 20). They recommend hospitals should be furnished with highly flexible spaces in the absence of a way of relating capital expenditure to future hospital requirements. Their architectural analysis uses physical solutions to respond to the problems of uncertainty or ineffective capital allocation(Rechel 2009b).

2.8.2 Capital to enhance hospitals operational effectiveness and efficiency

Building efficiency

Research in Europe and the USA on capital and funding for hospitals has focussed on reducing waste and costs in facilities and enhanced operational efficiency. To reduce waste clinical pathways as “the optimised sequence of interventions by healthcare workers in response to a diagnosis” (Lennarts 2009)page 140) have been evaluated for use in German hospitals for allocating recurrent costs and are used in determining overheads for facilities management (FM) costs. Optimizing processes in hospitals (OPIK) sought to test the relationship between medical services and facility management costs to create benchmarks

for FM costs for specific areas. Benchmarking of hospital costs identified areas for savings and fixed cost areas. Lennart's research sought to activate Facility Management costs as a component of DRGS to align incentives for clinical and non-clinical staff with service quality and cost minimisation(Lennarts 2009).

To enhance building and facility efficiency, differential lifecycle costing of hospitals by functional area was pioneered by the Netherlands Board for Healthcare Institutions studies outlining the 'layers approach' to hospital building. By dividing hospital functional areas into hotel, 'hot floor'³, office and industry they used a property approach to determine the lifespan, technical specificity, flexibility and ultimate marketability or disposal value of hospital components. Benchmarking of functional areas and costs was achieved through the Netherlands using shared data. This was another architectural study considering building massing to balance healthcare processes with construction and property management costs(Netherlands Board for Healthcare Institutions 2007a).This research informed the approach taken in Chapter 7.

Three US professors⁴ advise that American research on the relative costs of hospital building design, construction and operation has relied on the MacLeamy Curve for the ability to influence building lifetime functional costs by enhanced design research and informed design interventions(American Institute of Architects 2007). The curve includes additional design and research time to manage project uncertainties harnessing design and communications technology advances including Building Information Modelling(BIM)to support simultaneous design for architecture, engineering, quantity surveyors and construction professionals(Talebi 2014). BIM is standard for major hospital projects due to their functional complexity. Evolution of comparative building to function costing involves life-cycle costing of buildings incorporating energy and operational costs (Fuller 2016). This vein of research argues that expanding BIM design time supports improved levels of project research and reduces project uncertainty with direct links to on-going facility management and lower life-cycle costs(Rechel 2009b)page 259).

These studies frame the intrinsic research conundrum of the effect of capital investment on the operating costs of hospitals. The research above addresses costs associated with management of the hospital building over its life-cycle but there are larger cost

³ Containing operating theatres, labour- delivery rooms, ICU, CCU,HDU, imaging and cardiac catheterisation labs.

⁴ Advice from Prof. Kirk Hamilton, A. Prof. Zofia K. Rybkowski, and Prof. Ray Pentecost III specialists in health facility design of the College of Architecture, Texas A&M University and Mr Cliff Harvey, Chief Planning officer Canada and President of the Union of International Architects-Public Health Group.

implications from the recurrent costs associated with the operational efficiency of acute care to patients.

Sustaining acute care efficiency

Capital investment to enable sustainable health care can align with operational objectives to support improved functional relationships as at Rhön-Klinikum where on-going financial benefits were achieved through improving nurse effectiveness and reducing nursing costs from increased, targeted capital investment (Bjorberg 2009).

Enhanced alignment between clinical and operational objectives and capital investment these authors argue can provide improved operational effectiveness (Lennarts 2009; Rechel 2010a; Rechel 2009b; Bjorberg 2009) enhancing sustainability. Uncertainty regarding the hospital design brief, in a volumetric system, covers many assumptions including estimates for the number and type of patients over the lifespan of the hospital building, regarding the levels of functionality versus flexibility in hospital spaces, models of care and levels of patient acuity, projections of technologies and ICT systems(Lancet Editorial 2018). Clinical operations are set for many years by these assumptions and projections which are literally set in concrete. Samset and Dowdeswell found that hospital projects that emerge as a result of politically-expressed needs involve a range of stakeholders in decision-making providing short-term tactical benefits for political stakeholders at the expense of the longer-term strategic focus(Samset 2009).

It has been observed that a DRG-based capital allocation system has the potential to provide detailed objective patient and facilities data required for hospital building projects. Using DRG-based capital cost allocation, the Dutch ‘layers approach’ to optimize functional building relationships and BIM technology, a range of capital uncertainty issues such as flexibility of area versus functionality can be resolved with reference to clinical pathways and DRGs as in the German FM system(Lennarts 2010).

2.8.3 Allocative efficiency

Of the three aspects of efficiency, allocative or distributive efficiency is the most relevant to capital allocation for acute care. Productive or technical efficiency (2.8.4) and dynamic efficiency (2.8.5) are dependent on allocative decisions in healthcare. The values for allocative decisions have been identified (AIHW 2018b; SCRGSP 2018)(Ch.2.1) and this section reviews the literature on valuation of acute capital and the allocation processes for allocative efficiency.

Values

Little is published on the allocative efficiency of systems for capital allocation for acute care although billions of dollars are invested in annual capital allocations for healthcare (AIHW 2018d; SCRGSP 2019)Table 4.2). Allocative efficiency is expected to ensure capital is distributed between Australian hospitals to provide access for Australians to appropriate and efficient clinical facilities and equipment.

Traditionally bed numbers per 1000 population have been regarded as a measure for allocative and technical efficiency for hospital capital (Cylus 2017; Productivity Commission 2010; The Henry Kaiser Family Foundation 2015; Koff 2017).However the bed-based measure is an insufficient measure of diagnostic and treatment resources(Travis 2015), major medical equipment and ICT(Lee 2012) (Victorian Auditor-General 2015)(Ch2.6.1)and fails to capture the uptake of technology over time(Productivity Commission 2009c). Beds as a single measure are no longer directly comparable in all hospital settings due to varied resource intensity associated with casemix, technologically-specific bed use (for example ICU, and high dependency unit beds compared to sub-acute beds, short-stay observation beds, chairs, cots and hospital-in-the home places), and varied reporting, classification and counting practices(Australian Institute of Health and Welfare 2016; Productivity Commission 2010)page 42).

In this thesis allocative efficiency for capital aims to identify the value of capital, and the optimal process for capital distribution, required to achieve the outputs defined for acute care with the minimum waste. This approach to find allocative efficiency for capital in acute care is derived from three definitions of allocative efficiency:

- to determine the optimal choice of inputs, given their relative prices, to achieve cost effectiveness for the determined outputs with specified quality and quantity(Evans 2000).
- ensuring an optimal allocation of resources to yield the same level of marginal benefit from each dollar across health programs.(Duckett 2015)page 9)
- assessing the input combinations to achieve the correct mix of healthcare outputs including the optimal combinations of labour and capital (Cylus 2017)

Allocative efficiency measures for hospitals have been assessed as capital that is:

- timely, flexible and readily available (Hellowell 2012b),
- regular in funding and fairness of distribution (Murray 2001) and

- affordable to the hospital (Shaoul 2011).

Australian studies have also identified data transparency, process effectiveness and patient focus as important to allocative efficiency (Productivity Commission 2009a, 2010; Forster 2005; Garling 2008b; NHHRC 2009; Deeble J 2002f). The following section reviews the literature on the allocative efficiency of the prevailing process for capital allocation.

Process

National and state health reviews and other studies have identified system deficiencies in hospital capital allocation processes as previously discussed (Ch2.6.3)(Leggat 2008; Rolfe 2017; Reid 2004; Menadue 2003; Garling 2008b; Forster 2005; Richardson 2004; Bansemer 2014; Travis 2015; NHHRC 2009; Productivity Commission 2009e, 2010; Australian Senate Community Affairs and References Committee 2018; Eyles J 1985).

Deeble was the first to address the allocative effectiveness of capital for acute care by the type of hospital for Australia. He found hospitals did not receive capital that was efficiently or fairly-distributed. The prevailing method of capital allocation was timely and readily available for politically-connected hospitals but lacked equity for all hospitals particularly rural hospitals (Deeble 2002a; Tudor Hart J 1971) Aligning capital with the effective functioning of a hospital was an appreciable advance as was identification of medical equipment allocation by estimated the value and then weighting the equipment value “according to the separate capital output ratios.”(Deeble 2002a)

Meanwhile the values in acute care have changed from funding the hospital to the patient and no studies were found on capital allocative efficiency at the patient level.

2.8.4 Productive or technical efficiency

Critical to the role of capital in supporting sustainable acute care is the ability of capital to improve productive efficiency in clinical services. Studies of investments to improve patient outcomes, reduce length of stay and decrease pharmaceutical and staffing costs have been incorporated into evidence-based design for hospitals(Ulrich 2008b, 2008a; Sadler 2011; Sadler 2009; Berry 2004; Dodswell 2009; Ulrich 2007). However the role of capital in improving the productivity and technical efficiency of hospitals is rarely considered(Rumbold 2015). When capital has been included in estimates of productive efficiency using Data Envelope Analysis, beds are used as an imperfect surrogate for capital in Data Envelope Analysis and Malmquist Total Factor Productivity

analysis(Medeiros 2015; Productivity Commission 2010; Evans 2000; Murray 2001; Tandon 2002; Hollingsworth 2003; Hollingsworth 2008b; Wenzl 2017; Gabbitas 2008) .

However, including accurate capital values for (*Total Factor*) productivity estimates permits analysis for quality and output quantity of acute services and comparisons across systems including improvements in efficiency and technological progress. In one study capital investment in hospitals proved beneficial for increasing quality and productivity in West Germany but not in recently modernised East Germany(Karmann 2017).Comparable, comprehensive and consistent capital information enabled detailed economic evaluation of productivity, technological progress, investment options and reimbursement policies including the adoption of ABF (Karmann 2017). With an accurate figure for capital and technological investments productive efficiency can be assessed at the DRG level, the hospital regional and national levels. The effect of capital investment could be assessed for enhancements to labour productivity, for policy changes and reimbursement methods informing questions of the financial sustainability of acute care(Thomson 2009; Birch 2015b). Studies have identified improved staff productivity from decreased sick days and higher staff satisfaction associated with enhanced design of health facilities linked to sustainability principles(Laski 2018; Green Building Council of Australia and the New Zealand Green Building Council 2019).

Across Europe capital investment to buttress and promote efficiency were deployed during the Global Financial Crisis austerity to support systems moving patients out of hospitals, ehealth and better information systems (Thomson 2014). These are areas the PC has identified as deficient in the Australian health system(Productivity Commission 2017b)

2.8.5 Dynamic efficiency

A sustainable health financing system manages planned and unplanned patient requirements. Dynamic efficiency examines how well systems for the distribution of capital respond to emerging risks for public hospitals. Clinical and technological change provide uncertainty posing financial risks and opportunities to improve efficiency, patient treatments and quality. Additional uncertainties from policy or funding changes, patient number increases, environmental challenges, epidemiological and population variations such as chronic disease compound the complexity(Duckett 2008a).

Evaluating investment strategies for policy responses to uncertainty, change and innovation encourages dynamic efficiency analysis(Tremblay 2012). Abel considered the

role of capital, technological change, growth, uncertainty on efficiency at the national economic level (Abel et al. 1989). Duckett applied the theory specifically to health defining dynamic efficiency as the extent to which the healthcare system adapts to change and innovation (Duckett 2008b). The NHHRC recognised the significance of evidence-based innovation, clinical and technological improvements recommending a health system with a continuous culture of dynamic efficiency or reform that is agile and self-improving. (NHHRC 2009)page 121)

Health outcomes suggest access to acute care may be regarded appropriate for many Australians However access to technologically advanced diagnostics is not universal (GBD 2016 Healthcare Access and Quality Collaborators 2018; Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017). Access to 20th century technologies for rural and outer metropolitan patients is poorer than for other Australians (Australian Senate Community Affairs and References Committee 2018) Indigenous Australians also have poorer access to advanced treatment options (AIHW 2018c; Walker 2014)

Acknowledging the importance of patient information systems and the technological innovations that can bring costs down over time, the PC recognised that the institutional and funding structures compromises performance and dynamic efficiency (Productivity Commission 2015) However no analysis of dynamic efficiency in Australian acute care has been identified.

2.8.6 Environmental sustainability

The third element of sustainability is environmental sustainability. OECD ministers, medical groups and WHO have identified environmental risks as a growing challenge for healthcare. Two aspects of environmental sustainability are significant for acute care: (i) changes in epidemiology and climate-related illness and (ii) managing hospitals to reduce their carbon footprints, water and energy consumption and optimise waste management.

To manage population health risks associated with climate change European nations found ‘green health systems’ are essential for sustainability (WHO Regional Office for Europe 2013). Epidemiological changes (reflected in patient demand) experienced in acute care will require adaptive and dynamic systems supported by effective capital allocation.

The challenge of sustainable hospitals has been met with systemic and individual hospital approaches. In the UK the NHS sustainable development plan anticipates carbon

restrictions and higher efficiency requirements for hospitals(NHS Sustainable Development Unit 2009). The UK National Audit Office questioned the resilience of traditional hospital infrastructure to manage the impacts of climate change(UK National Audit Office 2015).

The task of reducing carbon emissions has been identified. Australian healthcare is estimated to generate 7% of national carbon emission with 34% of that from public hospitals. Expenditure on health buildings has been estimated to generate an additional 8% of total health emissions (Malik 2018).The Commonwealth Fund identified similar costs in the USA with health estimated to be 8% of greenhouse and 7% of carbon emissions(Kaplan 2012). The NHS carbon footprint is of the order of 3% of the total UK carbon footprint with building energy at 17% of NHS energy use (UK National Audit Office 2015).

Strategies are in place for reducing carbon emissions, improving procurement, decreasing waste and energy costs in Europe, the UK, and the USA(Kaplan 2012; WHO Regional Office for Europe 2013, 2017). Considerable risk is posed by climate change for Australia (Hanna 2018)yet there are no national strategies for reducing carbon emissions across Australian hospitals although some policy and a range of individual exemplars exist(Desmond 2017; Burger 2010; Victoria Health and Human Services 2018b; Queensland Health 2017b; NSW Health 2016d). A study of exemplars drawing on the international experience found fewer than one percent of 2,000 Australian Greenstar-certified projects were in healthcare and most were offices. They identified hospitals typically used more than double the energy and six times the water per square metre of an office block finding sustainably designed and engineered hospitals achieved energy savings of up to 40% (Sunshine Coast University Hospital) and used 20% less water usage (the New South Wing of Flinders Medical Centre in South Australia) or saved potable water usage from gardens through rainwater tanks (Austin Hospital's Olivia Newton-John Cancer Wellness & Research Centre)(Green Building Council of Australia and the New Zealand Green Building Council 2019).

The PC considered governmental intervention appropriate in relation to climate change as externalities had arisen and the market had failed to deliver prices to achieve a sustainable allocation of resources. Capital stocks including natural capital they argued should be measured and valued (Markulev 2013). In the absence of a national policy for environmental sustainability for hospitals(Hanna 2018), an Australian Health Facility Guideline addressing energy, waste and carbon emissions for hospitals has been developed

in compliance with AS/NZS ISO 14000 : Environmental Management Standards for use at construction.(Australasian Health Infrastructure Alliance 2016k)

Sustainability

The literature has identified a role for capital in acute care to enhance sustainability through allocative, productive and dynamic efficiency and to facilitate aspects of some measures for environmental sustainability for acute care. Studies of capital allocation for sustainability have not been identified. Key attributes for capital allocation were investment for productive efficiency, communications systems for hospitals within the health system, and flexibility to align with functional changes within the changing context for hospitals. These were identified as significant for sustainable acute care (Rechel 2009a; Thomson 2014).

Flowing from dynamic efficiency required to sustainably meet the changing environment for acute care, the capacity of a capital allocation system to fund and enable innovation in acute clinical care is reviewed.

2.9 Capital for innovation

Economic Growth Theory recognised that inelastic growth of capital does not lead to productivity improvement(Solow 1956) Technological change and innovation improve productive outcomes by substituting capital for labour and through the elasticity of substitution minimising the risk of diminishing marginal productivity from capital(De la Grandville 2016). Economic Growth theory is based on firms competing to increased income through innovation(Aghion 2016). Competition, profits and innovation however are exogenous to public hospitals so, unlike firms, a mechanism to introduce innovation is required to minimise the risk of decreasing productivity.

For acute care ‘Innovation’ covers a wide range of medical technologies, clinical procedures, equipment, support and organisational systems and can include changes to place of treatment or model of care(Quentin 2011). As this thesis focusses on capital for acute care it is assumed, that prior to consideration of capital funding, innovative technologies, equipment and processes have approval granted through:

- Commonwealth National Technology Assessment (NTA),
- clinical quality and safety
- funding approval for the DRG recurrent costs.

From the literature, a capital funding system characterised by equitable access, a consistent approach, transparent data, systematic decision-making, supported by high quality analysis and benchmarking is desirable. Beneficial innovation would be clinically relevant and consistent with the values of healthcare(Phillips 2019a) . Funding at the national level for capital in the transitional, short-term and longer term have been identified as preferable (Wernz 2014; Productivity Commission 2015).

Several modes of innovation and technology funding exist in the USA and Europe including DRG funding, short-term and long-term allocations to hospitals, outlier and special payments. These cover all costs of care in most cases but in Austria, Finland, Germany and Ireland exclude capital costs. Special payments were used to fund Electronic Medical Records (EMR) in the USA. New technology funding within the DRG poses challenges for costing (as DRGs are based on historic costs) and weighting. Separate payments for technology introduction and on-going performance may be less disturbing to DRG efficiency incentives (Quentin 2011). Most nations have a form of funding for new technologies (Quentin 2011; Wernz 2014).

In Australia there is no program for funding the capital component of innovation in acute care. Advances including the My Health Record exclude capital payments for public hospitals(Australian Digital Health Agency 2018). State health department innovation funding programs do not include capital funding(NSW Agency for Clinical Innovation 2014; Victoria Health and Human Services 2018a; Queensland Health 2017a; WA Department of Health 2013).

Additional funding for the adoption of technologies such as Electronic Medical Record (EMR) cost was deemed appropriate from evidence for improved patient care and decreased wasteful expenditure (Productivity Commission 2017b)page 73). However, data integration is impeded by the absence of Commonwealth as a partner(Productivity Commission 2017a). The PC identified that acute care funding is not oriented towards innovation or improved outcomes and continues to fund outdated systems and technologies with inadequate data and information flows(Productivity Commission 2017b).

The availability of funding has been identified as critical to supporting innovation (Quentin 2011)in Australian hospitals however there are structural barriers including misalignments in policies and financing at many levels including between States and the Commonwealth. The critical areas of health information systems was judged to be below

the standards of comparable industries as an example of innovation failure(Dwyer and Leggat 2002; Productivity Commission 2017a).

Anticipated in the early 1990's EMR have been slow to materialise in Australia. Described as Australia's first digital public hospital Prince Alfred Hospital installed EMR in 2015 with transitional issues between 30 year old systems and EMR, problems with e-prescribing but improved visibility of patient data, particularly real time monitoring equipment (Sullivan 2016a).

The absence of contemporary information systems is acknowledged as causing patients harm arising from patient transfers, primary to acute information flows, non-adherence to treatments and poor engagement with chronic disease. Digital opportunities offer improved clinical, quality and economic outcomes(Productivity Commission 2017a; Tan 2018). A range of emerging technologies offer clinical improvement that are appropriate, sustainable and fit with clinical requirement(Tan 2018; CSIRO 2018).

The process for funding the capital required for the implementation of next generation of technologies (Joe 2013)including, but not limited to, artificial intelligence (AI) as a clinical aid(Sampler 2018; Dewey 2018), wearable devices with real-time physiological outputs(Productivity Commission 2017b; Phillips 2018; CSIRO 2018), Big Data(Productivity Commission 2017a; CSIRO 2018), precision and genomic medicine(Williamson 2018; CSIRO 2018) in Australia is not evident.

2.10 Discussion: Key determinants and the impetus for change

This section discusses the main themes of capital allocation- effectiveness of capital allocation (2.10.1), appropriate and equitable capital (2.10.2), sustainable capital (2.10.3) and a system for funding the capital component of innovation (2.10.4)- followed by conclusions (2.10.5) and limitations of the review (2.10.6).

2.10.1 Effective

The theoretical basis for capital allocation to enable clinical services is at once explicit and invisible.

Australia's standard in health is for universal entitlement to access safe, high quality care(Australian Commission on Safety and Quality in Health Care 2009; Council of Australian Governments(COAG) 2011b) at an economically sustainable level. However, the value of the capital allocation to enable contemporary standards of clinical care is

invisible and without theoretical framework. The objectives and values of the Australian system of capital allocation could not be identified from government documents or from other studies. Nor could the theoretical basis for capital allocation for acute care be determined from the allocation decisions of the system, the outputs in terms of patient services, or how capital is shared between hospitals for patient care. In the absence of accurate information, it cannot be determined that public value commensurate with public expectations and standards has been created. Estimates of value based on depreciation or old bed-based measures are unable to specify inputs, connect inputs to outputs (in terms of patient outcomes) or illuminate issues of distribution for the public good (Mazzucato 2018).

Quantitative estimations of the cost of capital consumed in providing contemporary patient care have been found to be unsound for methodological and data accuracy reasons (Ch.2.6.1). As there have been no studies of capital for acute care in Australia since 2002, qualitative evidence in this century is limited but encompasses patient and health service needs nationally and of each state at particular times (Ch2.6.3). Cumulatively, the qualitative results diminish confidence in the depreciation-based estimates for capital used in acute care as each state or national review of clinical care recommends additional capital investment or expresses concern about the capital data(Ch2.6.2). If the quantum or distribution of capital for acute care remains insufficient a depreciation-based system of capital cost estimation either compounds or ignores distributional issues.

There is no evidence from the literature that Australia has a framework for effective capital allocation or assessment to enable public value and national standards to be achieved. Further research is required to determine if the composite of state capital allocation processes provides a nationally consistent framework for capital allocation for acute services delivering patient access to appropriate and efficient care.

However, the review of the literature has produced nine compatible attributes of an effective capital allocation system from Australian and European research:

- i. regular and equitable distribution of capital for the same types of patients for fairness of distribution (Murray 2001)
- ii. maintenance of relevant assets at appropriate standards aligned with contemporary clinical standards
- iii. supporting the pursuit of efficiency by hospital management(Duckett 1995)
- iv. timely, flexible and readily available capital funding(Hellowell 2012b)
- v.

affordable capital incorporating the cost of capital and repayment costs over time(Shaoul 2011)

- vi.
- vii. transparent and based on verifiable data
- viii. sustainable, and,
- ix. at the patient level(Productivity Commission 2009a, 2010; Forster 2005; Garling 2008b; NHHRC 2009).

Further research is required to determine if these attributes described as appropriate, sustainable and innovative care are evident in the Australian system.

2.10.2 Appropriate

Equitable access and allocative efficiency

Good health outcomes suggest access to acute care may be regarded as appropriate for most Australians(GBD 2016 Healthcare Access and Quality Collaborators 2018; Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017). However, equitable access to technologically advanced diagnostic and treatment options is not universal. Access to 20th century technologies for indigenous, rural and outer metropolitan patients is poorer than for other Australians (Australian Senate Community Affairs and References Committee 2018; AIHW 2018c; Walker 2014) More research is required to determine if the capital allocation system provides access to required care for all Australians in line with national objectives ((AIHW 2018b)Australian Commission on Safety and Quality in Health Care 2009; Council of Australian Governments(COAG) 2011b)

Safety and quality – connected systems

Safety and quality of care are compromised by inadequate data and information flows in Australian health system (Productivity Commission 2017b; Duckett 2018c). The total value of hospital assets in each state is offered as a proxy for the quality of medical equipment, facilities and systems for patient care(SCRGSP 2019).There is limited information on the safety of medical equipment, facilities and systems for public hospitals(Australian Senate Community Affairs and References Committee 2018; Garling 2008a). Data from EMR and digital systems are expected to enhance hospital performance but paradoxically no data is published on how many Australian hospitals have EMR(AIHW 2018b)!

In a digital world patients and clinicians expect access to health services that are digital rather than analogue (Darzi 2018b; AIHW 2018b). In the absence of a unified funded policy for EMR, different systems of varying compatibility have developed within Australian hospitals (pharmacy, clinical records, operating theatre, discharge summaries etc.) and between hospitals increasing complexity, causing inefficiencies and the potential for adverse events (Allen-Graham 2018). Errors arise from paper-based and hybrid EMR systems and poorly written scripts (Productivity Commission 2017b) (Honeyman et al 2016). Adopting safer practices requires abandoning unsafe or redundant processes as part of a 'learning health system' (Coiera 2017; Productivity Commission 2017b; NHHRC 2009). Access to appropriate funding has been a key factor in the implementation of EMR in the USA, UK and Europe (Ross 2016). The relationship between clinical standards and patient safety through funding for ICT systems could not be discerned from the literature. No process for disinvesting in redundant systems was identified for Australia, although disinvestment in clinically unviable hospitals has been managed in most states. Further research on state systems for ICT in hospitals is necessary to identify the common theoretical basis and strategy for delivering safe, high quality care for all Australians.

The next stage of technologically-advanced modalities including precision medicine, big data and machine-learning, are expected to support clinical quality improvement through improved data and AI for clinical decision making, and enhanced communications capacities in connected systems (Darzi 2018b; Productivity Commission 2017b). Under Australian standards access to these improvements is expected to be available for all Australian patients (National Health Information and Performance Principal Committee 2017; Council of Australian Governments (COAG) 2011b) but no national funding mechanism has been found in the literature. Further research is required to determine if the processes for capital allocation in each state provides for the integration of digital systems with enhanced communications for patient safety.

2.10.3 Sustainable

Economically sustainable

ABF, as a patient-based form of acute care funding, has delivered economically sustainable low expenditure growth in Australian public hospitals (Biggs 2018). The patient focus of ABF has permitted recurrent funding for flexible evolution of clinical care in response to changing patient requirements. In contrast funding mechanisms for capital to support clinical care are for institutional asset replacement (Deeble 2002c) and are unresponsive to technological change or inert (Productivity Commission 2015, 2017a, 2017b).

Sustainability challenges for acute care are posed by developing levels of chronic disease for an episodically-focussed hospital system, access to health data, technological advances (AIHW 2018b), climate change (Hanna 2018), and antibiotic resistant organisms (Australian Commission on Safety and Quality in Health Care 2018a). Investing in sustainable acute care includes managing hospitals with technologically appropriate tools to address these challenges, support reductions in waste and further efficiency improvements in hospitals (Lennarts 2009). By optimising clinical focus from ‘diagnose and treat’ to include ‘predict and prevent’, technology can support chronic disease management through investments to prevent admissions to hospitals by methods including the remote monitoring of patients (Darzi 2018c; Productivity Commission 2017b).

Automation of hospital processes such as dispensing, robotics and the use of AI are expected to act as substitutes for skilled and semi-skilled labour in the hospital (Darzi 2018c; Joe 2013). Balancing technological optimism with cost-benefit analysis and technology assessments, clinical improvements will need to demonstrate a mechanism to judiciously invest when the elasticity of capital to labour is greater than one for short-term and on-going costs. Capital costs matching the accuracy of recurrent costs will be required for this analysis. Further research is indicated to identify if there is a method for delivering economically sustainable innovation.

‘Environmentally sustainable

Public hospitals have significant environmental challenges associated with building, carbon footprint, energy and water use and waste. While there is no national policy for change, clinical groups and some states are raising issues and developing solutions. Further costing, policy development and research are required in this area. ‘

2.10.4 Innovation

The history of capital funding for proven innovations in Australian public hospitals is inauspicious. The investment in innovations from the mid-20th century such as imaging equipment are not reported although processes for distribution, maintenance and replacement have been questionable for access, equity and efficiency (Australian Senate Community Affairs and References Committee 2018; OECD 2018; Audit Office of NSW 2017; WA Auditor General 2017; Victorian Auditor-General 2015; Queensland Audit Office 2017). The adoption of later 20th century developments (including e-prescribing, EMR, electronic medication management, robotic surgery, remote patient monitoring) are also not reported or funded although their clinical value and effectiveness are acknowledged (Sheperd 2012; Coory M D 2013; Australian Department of Health 2018;

Xu 2013; Astley et al. 2017; Auditor-General 2017; Hambleton 2019) . While new technologies and innovations have been included in some Australian hospitals the values underpinning investment, measurement of the investment and processes for capital funding of emerging technologies are not evident in the literature. The next generation of clinical and technological change in Australian hospitals requires investment(CSIRO 2018; Productivity Commission 2017b).Economic Growth theory identifies the importance of innovation and the elasticity of substitution of technology for improved productivity(De la Grandville 2016; Solow 1956). Australian capital funding processes to adopt and distribute proven innovations requires further clarification and research.

2.10.5 Strengths and limitations

Strength: This is the first review of capital allocation for acute care methods since Deeble in 2002. It is the first review to analyse the methods for national capital cost estimation and to compare the quantitative and qualitative studies. Likewise, this review has identified that deficiencies in capital allocation is a common theme in health service reviews since 2000. This review considers the capital funding for the adoption of new technologies and innovations for the first time.

Scope risk: Reviewing capital for the four themes of effectiveness, appropriateness, sustainability and innovation risks missing other aspects of capital allocation which may be relevant. This risk has been considered and tested against the literature, an expert panel (Appendix G) and tested through published articles and peer-reviewed workshop and conference presentations. However, there may be aspects of capital allocation which have been overlooked or undervalued in the analysis. Areas of information may not be publicly available or may have been discussed in languages other than English.

2.10.6 Conclusions

It is evident from the literature that Australia lacks a theoretical framework for effective capital investment in appropriate acute clinical services. However, the values of the health system to provide sustainable patient-centred, safe, high-quality care are clear(Council of Australian Governments(COAG) 2018a; Council of Australian Governments 2012). An effective framework has been developed for recurrent funding for acute care, reporting and evaluation(AIHW 2018b; SCRGSP 2018). The absence of public reporting on major assets including medical equipment and ICT raises issues of governance and probity (Ch.2.6.1). The distribution of capital across Australian hospitals, or between hospitals, is unknowable from the literature although concerns about efficiency and effectiveness have been

identified (Ch2.6.2-3). Studies from every state indicate an absence of alignment between patient clinical requirements and capital processes (Ch.2.6.3). Australia lacks a reporting mechanism for capital that relates to patients, their procedures and their outcomes.

The appropriateness of value of the investment in patient diagnosis and treatment cannot be determined from the literature (Ch.2.7). The Public Hospitals Performance Indicator Framework standards used for recurrent expenditure evaluation offers a relevant basis for the development of a framework for capital valuation and reporting (National Health Information and Performance Principal Committee 2017; AIHW 2018f; SCRGSP 2018).

Capital was “one of the key unresolved issues in casemix funding.”(Duckett 1994)page 117) Management of capital resources, aligned with recurrent resources, at the hospital level was considered necessary for operational efficiency (Duckett 1994; Deeble 2002c) However prevailing arrangements have capital allocated and accounted at the state level with no assessment of allocative efficiency (Ch2.8.3) or Australian activation of the connection between investment and operational efficiency(Ch.2.8.2 ,2.8.4). Similarly, environmental sustainability as a risk of significance for health facilities lacks a national policy, measurement method or strategy (Ch.2.8.6) although health facility guidelines afford some mechanisms.

From the literature the Australian capital valuation system appears to be ‘analogue in a digital world’ with the only available measure retrospectively focussed on the depreciation of assets rather than patient outcomes, disconnected from the clinical services it is meant to support, and unable to facilitate the systematic funding of innovative developments (Ch2.8.5). The apparent inability of the capital valuation system to incorporate, fund and distribute innovation (Ch.2.9) compromises the objective of capital allocation to fund appropriate facilities, equipment and systems for future patients.

Further research is required to determine the values embedded in capital allocation for acute care, if the process of capital allocation is delivering value to Australians, to determine if capital allocation matches national values for healthcare and how the system includes innovation. Additional research is required to identify if the system is sustainable. Chapter 3 outlines the approach taken to researching effective capital allocation for Australian public hospitals.

Chapter 3 Methodology

3.1 Introduction

There are a number of unanswered questions regarding public hospital capital valuation and allocation in Australia (Chapter 2). Capital was considered an inert element of hospitals, funding buildings and equipment at construction and then valued through depreciation over 40-50 years. However, three key determinants of hospital funding in Australia have changed since 1993. First the pace of clinical and technological change has increased prompting reconsideration of investment policies, (ii) recurrent funding systems have changed from institutional to patient-based funding, and (iii) national standards for equality of access to quality acute care have been adopted and embedded in the health care system (SCRGSP 2018; Council of Australian Governments (COAG) 2011b).

Clinical and technological change for patient care requires an investment method to enable universal access to quality care at contemporary clinical standards. The change from hospital funding to an efficient price for patient-based acute care places an emphasis on microeconomic efficiency at the patient level. Standards set in 2011 have been endorsed by Australian governments, codified in the National Health Performance Framework, funded through ABF and are monitored using the Australian Public Hospitals Performance Indicator Framework. (SCRGSP 2018; Council of Australian Governments (COAG) 2011b; AIHW 2018f)

These three factors formed the basis for this examination of capital funding for acute care in Australia. To determine the effectiveness of the current approach to capital allocation utilised values of the Australian Public Hospitals Performance Indicator Framework (PHPIF), to assess if capital allocation was:

- appropriate for clinical care in contemporary clinical and technological terms,
- sustainable economically, and
- able to incorporate innovation for clinical and technological sustainability.

(SCRGSP 2018)

Drawing from that analysis the purpose of this thesis was to develop a diagnosis-based system of capital allocation for Australian public hospitals that was appropriate, sustainable and able to support innovation.

3.1.1 Aim and Approach

Building from the literature review (Ch.2), the aim of this chapter is to outline the design, approach and methods used to examine effective capital funding for acute care in public hospitals in Australia. There are three parts to the research:

- i. Prevailing capital allocation was examined by value of investment and the process for allocating capital (Objective 1),
- ii. An alternative diagnosis-based model for capital allocation for acute care was developed based on Australian standards and tested on a range of high volume DRGs (Objective 2), and
- iii. Prevailing methods of capital allocation were compared to the results of diagnosis-based model for capital funding using the Australian Public Hospital Performance Indicator Framework (Objective 3).

An Exploratory Sequential Mixed Methods approach was used to evaluate the effectiveness of capital funding for acute care (Berman 2017). This approach was adopted to:

- i. overcome the weaknesses of the quantitative information available,
- ii. to explore approaches to capital allocation in Australia and elsewhere, and
- iii. to develop and test a new model.

Qualitative and quantitative data and analysis were linked at the design, methods and interpretation stages (Figure 3.1). Pursuit of the research question followed the seven steps of Time-Driven Activity-Based Costing in development of the model (Keel 2017).

Qualitative methods including expert interviews of:

- i. officials with responsibility for public hospital capital allocation (Ch.5.2),
- ii. professorial-level clinicians (Ch.7.5)), and
- iii. professorial-level experts (Ch.7.6.3) to test data and assumptions. Quantitative data informed the analysis of capital allocation and of standards compliance. Quantitative methods were used in combination with qualitative methods and to determine the significance of qualitative results.

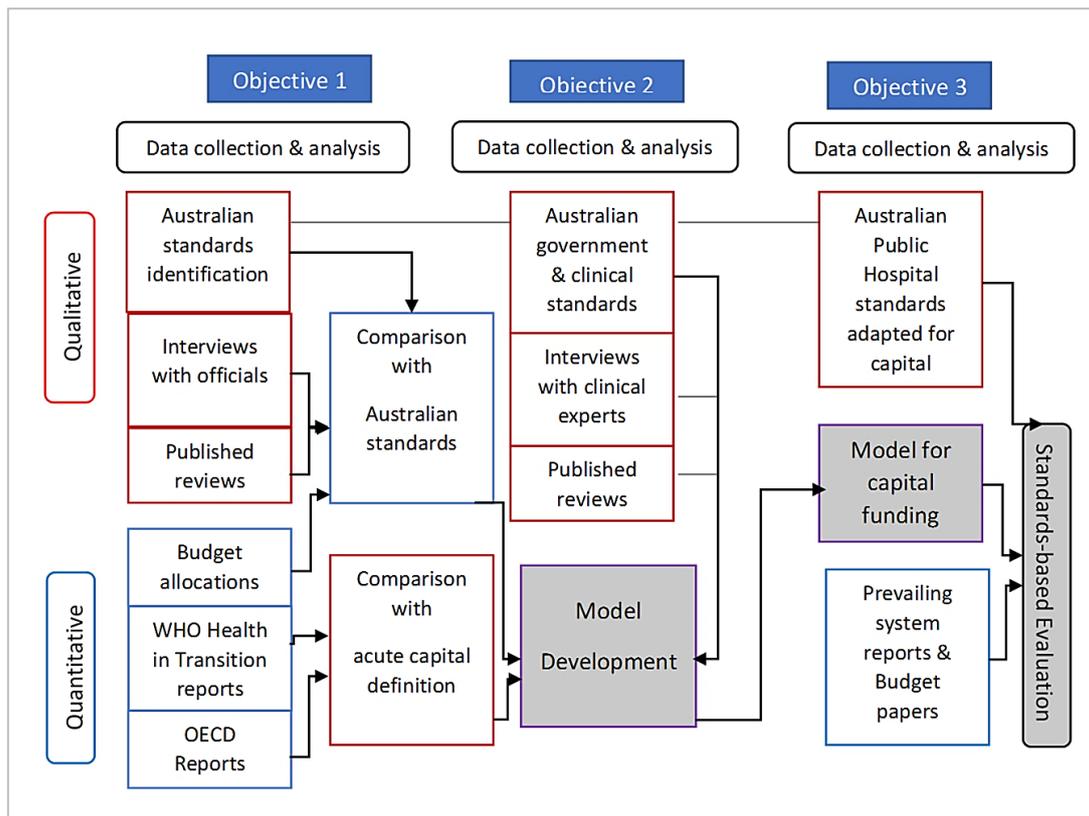


Figure 3.1 Exploratory sequential mixed methods approach to capital allocation

3.2 Research question

The research question “Can diagnosis-related capital facilitate more appropriate, sustainable and innovative acute care?” was examined through the three research objectives (Figure 3.1):

1. **Objective 1.** To examine if existing methods for allocating capital for public hospitals are focussed on facilitating effective capital funding by:
 - 1.1. Examining the process and basis for estimating capital for hospitals in:
 - 1.1.1. Australia (Ch.’s 4 & 5) and
 - 1.1.2. Selected comparable international healthcare settings (Ch.6).
 - 1.2. Assessing if these models of capital funding facilitate patient-based care that is appropriate, sustainable and facilitates innovation in acute healthcare (Ch.5).

2. **Objective 2.** To create a model in which the capital amount required for each patient care episode can be estimated using DRGs to facilitate appropriate and sustainable patient-based clinical care.
 - 2.1. To chart the clinical pathway for seven diagnosis related groups (DRGs) according to government standards, clinical guidelines and expert clinical opinion on established standards of care
 - 2.2. To determine the capital elements required for appropriate patient care in Australia for seven selected DRGs in terms of:
 - 2.2.1. Capital directly involved in patient care:
 - identifying within the modelling the capital elements required per DRG for key activity areas including theatres, ICU/HDU/CCU, procedure rooms, and
 - identifying the different forms of patient spaces required for contemporary clinical care including accommodation with bathrooms, bariatric rooms, isolation spaces, waiting areas, short-stay beds and chairs.
 - 2.2.2. Capital indirectly required for patient care but required to be accessible as part of the common facilities constituting the hospital.
 - 2.3. To cost the elements of acute care capital to identify a total cost for capital per patient by diagnosis group (Ch.'s 7& 8).
3. **Objective 3.** To compare the outcomes of prevailing capital allocation methods and the new model for allocating capital using the values of an adapted Public Hospital Performance Framework for the:
 - 3.1. Effective facilitation of contemporary standards of care
 - 3.2. Responsiveness to changes in patient requirements,
 - 3.3. Responsiveness to evidence-based improvements in clinical practice
 - 3.4. Hospital efficiency
 - 3.5. Equitable access and
 - 3.6. Sustainability (Ch.9).

Methodology sections in each subsequent chapter detail the application of this approach.

3.3 Data

The data strategy was developed to address the issues of poor published data quality (Ch.2.6.2) and concerns about the relevance of capital information for the effective delivery of clinical care (Ch.2.6.3). The aim was to draw information from experts actively involved in the relevant operational areas to supplement the research and data identified in the literature review (Chapter 2). Experts were defined as professorial-level practitioners or the practitioners they nominated. Interviews were semi-structured to gain specific information, based on the relevant guidelines and elicit additional advice experts deemed relevant.

As Figure 3.1 describes:

Objective 1 data was drawn from:

- standards set by Australian government authorities (Council of Australian Governments, Australian Commission on Safety and Quality in Health Care, Australian Institute of Health and Welfare (AIHW), Australasian Health Infrastructure Alliance),
- interviews with state government officials who were members of the Australasian Health Infrastructure Alliance reporting to the Council of Australian Governments (Ch.5.2, 5.4, Appendix B),
- published health services reviews (Ch.2.6.3)
- capital allocations from Commonwealth and state Budget papers for hospitals (Ch.4.4)
- data on the history of Australian hospital capital formation (Ch.5.3.1, Appendix C)
- WHO health in transition reports on capital funding for hospitals (Section 4.1.1)
- OECD Reports on hospital capital and major medical equipment.

Objective 2 data additionally included:

- Australian government standards for effectiveness detailed in the Australian Public Hospital Performance Indicator Framework (AIHW 2018b; SCRGSP 2019)
- national and state clinical guidelines (Ch.8.2.1, 8.3.1, 8.4.1, 8.4.1 and 8.5.1)
- interviews with clinical experts for the diagnosis groups reviewed (Ch.7.5, 8.2.2, 8.3.2, 8.4.2, 8.5.2, Appendix E)
- Data on building from the Australian Building Codes Board, the Australian Institute of Quantity Surveyors, a published index of hospital costs by national firm of Quantity Surveyors recommended by professorial level experts and AIQS (Rider Levett Bucknall 2017).

Objective 3 additionally used:

- Data on access to acute care in Australia from AIHW, the Administrator of the Health Funding Pool, the Australian Health Policy Collaboration, the Australian Bureau of Statistics, Commonwealth and state Auditors General, medical professional colleges and associations, and,
- Information on building standards from the Green Building Council of Australia.

Data selection and extraction methods, interviewee selection and recruitment, interview questionnaires, transcription, verification and analysis are addressed in detail at the beginning of each chapter.

3.4 Research design

Value theory has informed this study (Mazzucato 2018); assessing the values Australian governments have for public hospitals in terms of standards, the monetary value of investment in public hospitals, and how those funds are valued. The model created from the research seeks to align the value of capital for acute care with government standards in a dynamic system.

This research draws on previous resource allocation studies from the literature and Australian government standards. Studies into priority setting for health resource allocation including WHO standards (Wenzl 2017), systematic reviews (Kapiriri 2017; Aidem 2017) and individual studies (McKie 2008; Sabik 2008). These identified key qualities of expert advice, financial and economic responsibility, transparency of decision-making and patient-centeredness. European and American studies of hospital funding were also influential in framing the research question (Chapter 6).

Australian government standards for health services and evaluation of public services drew from reporting standards developed by the Productivity Commission and the National Health Performance Framework (Ch.3.4) as the basis for evaluation (SCRGSP 2018; Council of Australian Governments (COAG) 2011b). The research question was developed from the standards established by Australian governments for the effective delivery of public hospital services, adapted for capital allocation.

In this thesis the function of capital for acute care was defined as “*to fund patient access to appropriate care in efficient hospitals*” (Ch.2.2).

3.5 Analysis theoretical framework

This research analyses the system of capital allocation for acute care in public hospitals to determine an effective system of capital funding using the standards set by government and described through the literature. As mentioned the theoretical framework for examining the capital funding systems relied on the measures of public hospital performance used for the annual Report on Government Services developed within the Productivity Commission (Figure 3.2) (Public Hospitals Performance Indicator Framework Figure 12.4) (SCRGSP 2018; AIHW 2018b). The Public Hospitals Performance Indicator Framework (PHPIF) has become the nationally accepted standard of review for public hospitals (AIHW 2018b; Auditor General Australia 2019).

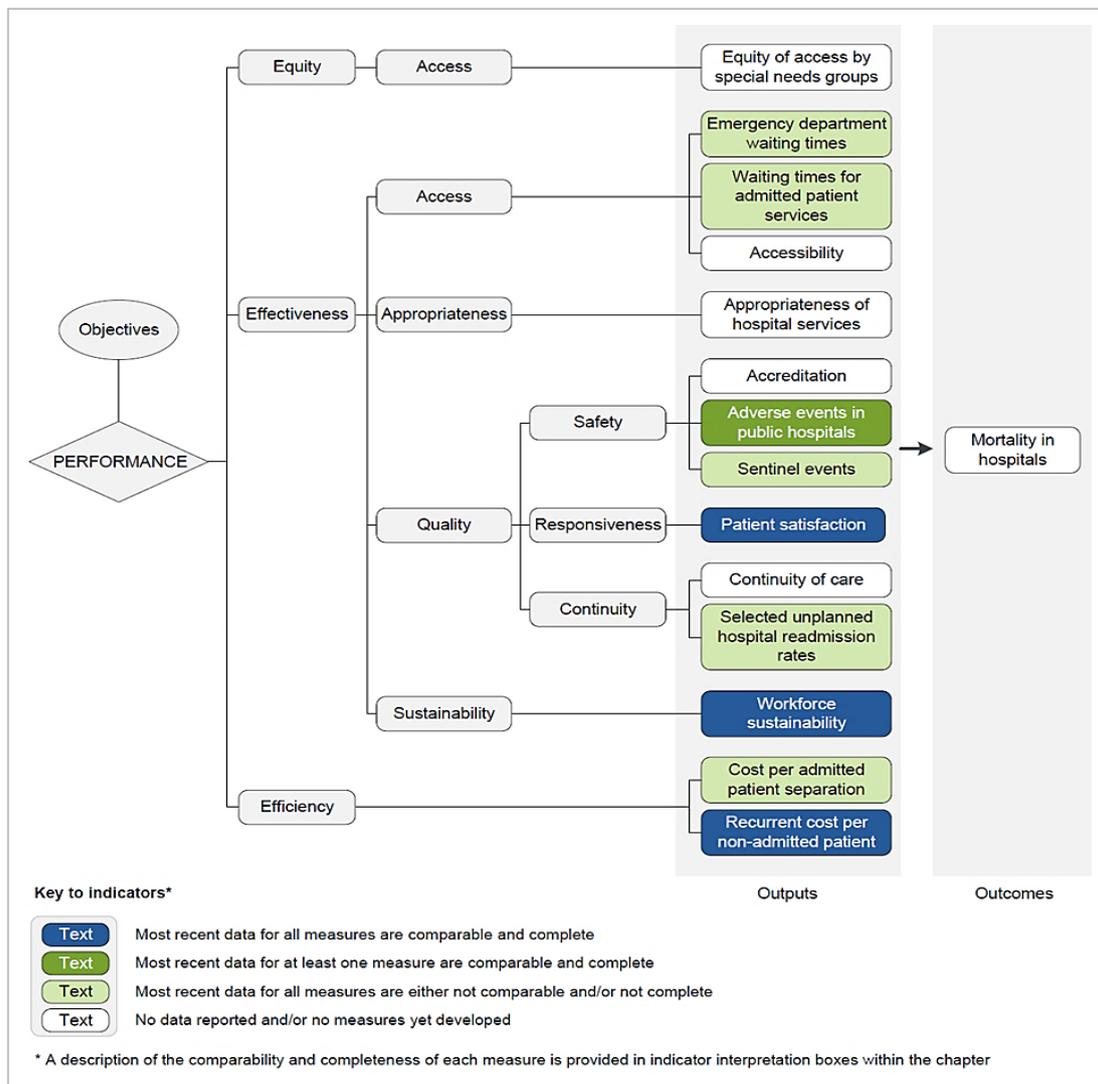


Figure 3.2 Public Hospitals Performance Indicator Framework, Report on Government Services
 Source: Report on Government Services, Steering Committee for the Review of Government Service Provision, (SCRGSP 2018)

As capital funding is not included in this system of assessment the qualities used to assess public hospitals for equity, efficiency and effectiveness and the standards of access, appropriateness, quality and sustainability have been combined to standards relevant to capital allocation. The aim of Effectiveness in capital allocation is:

- ‘Appropriate’ contains the standards and qualities of access, appropriateness and quality with each quality identified for measurement.
- ‘Sustainable’ includes the standards and qualities of efficiency and environmental sustainability, and
- ‘Innovative’ is defined as containing evidence-based innovation.

The aim of ‘effective capital funding’ adapted from the Public Hospitals Performance Indicator Framework (PHPIF), is composed of funding qualities defined by government as appropriate, sustainable (SCRGSP 2018) and innovative (Council of Australian Governments(COAG) 2018a).

- At the next level these *qualities* are sub-divided into *standards* set by governments through standards and reporting frame works (Australian Commission on Safety and Quality in Health Care 2009, 2011, 2012; Australian Government 2011; SCRGSP 2016; SCRGSP 2017; SCRGSP 2018) (e.g. the quality ‘appropriate’ is divided into evidence–based national standards and patient-based care).
- At the next level the *standards* are further subdivided into *components* based on divisions identified in the literature (e.g. Evidence–based national standards are sub-divided into facility and clinical standards and efficiency is considered as allocative, productive and dynamic efficiency).

Drawing on this hierarchy the components are measured to aggregate capital effectiveness by each of the standards and qualities in Chapters 5 and 9.

Figure 3.3 depicts the relationships between the qualities, standards and components that have been used in this thesis to measure effective capital allocation. The definitions (Appendix A) and relationships are from the National Public Hospital Performance Framework(SCRGSP 2018) adapted to determine effective capital allocation.

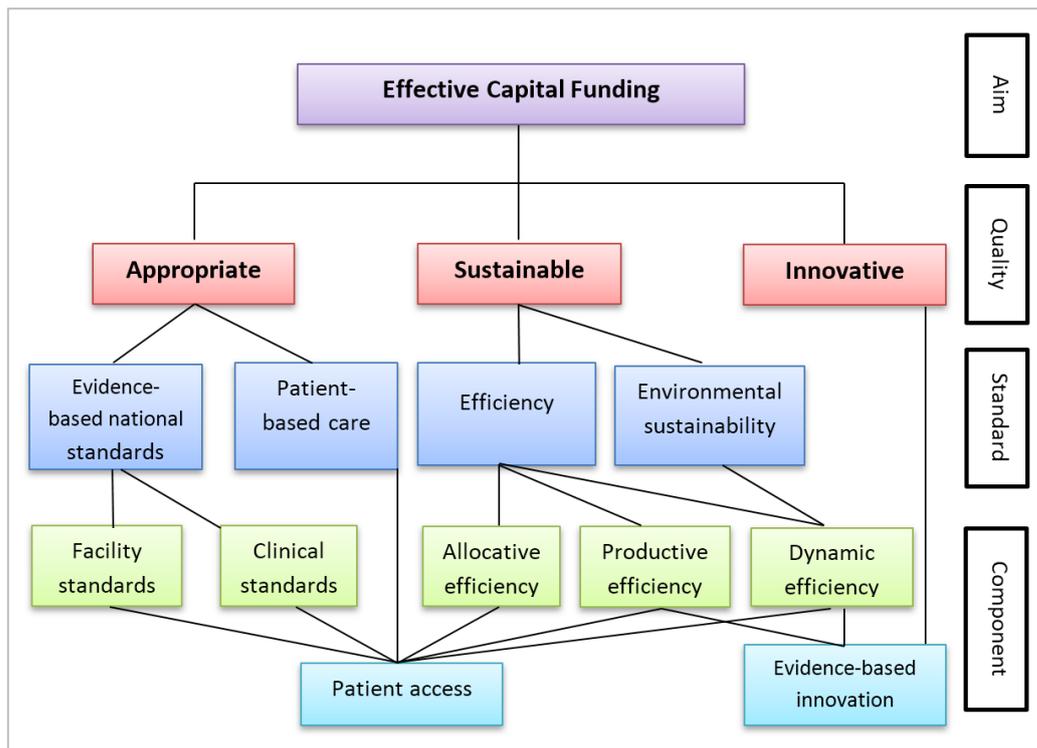


Figure 3.3 Effective capital funding for patient access to efficient hospitals

3.6 Reliability

The reliability of the research methodology has been considered in terms of credibility, transferability, dependability and confirmability (Shenton 2004).

Credibility: As there are few precedents for this research the research methods adopted have been carefully considered for each objective and task. The research strategy and data strategy were focussed on identifying the experience of acute clinical services with respect to capital. Evidence has been used as the basis for methods. The background research for the tools and methods adopted and created for this research are further discussed in the methodology section of each chapter. Assessment of the data has benefited from familiarity with the culture of participating organisations has been developed over 35 years practice in clinical service and facility planning in every Australian state and with the Commonwealth.

Random sampling of interview subjects has not taken place however experts have been invited to participate from every Australian state and territory with clinical advice received from four mainland states involving predominantly metropolitan and also regional clinicians. Medical clinicians worked in both public and private hospitals to ensure diversity of opinion. Clinical experts were from 17 public hospitals across Australia. The research was designed to ensure all major facilities of a contemporary general hospital were captured in the range of DRGs costed.

Triangulation: As there is limited data and literature and no formal studies of capital allocation processes in Australia(Kerr 2015), three methods of verification were adopted- (i) testing of assumptions with experts and (ii) clinical interviews based on published clinical and building standards (Chapters 5,7 & 8), and (iii) verification of processes by a national assessment standard(Anney 2014).

The assumptions made in this study were tested with experts with specialised knowledge of the area of inquiry to validate the premise of the thesis and then the tools applied in later chapters:

- First the objective of capital allocation defined in this thesis as *'funding patient access to appropriate care in efficient hospitals'* was tested in peer-reviewed and invited presentations to the Australasian College of Health Service Management(Kerr 2018a, 2017a; Kerr 2016), the European Health Property Network(Kerr 2017b) and European Healthcare Design Conference(Kerr 2018b) and with engineers, administrators, academics and architects at the International Union of Architects Public Health Group via private correspondence. This peer-scrutiny and debriefing informed the development of the definitions and transferability of the research findings. The definition was unchallenged.
- For Chapters 5 and 8 questionnaires developed from official document analysis were tested before application with:
 - a retired senior health official (for the officials' questionnaire Appendix B) and
 - retired health professionals- medical specialists and nurses to test validity of questions and the clinical pathways determined from the literature (Chapter 8, Appendix E). Consequently, the questionnaire was simplified.
- For Chapter 7 assumptions made in the development of the Girt-by-sea General Hospital were checked with Project Team Leaders from NSW Health Infrastructure and the Australasian Health Facility Guidelines, the Australian Council on Healthcare Standards and the national President of the Australasian College of Health Services Management (Appendix G).

Verification and validation of the model

For Chapter 7 Australian experts reviewed the model hospital area schedule created from three hospital projects for indirect hospital cost distribution (7.7.2) and test assumptions made regarding the range of services. They agreed the model hospital reflected the areas and departments of a general hospital providing Level 4 clinical services. The results

were further tested against (i) other Australian hospital or partial hospital projects(Copeland 2013), and (ii) European and British hospital or partial hospital projects with slightly lower alignment.

Chapter 8 contains the proof-of-concept testing for the model developed in Chapter 7. A sample of seven diagnosis groups representing 36% of Australian public hospital inpatients were selected to represent (i) a significant number of hospital separations, (ii) patients who required access to a broad range of acute care environments including operating theatres, ICU and specialist facilities, rehabilitation services and different types of patients accommodation and (iii) overnight and day only cases. This was to test if it was possible to build the profile of a whole hospital based on DRG capital requirements and if the results were replicable across a range of services. Research design matched the seven steps of time-driven activity-based costing(Keel 2017).

In Chapter 8 Sensitivity Analysis was conducted on the estimation of costs for seven DRG's for areas of clinical divergence or alternative costing models to test the effect on the cost estimates. In addition the relationship between the DRGs modelled and their recurrent costs were assessed (to compare with Deeble(Deeble 2002a)) and compared to national estimates(IHPA 2016b; SCRGSP 2018).

In Chapter 9 the model approach was tested using the Australian Public Hospital Performance Framework for the standards of equity, appropriateness, effectiveness quality, responsiveness, innovation and sustainability(SCRGSP 2018). Two additional factors were assessed to measure dynamic efficiency. Standards of service delivery should be able to absorb (i) short-term fluctuations due to reasonably foreseeable factors and (ii) provide a trust-worthy base for future investment (Victorian Auditor-General 2017). The prevailing system of capital allocation was also assessed against these measures.

Transferability: Consideration has been given to the transferability of the model developed in terms of clinical and contextual credibility. Clinical advice was sought from a range of clinical professors (Chapter 7) and interviewees were advised that they would not be personally identifiable. Frankness was encouraged and gained through use of the semi-structured questionnaire including open-ended questions. The analysis includes discussions and sensitivity analysis around diverging opinions.

Contextual credibility for the model has been pursued by:

- selecting high volume DRGs
- modelling DRG's that utilize an extensive range of inpatient clinical facilities
- DRG's that are experiencing clinical and technological change
- Official, expert and clinical interviews covered five mainland states
- Clinical advice included interviews in four states with visits to ten hospitals
- The quality of interview outcomes can be influenced by the credibility of the interviewer (Shenton 2004). Interviews were all conducted by the thesis writer who identified her professional background and context for the research through publications and conference presentations.

Dependability: Creation of a definition for capital, a formula for capital estimation and a method for costing enable the results of this research to be replicated in other contexts and for other DRGs. Initial testing on DRG's for stroke, chemotherapy and chest pain suggested the methods created in this research would result in a reliable cost for capital. The model has been partially tested in outpatients and emergency department services.

Research methodology, data sources and instruments for information gathering and analysis have been described in some detail in this thesis. As published clinical guidelines were used to map the physical elements of patient clinical pathways and professorial-level experts affirmed the pathways providing detail of patient and clinical requirements, it is held that another study would find similar outcomes.

3.7 Ethical approvals

Approval for this study was granted by the Office of Research and Development, School of Public Health Human Research Ethics Committee, Curtin University on 30.01.2014. Advice of Curtin University complaints procedures were provided to all interviewees. Ethics reports of compliance with conditions of approval were provided annually. NH&MRC research ethics submission was made in January 2018. Ethics approval for interviews with clinical staff was granted in February 2018. Additional ethics approval was granted by St. John of God Health Care Human Research Ethics Committee on 23 February 2018 (Ref: 1310) and the final report accepted on 4 May 2018.

3.8 Limitations.

Data quality: The paucity of published information on capital investment in public hospitals and concerns about the relevance of depreciation-based data were outlined in Ch.2.6. (Productivity Commission 2009a, 2010; AIHW 2017f, 2015c, 2018e) AIHW published information on public hospital capital costs and depreciation up to 2013-14 data. The published material was found to conflict with state Budget Papers. A letter to the editor on the categorisation of Health and Hospitals Fund (HHF) investments and the accuracy of AIHW data on capital was published in a peer-reviewed journal (Kerr 2015). AIHW did not dispute the inaccuracies and has ceased publication of the contested tables and all information on capital for public hospitals. (AIHW 2015b).

Budget papers therefore have been used for identifying capital investment recognizing allocations made for the previous financial year by funded hospital project rather than planned allocations. Project allocations have had capital allocations outside the definition removed (Appendix A) (e.g. for roads, car parks or land purchase

Specificity: Complexity and heterogeneity were identified by the Productivity Commission as significant issues for hospital costing (Productivity Commission 2009a, 2009e). Both the complexity (Pettigrew 2013) and heterogeneity of hospitals (Piggott 2013) have been considered. Hospitals across Australia provide a varied range of services captured in DRG data. In that context complexity and the interactions of recurrent and capital funding have been distinguished. Unresolved complexity exists where private-public partnerships involve unpublished capital payments. Similarly leasing arrangements for medical equipment are not included in the capital allocation values published. Care has been taken to exclude capital investments not specific to inpatient treatment as outlined in the methodology sections of chapters 4-9.

The primary data from government capital sources does not distinguish between capital funds for inpatient and outpatients and, after 2013-14, combines the annual capital funds for all health including private and public hospitals. Capital costs for teaching and research are also included. Capital expenditure data incorporates investment in a wide, undifferentiated range of health products including the range of activities within hospitals. It has not been possible to make assumptions or corrections for this data in this thesis. As an alternative, this research focussed on developing a model that managed complexity of inputs and outputs by specific costing for each DRG, documenting the particular capital

required for areas, MME and systems for each DRG. A formula has been created to manage complexity of capital required for each DRG in a standardised system (Chapter 7).

The heterogeneity of hospitals is assumed in all prevailing Australian capital estimates but is contested in this research based on the findings of clinical bodies, auditors, inquiries and health service reviews (Chapter 2.6.3)(Kerr, Hendrie and Moorin 2014). Data used for the development of the model (Chapter 7) and proof-of-concept testing (Chapter 8) has come from the literature review particularly of grey literature (Ch.2), expert interviews and the application of standards set by the Australian government. Using the DRG based formula for capital allocation provides specific capital requirements and costing schedules for each hospital based on the patient profile. Elements common to hospitals including facilities, non-clinical and clinical support services can be benchmarked using the methods developed in this thesis.

Further strengths and limitations of the research methods are discussed in more detail in each chapter.

Chapter 4 The Value of Investment in Acute Health Services in Australia

4.1 Introduction

This chapter addresses capital allocation for public hospitals through values (Mazzucato 2018); comparing the values Australian governments hold for appropriate and efficient care with the value of the investment in public hospitals. The prevailing systems for investing in hospitals (Objective 1) are assessed in terms of output (or value of capital) in this chapter and the process for allocating capital in Chapter 5. The central values accepted in Australian healthcare are for patient access to safe, high-quality clinical care (COAG 2011; COAG Health Council 2017) assessed through key performance indicators (Figure 3.2). The value of capital allocated for acute care relative to the value of the acute services is assessed to determine if investments are appropriate, sustainable and support innovation through quantitative and qualitative approaches.

To assess the appropriateness of the prevailing system of capital allocation two quantitative concepts for reviewing value are addressed in this chapter (i) the concept of investment relative to recurrent expenditure on acute care, and (ii) the value of capital consumed per patient (or the capital cost per patient) relative to investment. The qualitative appropriateness of the investments (referenced in Ch.2.6.3) is considered through examining the issues raised in state and Commonwealth health service reviews (Ch.4.5)

4.2 Aim

The aims of this chapter are to assess if:

1. the value of capital allocations for public hospitals in Australia keeps pace with the growth in hospital recurrent expenditure,
2. capital allocations provide appropriate and sustainable funding for acute facilities, equipment and systems, and,
3. annual capital allocations meet or exceed the cost of capital consumed allowing for growth and technological innovation.

4.3 Methodology

The investment in Australian public hospitals relative to recurrent hospital costs since 2000 is considered by drawing from the available data, and the literature including the reports of 13 major reviews of hospital services in Australia this century. The study used qualitative methods to review the literature on capital investment in the healthcare sector and quantitative methods to assess levels of capital investment.

Data Sources

Chapter 2.3 detailed the methodology for the literature review which identified 13 major health service reviews commenting on capital allocation. In addition, national information on public hospital recurrent and capital expenditure has been collected from 2000-01 to 2018-19 from Productivity Commission (including the Steering Committee for the Review of Government Service Provision), and Australian Institute of Health and Welfare (AIHW) publications. AIHW publication of data on capital for public hospitals was ceased with the last data available for 2013-14(AIHW 2015b).

Consequently, state data on recurrent and capital expenditure in the health sector were obtained from Hansards for Commonwealth, State and Territory Parliaments and Budget Papers for each Australian jurisdiction. In most instances Commonwealth funding for hospitals included in state and territory budgets was extracted to prevent double counting. Data on recurrent and capital costs was also drawn from Deeble's study(Deeble 2002c).

Data Extraction

Qualitative- In a deductive document review, statements on the value of capital, recommendations and actions in relation to necessary investments and issues of access to capital from 13 major reviews of health services and hospital services were extracted by author and inquiry. Themes for values common to the reviews were 'capital estimation method', 'Investment recommended for built capital, medical equipment and information technology and communications (ITC)', 'Investment required by type' and 'Comments on the capital allocation system'. State and national reports completed between 2000 and December 2018 were included. One report has been withdrawn from public access and has therefore been removed from the analysis(Bansemer 2014).

Quantitative- (i) data on indicative capital cost and recurrent expenditure per case mix adjusted separation for each state was drawn from each of the Reports on Government Services for 2010–18 and (ii) expressed as a percentage for comparison with results from

Deeble's study(Deeble 2002c). Data on the (iii) total asset value of acute care buildings and equipment by state was extracted from the annual Reports on Government Services (ROGS)(SCRGSP 2015, 2016; SCRGSP 2017; SCRGSP 2018, 2019)

Investment data was drawn from Commonwealth and State Budget Papers for projects containing the word 'hospital'. Inclusion was for patient-focused hospital services. Exclusions from hospital funding were for roads, carparking, medical research, education, land and other factors are outlined in the definition of capital in Appendix A.

Analysis

Qualitative statements from major health service reviews (Ch.2.6.3) were grouped by jurisdiction, year, investment recommendations for built capital, equipment and ICT and for the type of the investment recommended. Comments on capital allocation processes and investment were analysed for statements on capital funding appropriateness, and support for sustainability and innovation in acute care.

Quantitative comparisons were made between data sets using percentages. Values from the ROGS for 2013-14 to 2016-17 were compared for percentage growth in value of total buildings and equipment for 2011-12 for Australia and by states.

Quantitative testing for appropriateness, sustainability and innovation involved two concepts:

1. Investment relative to recurrent expenditure. (i)Trends in the growth of the value of recurrent services were compared to the growth in capital invested to support hospital care. The data on recurrent and capital costs was compared to (ii)Deeble's conclusion that the ratio of capital to recurrent costs was 7.9% allowing for 0.4% technological change and growth(Deeble 2002a).
2. Capital consumed relative to investment. Assessing if capital allocations provide appropriate and sustainable funding for acute facilities, equipment and systems the annual cost of capital consumed delivering patient care was compared to the value of funds invested annually. Sustainable service delivery was considered to be when capital invested was greater than the cost of capital consumed allowing for the replacement of assets. The relationship of capital consumed to investment was also examined to determine if there was evidence of capital funding for innovation determined to be funding in excess of replacement costs.

The mix of qualitative and quantitative methods was selected to address the qualities of appropriateness, sustainability and innovation within the limitations of the available data.

4.4 Valuing investment relative to recurrent costs

Capital is an essential enabler of contemporary public hospital services funding hospital buildings, medical equipment, information technology and communications (ITC). This research argues that capital investment is best understood within the context of the services it is designed and funded to facilitate. Identifying capital expenditure appropriate for clinical care has been approached quantitatively and qualitatively.

Ideally the relationship between capital and recurrent costs should be demonstrably clinically appropriate and economically sustainable. There are three approaches to estimating the value of investments for hospitals (i) The Productivity Commission (PC) top-down costing based on depreciation and UCC assuming all capital invested has an equal relationship to the recurrent costs of each patient (Ch.2.6.2), (ii) Australian Institute of Health and Welfare (AIHW) and Australian Bureau of Statistics estimates investment based on bi-annual surveys with extrapolations in the intervening years (AIHW 2012) and (iii) Deeble's approach using bottom-up costing for hospital capital based on a sample of 140 hospital asset registers(Deeble 2002c).

Deeble found that there was a near constant ratio of capital investment to recurrent expenditure over 40 years to 2000, with capital representing 7.1% to 7.9% of acute public hospital recurrent expenditure. However, from his detailed costing only 0.4% of capital expenditure was for growth or innovation. Almost all capital expenditure on public hospitals was for the replacement and updating of existing assets.(Deeble J 2002d)

Can the percentage of capital investment to recurrent expenditure be seen as a constant? An alternative interpretation of Deeble's figures identifies a progressive increase (from 6% in 1980-81 to 8.4% in 1999-00) in capital as a percentage of recurrent expenditure(Deeble 2002a). Since Deeble's study capital investment for acute care, expressed as a percentage of recurrent expenditure, has continued increase to 2012-13 which was the last published expenditure data on public hospitals(Table 4.1) (AIHW 2015c). While varying year to year the trend for expenditure on capital for hospitals was a progressive increase from 7.1% of recurrent expenditure to 13% of recurrent expenditure. Therefore, it could be considered that the growth in capital expenditure in public hospitals exceeded the rate of increase in recurrent expenditure to 2012-13, with some caveats.

Table 4.1 Total recurrent and capital expenditure for public hospitals, constant prices, AIHW, 2000-01 to 2012-13

	Recurrent <i>\$ million</i>	Capital <i>\$ million</i>	Ratio <i>%</i>
2000-01	22,477	1,592	7.1
2001-02	23,615	1,758	7.4
2002-03	29,952	2,117	7.1
2003-04	26,192	1,460	5.6
2004-05	27,690	2,098	7.6
2005-06	28,837	2,285	7.9
2006-07	30,594	2,476	8.1
2007-08	32,589	2,162	6.6
2008-09	34,152	2,736	8.0
2009-10	35,716	2,964	8.3
2010-11	37,658	4,298	11.4
2011-12	39,686	5,307	13.4
2012-13	39,686	5,171	13.0

Sources: Health expenditure Australia 2012–13: analysis by sector. Health and welfare expenditure series no. 53. Cat. no. HWE 62. Tables A12 and A43 and AIHW 2012. Health Expenditure Australia 2010-11. Tables 4.4 and 4.27. Constant prices are 2009-10 prices.

There were additional methodological concerns about the accuracy of the information published by the AIHW including the adjustments for constant prices¹ (Kerr 2015). For the crucial year of 2012-13, when Activity-Based Funding (ABF) for hospitals was introduced nationally, the allocations of capital investment drawn from Commonwealth and state budget papers providing a conflicting estimation of capital as percentage of recurrent expenditure (Table 4.2).

Government Budget information (Table 4.2) identified capital allocations for hospitals at less than half the AIHW estimate (Table 4.1). The Commonwealth, through the national Health and Hospitals Fund (HHF) funded \$721.75 million for public hospital improvements in 2012–13 (Swan W. (Australian Treasurer) 2012). The addition of HHF funds brings national capital expenditure for hospitals to \$3.4 billion or equivalent to 6.2% of recurrent expenditure on health. However, this remains below the level of 7.5% of recurrent expenditure Deeble estimated as representing the replacement level (Deeble J 2002d). Excluding WA, Tasmania and the ACT, individual states did not meet Deeble's 2000 asset replacement levels.

¹ Constant price anomalies arise in AIHW estimate as there was not significant inflation between 2011-12 and 2012-13 yet the figures show 11-13% variations on capital expenditure estimates for 2008-09, 2009-10, 2010-11, 2011-12 between successive AIHW health expenditure publications (AIHW 2013b, 2014b).

Table 4.2 Capital allocation for public hospitals as a percentage of recurrent expenditure, 2012-13

Source: State and Territory 2012–13 Budget Papers.

	Expenditure		Capital % of Recurrent
	Recurrent \$ million	Capital \$ million	
Commonwealth		722	
NSW	17,300	457	2.6
Vic	13,684	480	3.5
Queensland	11,862	783	6.6
SA*	4,895	239	4.9
WA	3,711	311	8.4
Tas*	1,331	161	12.1
ACT*	795	202	25.4
NT	1,229	50	4.1
Total	54,805	3,406	6.2

*Includes some funds from the national Health and Hospitals Fund

An alternative view of the higher ratio of capital to recurrent expenditure relates to greater use of technology in acute care in the period from 1980. Over the five years from 2011-12 to, the most recent information for, 2016-17 total capital for Australian public hospital buildings and equipment increased by 62% with a 57% increase in the value of buildings and an 89% increase in the value of equipment (Table 4.3) Over the four years from 2012-13 recurrent expenditure increased by 5%.

But the increased value of capital was not equally distributed between states. While the asset value of hospital buildings increased for every state over five years, the value of medical equipment in hospitals decreased in 2013-14 continuing to decrease in Queensland (until 2016-17), South Australia and Tasmania (Table 4.3). The decreasing values for equipment in hospitals is unexpected during the time of maximum expenditure of the Health and Hospitals Fund on new hospitals, regional hospitals and cancer centres. Increases in the value of hospital buildings and hospital equipment would usually be aligned². This qualifies the value of the capital data produced in the annual Report on Government Services (ROGS).

² As the National Hospital Cost Data Collection comparison between 2014-5 and 2015-6 funding shows an equal percentage change for depreciation of buildings and equipment per patient (Table 5 Round 20 Admitted acute average cost by line item, national(IHPA 2018b))

Table 4.3 Percentage change in the total value of assets, buildings and medical equipment, by state, base year 2013-14 to 2016-17

Source: Calculated from Report on Government Services 2016 Table 11A.62, Report on Government Services 2016 Table 12A.57, Report on Government Services 2017 Table 12A.56, Report on Government Services 2018, Table 12A.56, Report on Government Services 2019 Table 12A.57. Report on Government Services 2015 Table 12A.62, and Table 10A.56.

	NSW	Vic	Qld	WA	SA	Tas	ACT	NT	Australia	Annual
Buildings										
2013-14	23	29	2	0	35	44	26	4	20	
2014-15	35	17	-9	67	34	53	28	12	30	10
2015-16	41	12	30	64	26	63	41	29	38	18
2016-17	47	30	111	72	22	59	44	28	52	14
Equipment										
2013-14	-2	-2	-7	30	-10	-60	-5	1	-7	
2014-15	5	35	-10	184	1	-56	-21	24	20	27
2015-16	23	151	-1	146	-9	-59	12	35	37	10
2016-17	35	153	41	123	-9	-58	41	65	49	12

Is capital investment for asset replacement as Deeble maintained or for technological augmentation and what is the appropriate level of funding? These questions are further considered through the available quantitative (Ch.4.5) and qualitative (Ch.4.6) information.

4.5 Assessing the appropriateness of investment

Assessing quantitatively if the investments in acute care are appropriate to enable patient access to safe, high quality care (Australian Commission on Safety and Quality in Health Care 2009) relies on the available data. The annual report on government services provides a national figure on capital for acute care published in the form of an indicative cost for capital consumed per patient each year by state (SCRGSP 2018). It provides no measure for the appropriateness of capital investment. Table 4.4 shows the per patient estimates for capital consumed as a percentage of recurrent expenditure per case mix adjusted separation. Each consider the average cost per weighted acute separation between 2011-12 and 2016-17 and suggest that capital relative to recurrent costs is increasing (Table 4.4).

Table 4.4 Average cost of capital per patient, recurrent and capital costs, 2011-12 to 2016-17

Sources: Report on Government Services 2016 Table 11A.60, Report on Government Services 2016 Table 12A.56, Report on Government Services 2017 Table 12A.56, Report on Government Services 2018, Table 12A.56, Report on Government Services 2019 Table 12A.57. Report on Government Services 2015 Table 12A.62, and Table 10A.56.

Year	Recurrent Cost \$	Capital Cost \$	Ratio %
2011-12	5,204	493	9.5
2012-13	4,784	n.a.	n.a
2013-14	4,970	709	14.3
2014-15	5,025	818	16.3
2015-16	5,199	927	17.8
2016-17	5,020*	966	19.2

*disputed capital cost estimate from Table 12A.58 Report on Government Services 2019

In addition to the previously mentioned concerns about the reliability and accuracy of these figures (Ch.2.6.2) there are additional caveats. The capital cost per patient figure was not published for 2012-13 (SCRGSP 2015) and inexplicably there are two sets of estimates for recurrent costs for the period 2012-13 to 2016-17. Each year between 2015 and 2018 a recurrent cost was published in the Report on Government Services and these have been reproduced in Table 4.3(SCRGSP 2015, 2016; SCRGSP 2017; SCRGSP 2018). In 2019 new recurrent estimates were published with different capital cost estimates showing decreasing recurrent costs contradicting trends for previously published recurrent costs and inconsistent with increasing costs identified in:

- IHPA efficient price determinations(IHPA 2012a, 2013, 2014b, 2015a, 2016b, 2017b)
- The National Hospital Cost Data Collection(IHPA 2015b, 2018b) and
- Parliamentary Library research(Biggs 2018).

In addition, the state 2019 ROGS recurrent cost figures (in Table 12A.58) do not relate to the Australian average. There are clear errors in the table and inconsistencies in the figures that make the recurrent cost estimate unreliable. Calculating the 2016-17 average capital cost per acute separation (weighted) from the data in the table the average of the states would be \$5,383 per patient. Capital costs would therefore be equivalent to 18% of recurrent costs. However, the trend in the ratio of capital to recurrent costs is for percentages to increase over time beyond Deeble’s standard doubling as a percentage since 2011-12. The capital cost estimate is progressively rising to levels estimated to be over 20% of recurrent expenditure per patient by 2017-18.

However, it is not possible to determine if the level of capital funding is funding appropriate patient access to efficient acute care based on ROGS data. As discussed, ROGS is reluctant to combine the average weighted recurrent and capital costs to identify a measure for efficiency due to a lack of confidence in the estimate of capital (SCRGSP 2017; SCRGSP 2018, 2019). Capital data is 2-3 years out of date when published. The rapid rate in the growth of capital assets (Table 4.3) implies the available capital information is historic. While the estimated capital cost of providing care may be progressing to 20% of recurrent expenditure for 2017-18, an accurate value for the capital used, and relevance to patient care, remain unknown. Further, the data suggests there is an inequality of hospital resources between states, particularly for medical equipment where some states have persistently decreasing values of hospital equipment (Table 4.3). Based on the available information it is not possible to determine that the current system of capital allocation is appropriate based on the quality and contradictory nature of the data on the value of capital for acute care.

4.6 Sustainable investment

Inequality of asset distribution was a theme emerging from the major qualitative reviews of health services in each Australian state and for national reviews this century. Key themes found for investment levels were requiring (i) enhanced investment (n=7) and (ii) improved alignment with clinical requirements and standards (n=4). Access for indigenous and rural residents and funding for innovation were also referenced (n=4) (Table 4.5) (Forster 2005; Garling 2008a; NHHRC 2009; Menadue 2003; Richardson 2004; Reid 2004; Travis 2015; Australasian College for Emergency Medicine 2018; Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017; Australian and New Zealand Intensive Care Society 2017; Australian Medical Association 2018; Productivity Commission 2009b)(Ch2.6.3)

Most studies required additional investment for built capital and made comment on effect on patient services of the quality of capital distribution. Although Table 4.3 portrayed increasing values for hospital equipment in most states, more than half the studies identified allocations for additional hospital equipment was required. Fewer than half the studies called for investment in ICT (Table 4.5).

Each of the reviews found fault with access to capital or the quality of the capital funding system. Efficiency and transparency were issues that continue to be identified (Duckett S 1995; Eyles 1985; Deeble 2002c). Only one review offered a solution to the ongoing issues

of appropriate investment for patient access to clinical care. The national review of health and hospitals recommended capital allocation be included in activity based funding(NHHRC 2009).Clinically appropriate capital resourcing and evidence-based policies linked to efficiency have more recently been identified as an appropriate direction for a system of capital allocation(Table 4.5).

Table 4.5 Australian health service reviews 2000-2018: commentary on public hospital capital allocation

Report	Year	Author	Capital estimation	Recommended investment			Level of investment	Comments on capital
				Buildings	Equipment	ICT*		
Better choices better health for South Australia	2003	Menadue	Service based	Yes	Yes	Yes	State-wide	Poorly aligned with patient need
The Tasmanian hospital system reforms for the 21st century	2003	Richardson	System wide	Yes	Yes	No	Replacement	System inefficiencies
Healthy future for Western Australians	2004	Reid	Asset based	Yes	Yes	No	Major investment	Improved access required
Queensland Health System Review	2005	Forster	Asset based	Yes	Yes	Yes	Addressing inequities and delayed repairs	Not transparent
Special Inquiry. Acute care in NSW public hospitals	2008	Garling	Asset based	No	Yes	Yes	Assessment of hospitals	Improvement required
A healthier future for all Australians	2009	NHHRC	Asset based	Yes	No	EMR	\$2.1-4 billion over 4 years	Capital to be included in ABF
Public & private hospitals research report	2009	Productivity Commission	Asset based	No	No	No	For improved data to value assets	Concerns about inconsistent values
Four hour rule (WA)	2011	Stokes	Productive value	Yes	Yes	Yes	To facilitate clinical redesign	Special application required
Increasing the capacity of Victorian public hospitals	2015	Travis	Service based	Yes	Yes	No	For innovation	State Plan required

Report	Year	Author	Capital estimation	Recommended investment			Level of investment	Comments on capital
				Buildings	Equipment	ICT*		
Australian Commission on Safety & Quality in Healthcare with AIHW	2017	ACSQH, AIHW	Service based	No	Yes	No	To improve access for rural & regional residents	Unequal access
ANZ Intensive Care Society	2017	CORE	Service based	Yes	No	No	To meet clinical standards	Exit block from ICU
Australasian College for Emergency Medicine	2018	ACEM	Bed based	Yes	No	New system	Capacity expansion	Evidence- based policies required
Australian Medical Association	2018	Gannon	Bed based	Yes	Yes	No	Clinically appropriate resourcing	Adequate system funding to improve performance

Sustainable investment demonstrates allocative, productive and dynamic efficiency and contributes to environmental sustainability (Ch.2.8). Of these qualities, allocative efficiency for capital aims to identify the value of capital, and the optimal process for capital distribution, required to achieve the outputs defined for acute care with the minimum waste. The health service reviews determining the effectiveness of service delivery; however it could not be determined from their statements that capital was assigned to achieve allocative efficiency. The quantitative data was insufficiently specific or trustworthy to draw conclusions for productive efficiency in Australian hospitals. Similarly, the quantitative data was insufficiently detailed to determine if dynamic efficiency, as the measure of responsiveness to change, is evident in the increases in capital or, if as Deeble found, it is fundamentally asset replacement. The qualitative information did not address innovation (Table 4.5) (Ch.2.9) or environmental sustainability (Ch.2.8.6).

4.7 Discussion

Capital allocation for acute care is expected to be appropriate, sustainable and to enable technological and clinical innovation (Figure 3.2). Identifying expenditure appropriate for clinical care has been approached quantitatively and qualitatively. In pursuit of measures for appropriate and sustainable capital allocation two concepts have been explored to determine the appropriate value for capital expenditure: (i) the concept of investment relative to recurrent expenditure on acute care, and (ii) the value of capital consumed per patient relative to investment. The first uses a recurrent monetary value for all acute services in an attempt to quantify growth in demand and changes in acuity. The second aims to identify the value of investment required to sustain acute care at the same asset value. In theory if the value of investment is greater than both the growth in demand and acuity (recurrent expenditure) and the capital cost, there is capacity for investment in technological and clinical innovation. Both measures have significant imperfections.

The value of capital invested has exceeded (i) the growth in recurrent expenditure rising above Deeble's replacement standard after 2009-10 (Table 4.1) and (ii) the average cost per weighted separation (Table 4.4). The total value of capital buildings and equipment have increased across Australia (Table 4.3).

However, the accuracy of the published data for capital and the imperfections of the measures reduces confidence in this conclusion (Ch.4.4) (SCRGSP 2017; SCRGSP 2018, 2019). Applying the theory of the measures to practice, the relevance of capital

expenditure to clinically and physically suitable patient care environments cannot be determined from the quantitative data due to the assumptions of equal distribution inherent in the average figure, valuation and accuracy qualifications and limitations of the top-down approach to costing capital (Ch.2.6.2). Conflicting estimates of the value of capital for clinical care were identified for 2012-13 from AIHW reports and Budget papers. AIHW estimated capital was equivalent to 13% of recurrent expenditure (Table 4.1) while budget allocations had capital equal to 6.2% of recurrent expenditure (Table 4.2). Under the first scenario capital was above both activity and replacement levels but based on budget allocations was below replacement level. Challenging the accuracy of the AIHW estimate resulted in cessation of capital data publication for hospitals by AIHW (Kerr 2015). Consistency problems have also been identified for capital estimates (buildings and medical equipment) from the Report on Government Services.

Assessing which level of capital allocation was appropriate involved qualitative analysis and assessment of economic efficiency. Qualitative analysis of 13 health service reviews identified repeated incongruence between health service requirements for clinical care and capacity of the prevailing capital allocation system to deliver appropriate facilities and equipment.

However, the appropriateness of capital invested in buildings and equipment for clinical care cannot be determined due to the high levels of data aggregation. The efficiency of the system is difficult to identify for three reasons. First the capital to enable appropriate and sustainable care specific to each DRG is not being valued, the total stock of assets is valued and divided by the number of patients. Capital estimates remain based on the depreciated values of older assets rather than on the actual investment required to enable contemporary clinical care. Depreciated hospital investments of the past 40 years may not be the best indicators for the mix of contemporary health equipment, IT and built assets required for clinical care. Indeed, Deeble argued that an 'allocation based on the present capital stock would simply perpetuate inequalities'. (Deeble J 2002d) page 54).

Secondly the capital data is not sufficiently specific. Resource allocation for acute care varies for each DRG for recurrent and capital expenditure. The capacity of capital to enhance hospital operational effectiveness and efficiency (Ch2.8.2) cannot be assessed in the Australian context due to the non-specific nature of the capital data. The limited data valuing assets however identifies differences of resource allocation between states for Australian patients guaranteed equality of access. Continuously decreasing medical equipment value in smaller states over four years is not indicative of allocative efficiency (Table 4.3).

Thirdly, capital expenditure and the cost of capital used in delivering patient care are not linked to decision-making for recurrent costs and are not transparent or reliable. Duckett and others have argued that in an activity-based funding environment, where the focus is on achieving quality care at the efficient price for each DRG, health managers require accurate information on capital to facilitate efficient clinical services(Duckett S 1994a; Vogl M 2014)

Important issues of investment for environmental sustainability, clinical innovation and health service adaption have been considered but, due to data limitations, have not been quantified. The NHHRC made clear that: ‘Capital can drive change and is fundamental to achieving the efficiencies and reorientation of the health system...’(NHHRC 2009)page 168)

4.8 Strengths and limitations

Strengths: This is the first study to analyse the trends in the value of acute care buildings and equipment in Australia. Similarly, this study considered the theme of capital allocation systems as a common thread of Australian health service reviews. The study identifies some measures of appropriate capital allocation relative to recurrent expenditure to align with the growth in clinical services and with the cost of replacing capital consumed in delivering care.

Limitations

Data: Published data inconsistencies have been discussed but may not be comprehensive. Due to limitations of the data the study examines capital allocation for public hospitals only at the jurisdiction level rather than at hospital level. Therefore, the information inherently generalises about the allocation of capital across a state or territory between hospitals.

The reviews quoted had varying terms of reference and made conclusions based on submissions and analysis, some of which were not research-based. It has not been possible to distinguish between hospital-based services for inpatients and outpatients or community care based at a hospital from the available information.

Minor works capital provided through recurrent budgets sit outside this analysis, as do charitable donations for the purchase of equipment in public hospitals. Capital costs associated with equipment leases and public-private partnerships for public hospitals include only funds allocated for capital purchases and do not include payments from recurrent allocations.

The study is restricted to published information.

Measures: The measure of capital investment (for the value of capital allocations for acute care to keep pace with the growth in recurrent expenditure) is not optimal. It is a general trend measure able to illustrate if the level of investment and the demand for acute care, expressed in monetary terms have a similar, positive or negative relationship over time. Analysis of the relationship assumes salary and wages costs are consistent over time and that demand for care and changing acuity are the primary dynamics of growth in recurrent expenditure.

Scope: Due to the high level of the available data and the age of some of the reviews of health services the findings are insufficiently specific.

4.9 Conclusions

Valuations of capital for contemporary patient care do not support the drive to improved efficiency in acute care for all Australian patients. It cannot be established that the allocations are appropriate due to the absence of a theoretical framework for analysis and poor data quality with measurements suited to a by-gone era. Thirteen health service reviews indicated that the existing system of allocation was not supporting contemporary patient requirements. For capital to enable appropriate and efficient clinical care alignment with decision-making for the resourcing of DRGs is necessary.

Key questions of the appropriateness and sustainability of capital allocation have not been resolved. The quantitative and qualitative reviews have identified growth in the value of hospital capital assets greater than the growth in recurrent costs but some problems with the system of capital allocation. Further research is required to determine if the Australian system of capital allocation enables patient access to appropriate and sustainable acute care and funds innovation.

Chapter 5 Australian Systems of Hospital Capital Allocation

5.1 Introduction

The value of capital in acute healthcare has three components: the value of the resource to the Australian people (Ch's.1 and 2), the monetary value (Ch.4) and the process for creating the value (Mazzucato 2018). Having examined the literature (Ch.2) and assessed the available quantitative information on capital allocated for acute care in Australia (Ch.4), an understanding of the effectiveness of the capital allocation system remains elusive.

This chapter aims to identify the process for capital allocation for acute care in Australia through interviews with the senior health officials, who have overseen the process of capital allocation for acute care, to determine if it is effective in supporting the standards expected by Australians and set by government for acute care.

Beginning with a brief background of hospital capital funding in Australia (5.3.1), the chapter outlines the common process used by states for allocating capital (5.3.2) and examines the state processes for key standards (5.3.3) concluding with a discussion of the evidence of appropriateness, sustainability and innovation (5.3.4) in capital allocation processes.

5.2 Methodology

For this chapter the qualities of effective funding (appropriate, sustainable and supportive of innovation (Figure 3.1) (SCRGSP 2018)) are sub-divided into standards:

- Appropriate capital allocation comprises evidence-based national standards for facilities and clinical standards and facilitates patient access.
- Sustainable capital funding includes efficiency (comprising allocative, productive or technical and dynamic efficiency) and environmental sustainability. Dynamic efficiency links to capital funding for innovation.
- Innovation describes capital funding for evidence-based innovation (Ch.3.4).

Using Value Theory, Research Objective One (to examine if existing methods for allocating capital for public hospitals are focussed on facilitating effective capital funding) required examination of both the process and relationship of standards to capital allocation. The research objective was pursued through sub-objectives to:

1. Determine how capital is allocated in Australia
2. Identify allocation methods for acute care buildings, medical equipment and ICT
3. Assess if planning for capital allocation for acute care is evidence-based
4. Evaluate if the standards of contemporary capital planning processes are:
 - 4.1. patient-centred,
 - 4.2. diagnosis-based,
 - 4.3. clinically-appropriate,
 - 4.4. efficient,
 - 4.5. environmentally sustainable, and,
 - 4.6. supportive of innovation.

Interviews with senior officials were the primary information source supplemented by information on capital allocation and planning on state health department websites. A historic analysis (Berg 2012) of systems for capital allocation in Australia drawn from the literature review(Ch.2.3) is presented in Appendix D.

5.2.1 Interviews with senior officials

To identify how the Australian public hospital capital allocation system operates 11 semi-structured interviews were conducted with senior health infrastructure officials across Australia in 2013-15. A questionnaire was designed and tested, as no prior questionnaire was found in the literature.

Recruitment and eligibility- Senior officials responsible for health infrastructure in each Australian state are members of the Australasian Healthcare Infrastructure Alliance responsible to the Australian Health Ministers' Advisory Council (of the Council of Australian Governments) composed of Commonwealth, state and territory Directors General, CEO's and Department Secretaries (Australasian Health Infrastructure Alliance 2016). Each Australian member of the Alliance was approached for an interview. Interviews were granted by all but two members. Two alternate members, three former members and one senior official from the Commonwealth were also interviewed.

Questionnaire Design- Three sources informed the design of the questionnaire- the Public Hospital Performance Indicator Framework(PHPIF)(SCRGSP 2019; AIHW 2018b), recommended procedures for developing business cases for capital investment in hospitals (NSW Health Department 2010; Victorian Department of Health 2010b; Queensland Department of Health 2012; Health Department of SA 2007; Health Department of WA

2010), and the standard health planning process that informs business case development(Eagar 2001).

Progressing from high-level decision-making to the inherent values (standards) in the process, the questionnaire aimed to identify four domains within the process of capital allocation by states and the Commonwealth:

1. Influences on the process for capital allocation for public hospitals (Questions 1-7)
2. Decision-making about funding levels (Questions 8-12)
3. The process for capital allocation for medical equipment and ICT, (Questions 13-14)
4. Standards including:
 - 4.1. Patient-centred and diagnosis-based (Question 18)
 - 4.2. Clinical appropriateness- the processes used to determine if the capital allocation is appropriate for clinical need, the involvement of clinicians in asset building, budget and capital support for clinical redesign (Question 15)
 - 4.3. Allocative efficiency –decision-making for funding (Questions 8-12)
 - 4.4. Appropriateness¹- Processes to judge appropriateness for capital allocation for (i) clinical need, (ii)clinical advice during design, commissioning and budgeting and (iii) clinical involvement in capital required for clinical redesign (Question 15)
 - 4.5. Sustainability-Environmental sustainability in acute care (Question 16)
 - 4.6. Innovation-how is capital funding for innovation supported and the acceptance of funding for innovation within capital priorities. (Question 17)

Additional questions arising from information gaps identified in previous chapters were on:

- Investment timespans (Ch2.6,4.4-5) (Question 12)
- Clinical pathways (Ch.2.8.2) (Question 19)
- Estimation methods for critical care areas Ch.2.8.4, 2.9) (Question 21).

There were 23 questions including two open ended opportunities for interviewees to state their views and three questions to verify previous questions. The questionnaire is in Appendix B.

Pilot testing of the draft questionnaire was with two former health officials and resulted in the removal of two questions on allocative and productive efficiency as they found them

¹ Measures how well services meet patient needs(SCRGSP 2018) through patient-based care, clinically appropriate care. Appropriate standards are determined by clinical standards, government agreements and Australian standards.(Council of Australian Governments(COAG) 2011b) (Australian Commission on Safety and Quality in Health Care 2009; Australasian Health Infrastructure Alliance 2004-2018).

confusing. Questions on efficiency were deleted from the draft questionnaire due to the absence of accepted measures of allocative, productive and dynamic efficiency in acute care (SCRGSP 2019).

Interviews- Interviewees were contacted by email for appointments and provided with a copy of the questionnaire before the interview with an approved coversheet relating to the research and ethics procedures. Of the 11 interviews, 5 were conducted face to face and 6 were telephone interviews. Each interview took between 1 and 1.5 hours between August 2013 and January 2014.

Transcription- Answers to the questions were transcribed into an excel spreadsheet. The transcription identified the interviewee by their jurisdiction and the order of the interview (e.g. NSW 2). Notes were taken for all interviews and are kept in a secure environment separate to the list of names of the interview subjects. Data from all interviews were transcribed within 4 days of each interview.

Verification- Each interviewee was sent a copy of the notes of the interview by email with an invitation for any corrections to ensure accuracy. None of the interview subjects asked for major corrections to be made. To confirm their overall satisfaction with the transcription their personal assistants were also asked to inquire if there were any amendments required within 14 days of forwarding the transcription.

Analysis- After the initial transcription deductive thematic analysis was applied aggregating answers by the four domains:

- the process for capital allocation (seven questions),
- decision making about funding levels (six questions),
- processes for the allocation of funds for medical equipment and technology (two questions),
- measures of quality (six questions), and
- open questions on matters not covered in the questions (two questions).

Answers were combined by jurisdiction for each of the research questions. Interview results are in section 5.3.3 and are detailed by question and state in Appendix C.

5.2.2 Strengths and limitations

Strengths

Original- this study is the first to identify decision-making processes and information inputs for the capital allocation processes in each state.

Limitations

Bias- Deductive thematic analysis has been used to examine key themes based on the Public Hospital Performance Indicator Framework, however this limits the breadth of analysis. To address this risk open-ended questions were used to elicit other information officials deemed relevant. Answers to those questions did not identify significant additional information.

Change- The information provided in this chapter reflects the opinions of the process of incumbent senior health officials at the time of interview. Over time some senior health officials have changed. Since the interviews some states have devolved some functions for building hospitals, however responsibility for capital funding for hospitals continues to be a prioritised, centralised function of health departments. Information for the interviews was verified through health department websites, some of which have been removed but not archived. Interviews were conducted in 2013-14 and some information may have become out of date. Official publications have been scrutinised since interviews and the results updated where new information has been released.

Comprehensiveness- Public private partnership (PPP) arrangements made by State governments for public hospitals in most states involve various contractual arrangements with a capital fundraising component. To the extent that these are in the public domain they have been included in interviews with officials. Costs associated with leasing major clinical and diagnostic equipment are usually in recurrent costs.

Data- the scarcity of information on capital funding for hospitals is problematic for the review. Additional information may have identified additional lines of inquiry.

5.3 Capital allocation for Australian hospitals

5.3.1 Background

Capital fund-raising for public hospitals, prior to the Commonwealth *Hospitals Benefits Act 1945*, had primarily been sourced from community fund-raising, ladies benevolent

societies and hospital committees given quasi-legal status, with donations of land or funds from state and local government (Appendix C)(Cummins 1979; Sax 1984). The amending Act (*Hospital Benefits Act 1948* section 5) legislated responsibility for the States to provide capital for hospitals. State governments borrowed funds for hospital developments after approval from the Australian Loans Council operated by the Commonwealth (NSW Treasury 1988; Sax 1990)with a portion of states loans provided by the Commonwealth and interest-free capital grants(NSW Treasury 1988; Sax 1990). But the physical distribution of health resources continued to “show the end-product of decades of piecemeal incremental resource allocation”((Eyles 1985)page 244). Despite the Commonwealth investments ‘the pattern of hospital provision depended upon the donations of the living and the legacies of the dead rather than on any ascertained need for services’(Eyles J 1985)page 243).Investment strategies were found not to meet standards for appropriateness, safety, efficiency or sustainability.(Neild 1983; Scotton 2000; Smith 1998; Deeble 2002a)

Capital funding for hospitals remained primarily a state responsibility supplemented by (i) occasional Commonwealth funding for specific hospitals and (ii)two short-lived Commonwealth programs- the Whitlam Government Hospitals Development Program “to restore, redevelop or re-equip dilapidated and inadequate hospital facilities, and to provide some geographic equity by building hospitals in grossly under-serviced localities“ (Sax 1984)page 140) and the \$ 5 billion Rudd-Gillard Government national Health and Hospitals Fund (*Nation Building Funds Act 2008*)(Auditor- General Australia 2012).

In 2010 the Commonwealth agreed to fund 60% of capital in public hospitals(COAG 2010) with a revised process nominating responsibility for capital funding to the states with Commonwealth funding from time to time to address national policy priorities(COAG April 2010 & February 2011). Commonwealth funding for hospital infrastructure ceased in 2014(Hockey 2014) and COAG has not authorised any further changes to arrangements for capital funding to 2019.Hospital capital funding by the Commonwealth is for six specific hospital projects and projects linked to elections(Frydenberg 2019; Duckett 2019).

The next section examines how the states allocate capital for hospitals through the process, priority-setting and decision-making arrangements, and, in the discussion, compares the process to government goals.

5.3.2 Process for capital allocation by state governments

From the literature (Ch.2.3) and interviews the states were found to have common and consistent processes for funding investment in hospital buildings and equipment. All Australian states operate systems of prioritised capital allocation based on population health planning, facility planning and business cases. Hospitals compete for funding within the health portfolio, and depending on the budgetary agreements, with other projects culminating in the annual capital allocation in the State Budget. Studies have found other issues influencing prioritisation including political involvement, issues of persistent under-investment, budgetary financial limitations, preferential treatment for powerful hospitals, maintenance backlogs, an absence of clinical alignment and lack of transparency in decision-making(Sax 1984; Alexander H 2015; Bansemer 2014; Barton 2004; Bridges 2001; Deeble 2002a; Duckett 1995; Duckett 2002; Eyles 1985; Forster 2005; Garling 2008b; George 2011; Leggat 2008; Menadue 2003; Neild 1983; Productivity Commission 2009e; Reid 2004; Sax 1974; Sax 1990; Scotton 2000; Stokes 2011; Travis 2015; Whitlam 1971; Australian National Audit Office 2012; Richardson 2004; McCauley 2019).

All states support the Australian Health Facility Guidelines as the standard for new acute care buildings(Australasian Health Infrastructure Alliance 2016l).

5.4 Interview results- process for capital allocation

Within each state the process for capital allocation was explored by seeking advice on the major influences on capital allocation including funding priorities (Sub-objective 1)

5.4.1 Determinants of process for capital allocation for public hospitals

Questions 1-7 asked how funding requests originate, were progressed, who made decisions, if there was a state plan for capital allocation, priorities and how political influences were managed to determine how capital is allocated in Australia (Sub-objective 1).Informants were asked if the request for capital funding originated at the clinical level (from clinicians or groups of clinicians or specialty groups), from individual hospitals, from the regional health authority (Regional) was a system-wide approach relating to all hospitals providing similar services or was there a planned sequence of replacement and upgrading of hospitals(Garling 2008a).

Primarily funding requests originated with regional health services (said 50% of informants) additionally 30% of informants identified funding was for allocations aligned with a state or regional plan, and 20% of informants recognised individual hospital requests (Appendix D, Table D.1). Funding requests were not made for system-wide improvements and requests from individual clinical services did not receive funding. External political involvement was not found to influence departmental prioritisations.

Funding decision points

Questions 8-11 asked about annual and three-yearly funding and the involvement of Treasury with the health department prioritisation process.

Informants confirmed that investment decisions are not made at the clinical or hospital level in Australia. Decision-making for capital funding was identified as the central department of health (by 60% of informants), the Minister (40% of informants) or the Treasury (30% of informants)². Amongst NSW and Victorian officials there were differing views about the locus of decision making between the Minister, Cabinet and the Treasury (Appendix D Table D.2) In each of these states there had been concerns expressed about the clinical appropriateness of capital allocation.(Garling 2008b; Carney 2012; Leggat 2008; Travis 2015)

Dollar Value-Total annual and tri-annual health capital allocations were set by Treasury in each state. There was no planned investment against agreed targets for system-wide renewal. In Queensland, WA and the ACT allocations were agreed with the Health Department while in NSW the Minister and Cabinet were perceived as making the decision (Appendix D Table D.3). Key factors affecting the quantum of the annual amount for hospital allocation were planned asset replacement (40% of informants), a similar annual allocation to previous years (30% of informants) or an amount contingent on the budgetary situation (20% of informants) (Appendix D, Table D.4).

5.4.2 Capital allocations (hospitals, medical equipment and ICT)

Questions 13-14 asked the degree to which medical equipment and ICT funding was aligned with built capital funding or if there were independent processes.

Medical equipment- All States prioritised applications for major medical equipment (MME) funding centrally. The dominant trend was for medical equipment funding to be

² Some informants gave more than one answer to this question (Appendix D, Table D.2 and Table D.3).

aligned to a major hospital development project (60% of informants). For 40% of informant's capital for MME was sometimes aligned to a major hospital redevelopment and for 30% of interviewees there was an independent process (Appendix D Table D.5). An absence of clarity for the process of MME funding was evident in NSW, Victoria and Queensland and has been noted in a national review (Australian Senate Community Affairs and References Committee 2018).

ICT- No national or state-wide approaches to ICT were identified. Funding for ICT is usually aligned with hospital building (6 of 10 informants) or sometimes aligned with major hospital building (6 of 10 informants) however ICT was not seen as a process that was fully integrated with all hospital developments (Appendix Table D.6). Between 2009 and 2014 the Commonwealth funded projects on electronic medical records and technology assessment through the HHF with most funding for medical equipment and ITC lodged within grants for hospital developments. (Australian National Audit Office 2012; Swan 2012; Auditor-General 2017) Since 2014 public hospitals have been excluded from funding under Commonwealth programs (Australian Digital Health Agency 2018).

5.4.3 Evidence in capital allocation

Questions 19-21 asked how *evidence* was incorporated into capital decision making across three domains -clinical pathways, evidence-based design and estimation methods for critical care areas. Decision-making in each domain has implications for construction costs, operational efficiency, and clinical effectiveness over many years.

Quality of evidence for planning-The preferred method of estimating for investment in ICU, HDU, Coronary Care, operating theatres, and clinical procedure rooms was as a fixed percentage of the number of beds in the hospital based on a historic benchmark standard (40% of informants), the second most common method was as part of a state-wide plan for critical care (30% of informants) and the third was similar to the most common method using a trend benchmark (20% of informants). (Appendix D Table D.7).

Clinical pathways are recognised as an appropriate form for planning and are always referenced, but not used, according to senior officials (Appendix D Table D.8).

Evidence-based design is supported by all jurisdictions (Appendix D Table D.8). It is a branch of research involving behavioural psychologists, architects, engineers, nurses, doctors, technologists and economists in research on the improving patient outcomes and staff well-being through design and the intentional creation of therapeutic environments. (Hamilton 2006; Sadler 2009)

5.4.4 The standards of contemporary capital planning processes

1. Standard-patient-centred

Most services are planned from the hospital base, clinical service or at a regional level with only Queensland having patient-based planning for hospital services (Appendix D Table D.9)(Australian Commission on Safety and Quality in Health Care 2011).

2. Standard-diagnosis-based

Capital planning and allocation are hospital-based rather than diagnosis-based (Appendix D Table D.9).

3. Standard-clinically-appropriate

Clinical alignment-Asked how the capital allocation process facilitates contemporary clinical standards (Question 15), all informants affirmed that clinical opinions were included in clinical service planning at the beginning of the funding process. However only 50% of informants reported clinical advice in the next stage of planning and at each stage of capital formation clinical representation decreased. Similarly, the inclusion of evidence in subsequent parts of the planning and funding process decreased as the process advanced. In best practice hospital developments clinical involvement continues through financing and facility planning. Clinical experts provide expertise on technological or practice changes as business cases are developed(Eagar 2001). Capital allocation processes did not include consideration of clinical guidelines and standards (Appendix D Table D.10). Similarly, clinical pathways are recognised but not included in capital planning and funding.

4. Standard-environmentally sustainable

Values-At the time of interview all states aimed to have new facilities comply with Greenstar standards minimising carbon emissions and the carbon footprint of new hospitals(Australasian Health Infrastructure Alliance 2016e; Audit Office of NSW 2013; Australasian Health Infrastructure Alliance 2011)

Question 16- informants were asked about processes for new hospitals and to improve the sustainability of older hospitals.

New hospitals were expected to meet contemporary standards. However, no national, regional or state-wide programs to improve the energy or carbon sustainability of existing hospitals were identified although up to half government energy costs and carbon emissions relate to health and hospitals (Burger 2010; Audit Office of NSW

2013). Informants advised that several states had trialled projects to monitor the use of energy in existing hospitals but to 2018 there was no state-wide system of energy or carbon management. The prevailing approach to improving energy consumption was at the time of the redevelopment of the facility (60% of informants) or the responsibility of the hospital (40% of informants) (Appendix D Table D.11).

5. Standard-supportive of innovation

Capital funding for the adoption of innovation in acute care was not provided for all patients on a state-wide basis, funding was at the hospital level (30% of informants) or for specific clinical projects (30% of informants said) or as required (20% of informants) (Appendix D Table D.12).

Question 12 sought the timespans considered for capital planning; are they seeking to replace older assets or are they seeking to strategically invest in clinically appropriate facilities and equipment? State differences were evident with NSW and Victoria valuing capital in terms of traditional lifespans and electoral considerations (40%) compared to Queensland and WA where different lifespans per areas were considered (40%)(Appendix D Table D.13).

5.5 Discussion

To identify how capital for acute care is allocated in Australia four themes were examined to: (i)Determine how capital is allocated in Australia,(ii)Identify allocation methods for acute care buildings, medical equipment and ICT , (iii)Assess if planning for capital allocation for acute care is evidence-based, and (iv) Evaluate if the standards of contemporary capital planning processes are:

1. patient-centred,
2. diagnosis-based,
3. clinically-appropriate,
4. efficient,
5. environmentally sustainable, and,
6. supportive of innovation.

Across Australia capital for hospitals was found to be allocated through a prioritised, competitive funding process governed by Treasury and politicians. While hospital funding priority decision-making is made within central health departments the monetary value of capital investment is determined within annual budgetary negotiations and political

priorities. No clear set of values for allocative efficiency or effectiveness was identified for Australian capital allocation(Australian National Audit Office 2012).

The monetary value of capital allocated for hospitals is more strongly influenced by budgetary and political priorities than clinical standards. The Productivity Commission noted institutional funding structures have been found to compromise acute health performance, allocative and dynamic efficiency (Productivity Commission 2015)page 4). Other studies have found the issues influencing prioritisation including political involvement, issues of persistent under-investment, budgetary financial limitations, preferential treatment for powerful hospitals, maintenance backlogs, an absence of clinical alignment and lack of transparency in decision-making(Sax 1984; Alexander H 2015; Bansemer 2014; Barton 2004; Bridges 2001; Deeble 2002a; Duckett 1995; Duckett 2002; Eyles 1985; Forster 2005; Garling 2008b; George 2011; Leggat 2008; Menadue 2003; Neild 1983; Productivity Commission 2009e; Reid 2004; Sax 1974; Sax 1990; Scotton 2000; Stokes 2011; Travis 2015; Whitlam 1971; Australian National Audit Office 2012; Richardson 2004; McCauley 2019)

The competitive prioritised process creates funding winners and losers unlike the universal access standard for acute care. Investment decisions are not made at the clinical or hospital level in Australia although this has been identified as effective (Ch.2.6.4)(Deeble 2002c). Funding was not found for system-wide improvements or in response to requests from clinical services. A focus on asset replacement for existing hospitals has been found aligning with Deeble's conclusions and other studies(Ch's2.6.3 & 4.6)(Deeble 2002c; Kerr and Hendrie 2018).

The methods for valuing capital in public hospitals are as assets (Ch.4), referencing previous investment and asset replacement more often than clinical services. Planning parameters based on bed numbers and historic benchmarks limit the capacity to engage with new models of care and new technologies. The PC has found Australia's approach to technology in hospitals to limit operational effectiveness(Productivity Commission 2017a). This may be, in part, attributable to the project-based prioritised system of funding and the absence of a universal approach to funding medical equipment and ICT in hospitals. Chapter 4 identified some states have persistently diminishing values for medical equipment and ICT, while asset values overall increase. National reviews have identified the imbalance of access for some patients (Table 4.3). These findings are not consistent with the values of governments for patient care or the standards set for public hospitals for effectiveness.

As an asset-focussed system the Australian system is self-referencing and retrospective in planning and funding for key activity areas of hospitals. An example of the retrospective nature of capital process is found in the historic benchmarks used for estimating critical care areas by some states. Historic benchmarks represent older models of care, technology and levels of acuity where state plans for future critical care areas would be expected to reference evidence and contemporary morbidity at the patient and diagnosis level, if not predictive trend models. Similarly, the investment timeframes allowed in planning for assets most commonly use older standards unaligned with contemporary usage or the research on changing life-spans for facilities. Unequal distribution arising from facility and equipment lifespan expectations beyond viable life has been previously identified (Deeble 2002c; Garling 2008a; Australian Senate Community Affairs and References Committee 2018) Australia's process for capital allocation is grounded in the past and defined by existing buildings and budgetary constraints.

Prioritisation expresses the values of the Australian capital allocation system. Priorities within the centralised system were strong for budgetary financial factors with little reference or relationship to clinical requirements. Political decision-making was evident in capital allocation through financial control, and for some states, prioritisation of projects. In contrast, Australia has a patient- and diagnosis-based system of acute care and recurrent funding. Interviews did not identify connections between capital and patient care after the initial clinical service planning stage. Efficiency for clinical services linked to capital was not identified by the informants as a matter of significance or to be a change they anticipated in the future.

Clinical advice is only included in the allocation process at the points required for hospital construction; clinical service planning, architectural design, design development and commissioning. This study found no use of clinical evidence or advice in the development of capital allocation prioritisation of projects. The quality of clinical input is not the systematic incorporation of the best available evidence based on research but advice by individual clinicians working in a hospital to be redeveloped. Individual opinions are accepted rather than evidence, clinical pathways or clinical standards. Clinical opinions on service provision may vary between clinicians, and therefore between hospital developments without an established standard.

Capital funding methods to enable new care environments from clinical redesign, new clinical techniques and emerging models of care were absent from the capital allocation system. Evidence-based clinical pathways and standards were not used in any state nor was

capital allocation diagnosis-based. The absence of identified clinical standards and pathways in the retrospective capital allocation process risks the delivery of clinically inappropriate facilities, equipment and systems. There may be evidence of an unhealthy disconnection between the requirements of acute care and the self-referencing process of capital allocation.

Compounding that risk is the non-universal nature of medical equipment and ICT funding. Allocation of capital for medical equipment and ICT was usually at the time of major hospital developments but not all hospital developments activated ICT investment. National programs for ICT improvement are absent although evidence for reductions in risk, waste and medical errors from electronic data management are acknowledged (Productivity Commission 2017b). Medical equipment and ICT investment remain primarily restricted to major hospital building projects, limiting patient access to new diagnostic and treatment technologies to new hospitals. Not all states provide equitable access to contemporary medical equipment and ICT (Ch.4.6, Table 4.3) (Australian Senate Community Affairs and References Committee 2018) Since interviews some states have created funding for medical equipment replacement but no programs for the capital funding of new technologies have been identified.

Innovation and environmental sustainability were not supported in the capital allocation system. While immediate financial risk from a budgetary perspective was managed by Treasury involvement, there was no evidence (in the literature or interviews) that the allocative, technical or dynamic efficiency of clinical services was included in capital funding decision-making processes. The traditional view of capital was based on capital investment for building and equipment lifespans of 50 years and up to 20 years respectively (Deeble 2002a). However, international best practice has adopted differential depreciation of assets based on the differing functional lifespan of building elements and major medical equipment (Netherlands Board for Healthcare Institutions 2007b) (Diez 2010; Sun 2009; Schinko 2016). Only Queensland and WA recognised differential depreciation.

The historic review of capital allocation arrangements for Australian public hospitals identified significant moments of change (Appendix D). Transitions in funding arrangements followed substantial changes in the range of clinical services expected in hospitals and significant technological change for delivering appropriate acute care.

Australian standards are for patient-based public hospital services focussed on providing safe, high quality care (Australian Commission on Safety and Quality in Health Care 2009; Council of Australian Governments (COAG) 2011b). However, the advice of officials was

that the Australian process for capital allocation for public hospitals was a prioritised system of capital allocation funding assets unaligned with these objectives.

5.6 Conclusions

The values set for hospitals by governments are not mirrored in the system of capital allocation for Australian public hospitals. Patient-centred, clinically-appropriate care with universal access is the standard set by all Australian governments for public hospitals. The contemporary capital allocation system remains a system for rationing capital to build hospitals predominantly determined by political and budgetary priorities. The system does not equitably distribute capital for patient care based on diagnosis group, clinical requirements or evidence.

The vision for the future of acute care can be seen as a patient receiving appropriate clinical care supported by technology in the most appropriate setting (Walsh 2002; NHHRC 2009; CSIRO 2018).

Three elements of that vision are unrepresented in the national system of capital allocation: the patient, the quality of clinical advice and technological change. The Australian capital allocation system has little reference to the patient, the treatment or the outcomes the system seeks to achieve for patients. Mechanisms to ensure equitable patient access to appropriate and efficient acute services are absent from the process of capital allocation. There are no mechanisms to address dynamic efficiency for changing patient numbers or respond to variations of acuity or changing models of care for patients.

Similarly, no measure was found that connected the equipment, systems and facilities required for quality patient care for the range of treatments administered in a contemporary Australian hospital. There is no measure of quality in the Australian system of capital allocation or process for evaluating or monitoring achievement. Beyond the Australasian Health Facility Guidelines used for construction, there are no national mechanisms or measures for connecting the quality of facilities with the clinical requirements of patients to ensure the objective of universal access to high quality care is supported.

The capital allocation system was found to operate with limited clinical involvement after initial clinical service planning with no systematic clinical involvement in priority setting. Clinical pathways based on clinical standards were recognised but not used. The absence of clinical evidence may be a contributing factor to the issues of capital inadequacy raised

by 13 health service reviews (Table 4.3) (Australian Senate Community Affairs and References Committee 2018).

A mechanism for identifying, assessing, and funding appropriate technological change is also absent from the prioritised system of capital allocation with ICT aligned predominantly with infrequent major hospital redevelopments.

As a mechanism for funding the facilities, diagnostic and treatment equipment and ICT for the next generation of Australian acute clinical services, the retrospective values in the Australian capital allocation process address the issues of a system before activity-based funding. Patient-focussed care through the diagnosis-based efficient price seeks to assure quality and efficiency. Restricted competitive capital funding does not ensure equal funding for patient care. As the capital allocation process is not attentive to patient-centred or diagnosis-based funding it is a system with insufficient relationship to national values for public hospital effectiveness within appropriate clinical standards.

Australian public hospitals are expected to provide patient access, be effective (in terms of appropriateness, quality and sustainability) and support efficiency (Figure 3.1) (SCRGSP 2018) (Figure 3.2) (Ch.3.4) It is not evident that the capital allocation system seeks to support Australian standards or is calibrated to universally provide access to quality, efficient, clinically-appropriate acute care for Australian patients. Significantly, as the system to fund future facilities, medical equipment and ICT, there was no identifiable mechanism to fund sustainability or innovation.

The next chapter examines how other countries manage capital funding for acute care.

Chapter 6 International Systems for Capital Allocation

6.1 Introduction

Chapters 4 and 5 identified major deficiencies in the values, valuation and processes for capital allocation for patient access to appropriate and efficient acute care in Australia. Examining if there are more effective funding options, this chapter compares approaches to capital funding and distribution between Australia and 17 comparable OECD countries, analysing which funding systems *effectively fund patient access to efficient acute care*. Major medical equipment allocation systems are also evaluated from evidence for 24 national systems. Evaluating capital allocations and major medical equipment (MME) allocation models, separately, by funding mechanism identified the significance of the funding method for funding patient access to efficient care.

This chapter assesses prevailing systems for investing in public hospitals quantitatively and qualitatively.

6.2 Aims and objectives

The aims for this chapter were to:

- determine the effectiveness of capital allocation for acute patient care in terms of access and efficiency, and
- identify the most effective system of capital investment for public hospitals based on evidence.

Three research objectives guide this analysis to:

1. Determine the methods for allocating capital for public hospitals in comparable health systems
2. Assess the ability of public hospitals to fund access to efficient care, and,
3. Evaluate medical equipment allocation, funding and distribution.

The results of the three objectives, analyzing capital allocation systems for their capacity to fund patient access to efficient care, identified the most effective system of investment for public hospitals are discussed in Chapter 6.5.

Although data on capital allocation was limited (Ch.2.3.1), methods for allocating capital were identified for 17 comparable OECD countries (Ch.6.4.1) (Objective 1). Each country was assessed for the ability of the hospital to fund patient access to efficient care (Ch.6.4.2) (Objective 2). The countries were then grouped by funding system to determine which funding system funds superior patient access to efficient care (Aim 1). A conclusion was drawn that one system funds superior access to efficient care (Objective 2).

To test this result major medical equipment (MME) rates per 1000 population were then compared for eight types of medical equipment (Objective 3) across 24 countries with comparable data. The equipment rates were grouped by funding system and compared to the OECD average distribution. Diagnosis-based capital funding was identified as providing major medical equipment funding closest to the OECD average and to be a superior mechanism for funding patient access to efficient care (Aim 2).

6.3 Methodology

The strategy was to identify information on capital allocation for nations with health status comparable to Australia from the literature. Capital allocation systems for hospitals were then categorized and assessed. Information analysed was from data collections of the World Health Organization (WHO) and the OECD designed to permit international comparison. The assessment methods drew on the definition of capital (Chapter 2.2, Appendix A), the national public hospital performance framework (Ch.3.4) and the attributes of an effective system of capital allocation (Ch.2.6.4)(Figure 6.2). A formula incorporating the attributes was developed with scoring methods (Ch.6.3.4) to convert qualitative information into quantitative data for comparison (Ch.6.4.2).

The definition used for the purpose of capital in this thesis (*to fund patient access to appropriate care in efficient hospitals*) has been modified as an internationally agreed measure for ‘appropriate’ care is not known. An ‘appropriate’ level of care is contextual and dependant on national and regional standards. Therefore, a modified definition (*for capital to fund patient access to efficient care*) is applied for analysis in this chapter. Similarly, comparable measures and standards for access to ICT could not be identified so ICT is not included in the review of international capital allocation systems.

6.3.1 Literature review

Gaining information on capital allocation systems involved searching the ‘grey’ and peer-reviewed literature. Search terms were for ‘hospital*’ with the terms ‘capital allocat*¹, ‘patient access’ and ‘public hospital’ and ‘investment process’ and “efficien* and variants thereof in the electronic databases Emerald, Informit and Medline. The inclusion and exclusion criteria adopted of Chapter 2.3 were maintained. Items were reviewed based on title and abstract and were excluded if only one hospital was discussed, references were for hospital social capital or hospital intellectual capital or the studies were focused on portfolio investment strategies.

These terms were also searched through the websites of the World Health Organization (WHO), relevant European, US and UK official websites, the OECD, the Commonwealth Fund, the European Health Property Network, the Kings Fund, the Henry Kaiser Family Foundation, the World Bank and university health economic sites (McMaster University, University of York, Imperial College London, London School of Economics, London School of Hygiene and Tropical Medicine).

A total of 112 articles and reports were identified through data base searches including 52 from targeted searching. However on closer examination four Commonwealth Fund reports comparing efficiency and patient access were removed as they did not include an acute care capital measure (Davis 2010; Mossialos 2016; Schneider 2017; Papanicolas 2018) There were 108 eligible articles assessed by full text of which 53 were included in qualitative and 55 in quantitative analysis.

¹ “allocate*” covers allocate, allocation and allocated.

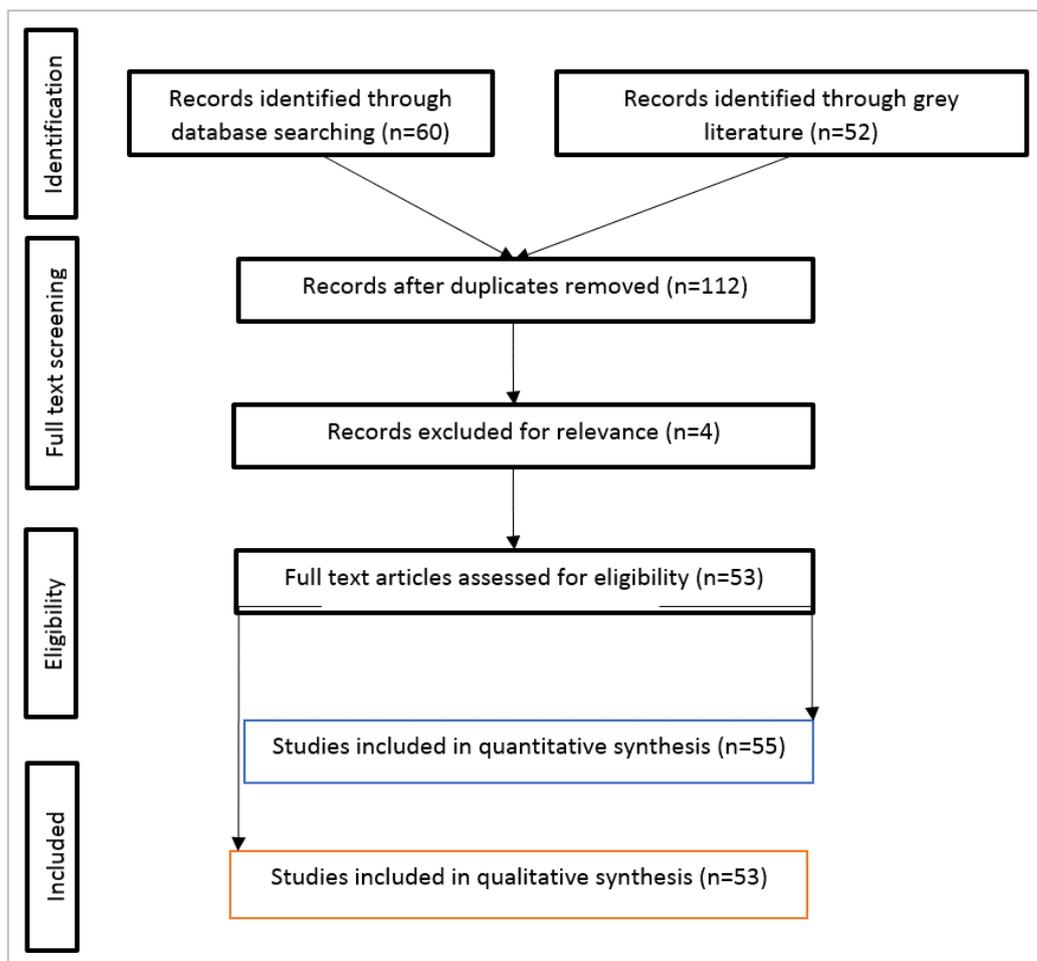


Figure 6.1 PRISMA flow chart
(Moher 2009)

6.3.2 Data extraction to compare international systems of capital funding

This section outlines how and why data was extracted from the sources identified in the literature review.

6.3.2.1 Selection of nations for comparison

Peer-reviewed and grey literature were combined to identify countries for comparison based on available data. Criteria for selection of OECD nations were:

1. availability of information on capital allocation for hospitals within the health system,
2. comparability of the information with other OECD hospital systems, and
3. secondary sources of information in peer-reviewed publications.

Comparable information on capital was found for the post-2000 period in the health system reviews of the Health in Transition (HiTs) series, published by WHO (WHO

European Observatory on Health Systems and Policies 2016). Secondary sources for each nation were identified confirming the HiT statements on capital allocation. Eighteen nations, including Australia, met the criteria² with Hit information and peer-reviewed secondary sources. The studies containing information on public hospital capital funding systems for each of the 18 nations are listed in Appendix E.

6.3.3 Data extraction and preparation: Objective 1

Data on the methods for allocating capital were extracted and tabulated for each of the identified countries for the source of capital funding for public hospitals (Table 6.5). Funding categories were deductively identified from the WHO publications. The primary source was the Health in Transition (HiT) reviews with additional sources used to confirm the categorisation of the funding system, the information remained current and the experience of capital allocation for hospitals. Australian information was extracted from Productivity Commission research reports(Productivity Commission 2009c, 2009e, 2015)

6.3.4 Data Extraction and Preparation: Objective 2

For this analysis effective capital allocation for public hospitals was defined as funding patient access to efficient care (Ch2.2) Characteristics of effective capital allocation for public hospitals were identified as timely access to capital, flexible funding, affordable capital and fairness of distribution (Ch.2.6.4) as outlined in Figure 6.2. To assess the ability of public hospitals to fund patient access to efficient care required testing for:

- the ability of public hospitals to obtain capital funding(K)
- patient access to hospital services (PA) and
- the efficiency of patient care (E).

The question has three testable areas outlined at the base of Figure 6.2 and can be expressed as:

$$\text{Objective 2} = \text{K} + \text{PA} + \text{E}.$$

Where:

K = ability of hospitals to obtain capital funding = (TA +FF +AK + FD)/4;

TA = Timely access to capital; FF = Flexibility of funding;

AK = Affordable capital; FD = Fairness of distribution of capital.

² Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Norway, Portugal, Spain, Switzerland, Sweden, The Netherlands, United Kingdom and the USA.

The relationship of the measurable factors to the standards is detailed in Figure 6.2

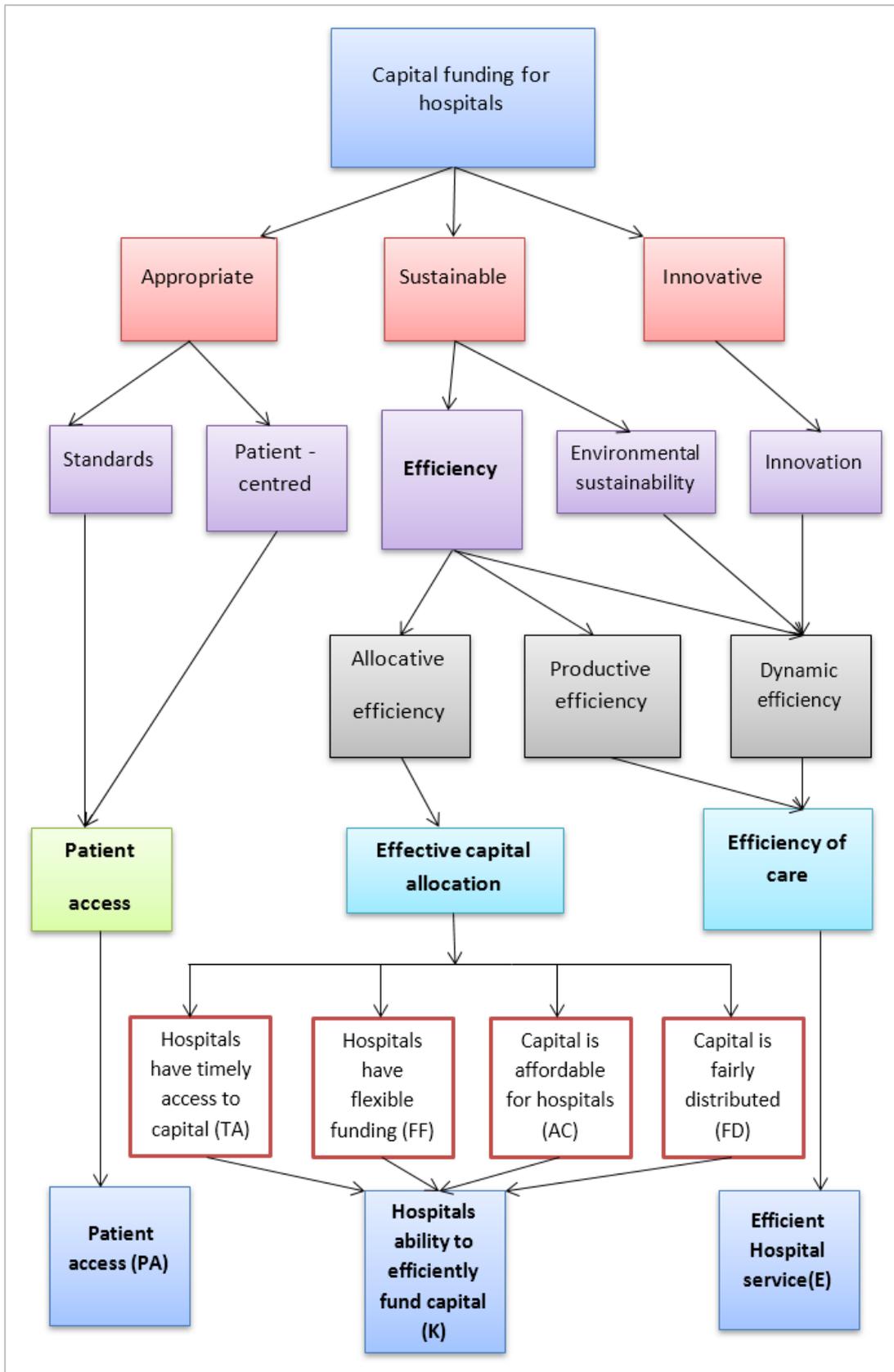


Figure 6.2 Effective capital funding: funding patient access to efficient care

To minimise risk from interpretation bias, three scorers (Rhonda Kerr, Dr. Delia Hendrie and A/Prof. Rachael Moorin) accessed information extracted from the literature (Appendix E) and used the same scoring system. The scoring system, of 0-1-2-3, was given to each of the main elements of the question (patient access, funding and efficiency).

Scoring for ‘public hospital ability to obtain capital’ per nation was for each of the four domains (timely access to capital, flexibility of funding, affordable capital and fairness of distribution) (Ch.2.6.4): these domain scores were averaged to provide a single score for K. ‘Patient access to hospital’ was scored directly for each country by each scorer.

Table 6.1 presents the scoring system for capital(K) and patient access. The method used for scoring efficiency is explained in Table 6.4 (Ch.6.3.4.2).

Table 6.1 Capital funding and patient access scoring system

Score	Timely access to capital for hospitals	Flexibility of funding for hospitals	Affordable capital for hospitals	Fairness of distribution between hospitals	Patient access to hospitals
3- highest score; good standard;	Timely access to capital	Flexible funding at local level	Low cost capital for contemporary health service delivery	Fair or equitable distribution of clinical assets	Good patient access to public hospitals
2- satisfactory or adequate standard	Access to capital within a reasonable period of time	Funding that responds to health service requirements	Some time or cost issues impede access to capital for clinical requirements	Distribution of assets that meets most population requirements	Permits most patients to access hospitals within clinical requirements
1-poor or inadequate standard	New capital is slow, delayed or infrequent (> 9 years)	Capital is highly rationed or difficult to obtain	The cost of capital influences service delivery	Distribution or volume of assets is very unequal	Barriers to some patients accessing care
0-lowest level; very poor standard; no effective system for capital	Little evidence of effective capital allocations or public investment in public hospitals.	Tightly controlled top-down regulations restricting access to capital; unconnected to clinical need.	Capital funds dependent on asset sales or privatisation of services; investment restricts service delivery	Only a small number of hospitals can obtain capital funding; funding not patient or clinical need-based.	Significant barriers for many patients seeking care

Scores for each nation, for each of the three scorers, were averaged to provide a final score per nation in the range 0–3 for ‘hospital ability to obtain capital’(Table 6.2)and ‘patient access’. Scoring was compared between scorers using weighted Cohen’s kappa analysis(Cohen 1968). Scoring of these measures reflected fair to moderate agreement or better, with no levels of poor agreement.

Table 6.2 Capital funding score, Australia and 17 OECD countries

Country	Criteria				
	Timely Access	Flexible Funding	Affordable Capital	Fairness of Distribution	Patient access
Australia*	1	1	2	1	1.25
Austria	1	1	3	3	2.00
Belgium	1	1	2	1	1.25
Canada	1	1	2	1	1.25
Denmark	3	2	3	3	2.75
Finland	1	1	2	1	1.25
France	3	2	3	3	2.75
Germany	2	3	3	3	2.75
Italy	2	1	2	2	1.75
Japan	2	2	2	1	1.75
Norway	3	3	2	3	2.75
Portugal	1	1	1	1	1.00
Spain	1	1	1	1	1.00
Switzerland	2	1	2	2	1.75
Sweden	2	2	2	1	1.75
The Netherlands	2	1	2	2	1.75
United Kingdom	0	0	0	1	0.25
United States	0	1	1	0	0.50

6.3.4.1 Patient access to public hospital care

Several econometric papers published by WHO assessed health system responsiveness and health inequality as factors determining relative health scores for international ranking systems.(Evans 2000; Murray 2001; Tandon 2002) Patient access to hospital care is reviewed in Section 7.3.2 of each HiT study.(Rechel 2010b) Data from Section 7.3.2 was collated for scoring based on the criteria in Table 6.1 (Appendix E).Peer reviewed studies and government reports also informed the paper used for scoring(Appendix E). The three scorers results were averaged to provide one score for patient access (Table 6.9).

6.3.4.2 Efficiency

Three international comparative studies of efficiency (Evans 2000; Murray 2001; Tandon 2002) using WHO data ranked 191 national systems for technical efficiency using Data Envelope Analysis:

- Evans reviewed countries for efficiency (allocative and technical efficiency) using deterministic and stochastic frontier models on cross sectional and panel data. Disability-adjusted Life Years Expectancy (DALE) were used as health outcome measure and health expenditure per capita was used as the input measure.(Evans 2000)
- Murray evaluated efficiency using health inequality, health system financial responsiveness to health status inequality and fairness of recurrent financial contribution modified by a scaled human development index.(Murray 2001)
- Tandon analysed the same variables as Evans and Murray but weighted them to construct a composite index of health sector goals as an outcome measure. Tandon also estimated a minimum level of health.(Tandon 2002)

The measurement of efficiency on a national scale is challenging: methods and data were reviewed extensively and unfavourably by an international Scientific Review Committee and in the literature (Anaud 2003; Greene 2004; Hollingsworth 2003). However, similar data and methods were confirmed by the European Commission³ to measure efficiency. After initial publication national concerns were expressed and efficiency relative to outcomes was reviewed by different measures. Due to the different measurement emphases individual nations had different scores in each study. Each of the methods have advantages and limitations while seeking to measure efficiency of health inputs to various compatible health outputs. Stochastic Frontier Analysis was also used for sensitivity measurement as a method of verification.(Medeiros 2015; Evans 2000; Greene 2004) A technical study using Stochastic Frontier Analysis and Data Envelope Analysis methods modelling hospital efficiency with OECD and survey data affirmed the appropriateness of these techniques (Varabyova 2013).

Commonwealth Fund studies in 2014 and 2015 compared fewer nations (11 and 15) and did not assess technical or allocative efficiency in the ranking of national health systems(Davis 2014). Significantly for this thesis, the Commonwealth Fund studies have no capital measures. So, the three WHO-based studies and the (less comprehensive)

³ The report is part of the Joint Assessment Framework of the OECD and European Commission measuring efficiency as part of health system performance.

European Commission study ((Evans 2000; Murray 2001; Tandon 2002; Medeiros 2015)were used as the basis for determining health and hospital system efficiency. The Commonwealth Fund studies were used for comparison (Table 6.3).

Table 6.3 Comparison of 2000-2015 studies of efficiency of hospitals and health outcomes

Year	Study Author	Organisation	Number of Countries	Data source	Content			Efficiency Assessed?			Result	Include Capital Funding for hospitals
					Outputs	Inputs	Method	Technical	Allocative	Dynamic		
2000	Evans	WHO	191	WHO	Indicators of healthy life expectancy (DALE*)	Health expenditure per capita & physical inputs	Data Envelope Analysis with Corrected Ordinary Least Squares Ranking by the sum of scores for 5 composite measures	yes	yes	no	Ranking 1-191 & in 9 bands	yes
2001	Murray	WHO	191	WHO & Clinical survey data	Indicators of healthy life expectancy (DALE*)	Health expenditure per capita & physical inputs fairness in funding	DEA with higher sensitivity analysis and wider confidence intervals. Ranking by the sum of scores for 5 composite measures	yes	yes	no	Ranking 1-191 & in 9 bands	yes
2002	Tandon	WHO	191	WHO & WHO survey data	Indicators of healthy life expectancy (DALE*)	Health expenditure per capita & physical inputs	DEA with higher sensitivity analysis and reassessed (Monte Carlo technique) confidence intervals. Ranking at the sum of scores for 5 composite measures	yes	yes	no	Ranking 1-191 & in 9 bands	yes
2014	Davis	Commonwealth Fund	11	Survey, WHO & OECD	Only Emergency	Departments surveyed for hospitals	Ranking	no	partially	no	Ranking 1-11	no

Year	Study Author	Organisation	Number of Countries	Data source	Content			Efficiency Assessed?			Result	Include Capital Funding for hospitals
					Outputs	Inputs	Method	Technical	Allocative	Dynamic		
2015	Mossialos	Commonwealth Fund	15	OECD & World Bank	Selected indicators	Selected indicators	No analysis	no	no	no	No result	No result
2015	Medeiros	European Commission	18	WHO & OECD	Indicators of healthy life expectancy, mortality rates	Health Expenditure per capita physical inputs, environmental	Data Envelope Analysis & Stochastic Frontier Analysis	yes	yes	no	Life expectancy improvement from increasing efficiency	yes

*DALE is Disability Adjusted Life Expectancies. (Evans 2000; Murray 2001; Tandon 2002; Davis 2014; Mossialos 2015; Medeiros 2015)

6.3.4.3 Efficiency Data Extraction and Scoring System

To determine a comparable measure for efficiency the most appropriate studies on healthcare efficiency (from Table 6.3) relative to health outcomes provided information as a ranking rather than an absolute figure. To compare efficiency standards for each of the studies and between each of the three ranking studies, a scoring system was developed to extract relative efficiency scores for the 18 nations from the rankings data. Each study had a different emphasis and measures providing different, but comparable, national rankings. The scoring method achieved a national score for efficiency for each nation. Conversion of rankings to graduated scores within the range 0–3 was based on relative rankings between the 17 OECD countries and Australia. For each study the highest ranking nation (of 18) scored 3, the second highest ranking nation scored 2.83 and the lowest-ranked countries scored 0.17 for each study. The scores for each nation across the three studies were then averaged to provide one national score for efficiency as outlined in Table 6.4.

Table 6.4 Efficiency Rankings of 3 studies converted to relative efficiency scores

Country	Ranking by			Converted to			Average
	Evans	Murray	Tandon	Evans	Murray	Tandon	
Australia	39	12	32	0.83	1.33	0.5	0.89
Austria	15	10	9	2.17	1.67	2.5	2.11
Belgium	28	13	21	1.17	1.17	1.33	1.22
Canada	35	7	30	1	2	0.83	1.28
Denmark	65	20	34	0.33	0.5	0.33	0.39
Finland	44	22	31	0.5	0.33	0.5	0.44
France	4	6	1	2.83	2.17	3	2.67
Germany	41	14	25	0.67	1	1	0.89
Italy	3	11	2	3	1.5	2.83	2.44
Japan	9	1	10	2.5	3	2.33	2.61
Netherlands	19	8	17	1.83	2.33	1.83	2.00
Norway	18	3	11	2	2.67	2.17	2.28
Portugal	13	32	12	2.33	0.17	2	1.50
Spain	6	19	7	2.67	0.67	2.67	2.00
Switzerland	26	2	20	1.33	2.83	1.5	1.89
Sweden	21	4	23	1.67	2.5	1.17	1.78
United Kingdom	24	9	18	1.5	1.83	1.67	1.67
United States	72	15	37	0.17	0.83	0.17	0.39

The scores for capital funding, patient access and efficiency as a measure for funding patient access to efficient hospitals are presented in Table 6.9.

6.3.5 Data Extraction and Preparation: Objective 3

Information was sought on (i) the distribution of major medical equipment (MME) per 1000 population (Table 6.8), and (ii) the funding method for major medical equipment (Table 6.9).

As comparable data was available on eight types of MME for 25 OECD nations, including some, but not all, of the previously examined nations(n=11), the analysis was expanded to a wider range of nations. The availability of data on capital allocation limited the previous analysis to 18 nations. To maximise the data available for analysis no MME types were excluded, however data on each type of MME was not available for all nations(OECD 2018).

OECD data on MME's was used in combination the WHO HiT studies. The HiT reviews and other sources for each additional country (Chile, Czech Republic, Estonia, Greece, Israel, Ireland, Korea, Luxemburg, Mexico, Poland, Slovak Republic and Slovenia) were examined to identify the method of funding medical equipment purchases (Bossert 2016; Alexa J 2015; Lai T 2013; Economou 2010; Rosen 2009; O'Reilly et al. 2012b; Chun 2009; Berthet 2015; Kual 2012; Sagan A et al. 2011; Sagan A 2011; Albrecht T 2016).

A report on medical equipment per 1000 population was extracted from the OECD statistics site¹³ under headings "Health," "Health Care Resources" and "Medical Technology" for the most recent information (2013 and 2014). The report detailed major medical equipment in hospitals by nation. The categories "total machines" and "machines in the ambulatory sector" were excluded from the data collection. Data was extracted for machines per 1000 population for:

- Computerised Tomography scanning,
- Magnetic Resonance Imaging,
- Positron Emission Tomography,
- Gamma Cameras,
- Digital Subtraction Angiography,
- Mammography,
- Radiation Therapy and
- Lithotripters. (Table 6.8)

¹³ OECD. Stat. at <http://stats.oecd.org/Index.aspx?DataSetCode=SHA> data extracted 16 November 2015

Identifying the locus of decision-making for funding major medical equipment from the HiT reviews resulted in four deductively-identified categories; DRG funding, national funding, regional funding and block grants or Private-Public Partnerships (PPP's)(Table 6.9). These are similar to, but not the same as, the categories identified for capital allocation. DRG and PPP funding systems are common to both capital and MME funding systems.

Machines per million data was aggregated for each medical equipment type by the funding method (Table 6.9). To permit comparisons between capital allocation systems, the aggregated data on machines per 1000 population by funding system was averaged (using the number of nations in each category as the denominator).

6.3.6 Data Analysis

An adapted methodology based on OECD and WHO data standards has been used. Averages across a number of nations are used by the OECD as a benchmark and a delineating point in comparative scores(OECD 2013a).After the three WHO ranking studies of countries the OECD health data moved to publish multiple detailed tables on health inputs and outputs with averages as the benchmark standard. This analysis follows the OECD standard by analysing information using averages as a benchmark (Anaud 2003; Hollingsworth 2003; Medeiros 2015). It is not an optimal method but may suggest indicative results.

Objective 1

Data analysis involved first reviewing the literature to produce a classification system of funding methods and then categorizing nations based on the classification system. Deductive review of methods of capital funding for public hospitals identified the major categories as:

- DRG-aligned capital funding
- Government subsidy
- Government Project Grants
- Mixed Government funding and Private and Public Partnerships (PPP's in Australia or Private Finance Initiatives in the UK) and
- Private funding of public hospital capital.

DRG-aligned funding is capital funding paid to the hospital per patient treated.

Objective 2

This objective assesses the ability of public hospitals to fund access to efficient care measuring (i) hospitals ability to fund capital (Table 6.2), (ii) patient access to hospital care (Table 6.6) and (iii) efficiency (Table 6.6). Each has been scored using a common scale and has equal weight. Table 6.6 sums the scores for each nation for a relative national score on the ability of nations to fund patient access to efficient care.

National scores for funding patient access to efficient care have been aggregated by capital funding system to obtain an average for each of the identified capital funding systems. To avoid distortions associated with the very low scores for the US for hospital funding and efficiency, Table 6.8 shows the scores for DRG based funding systems (i) when the USA is included and (ii) DRG-aligned funding system when the USA is excluded.

Objective 3

Objective 3 investigated the allocation of major medical equipment (MME) and considered if the system of funding influenced the distribution of medical equipment. Data was extracted by type of equipment and then grouped by funding system (Table 6.8) into:

- DRG-aligned funding,
- regional funding,
- national funding, and
- block grants and
- Private Public Partnerships/Private Finance Initiative (PPP/PFI).

The average distribution by funding system per 1000 population for each medical equipment type for was compared with the average of the 25 nations for which data was available (Table 6.9).

6.3.7 Strengths and Limitations

Strengths

Originality-This study appears to be the first to assess different hospital investment systems for effective capital allocation. Similarly, capital allocation is considered in terms of patient access to acute care by nation in a comparative manner. Capital funding and efficiency of care are also directly addressed for the first time. In addition, this research considers the effect of funding systems for capital allocation on the distribution of medical equipment. Comparative analysis of capital allocations for hospitals has rarely been attempted. Studies of efficiency have focussed on factors such as hospital size, recurrent payment systems,

competition and ownership, but not capital funding method. This research provides a definition of effective capital allocation applicable across nations for built and equipment technology. In the absence of a standard for effective capital allocation the definition provides measurable indicators. This may be the most comprehensive international review of capital relative to the services it is designed to deliver.

Limitations

Data- the analysis was limited to countries publishing information on capital allocation systems in English. While the template for HiT studies (Rechel 2010b) specifies the inclusion of capital allocation information, few countries included specific information. There was insufficient comparable data to evaluate funding for hospital ICT systems. There was a lack of contemporary data comparing efficiency.

Definition- The purpose of capital investment ‘*to fund patient access to appropriate care in efficient hospitals*’ is not fully examined for OECD systems. Analysis of appropriateness of care (aligned to clinical and governmental standards Chapter 1, Appendix A) in acute facilities could not be determined from the available information for OECD nations so a modified version of the definition has been adopted.

Measures- Although the measures used to quantify capital allocation, patient access and efficiency have been used with care, all measures have their limitations. Information has been drawn from various sources, themselves containing limitations. Patient access to hospital services relies on a wide range of factors, including recurrent funding of hospitals, staffing and access to primary care. The efficiency measure is a generalised measure because comparative efficiency studies are challenged by method (Hollingsworth 2003), data and specificity (Varabyova 2013) defining outputs or outcomes (Joumard 2010), and because inputs rarely include measures of capital investment other than hospital beds (Productivity Commission 2015; Davis 2014; Forbes 2010). The studies scored for efficiency date from the turn of the century and do not include later changes made in health systems. Therefore the validity of the indicative results may not hold over time.

Standards- This study finds there is no evidence of an international standard of capital allocation or capital sufficiency relative to clinical outputs. In the absence of a standard for hospital investment the average of a range of comparable nations is used for comparison. Averages are an imperfect standard. Similarly, there are no Australian or international standards for access to MME. Averages are used as a comparator in place of a reliable standard.

Comprehensiveness- Key areas explored in the Australian context could not be satisfied in the international context as there was insufficient verifiable information on capital allocation systems for the areas of clinical appropriateness and innovation. A wider search of additional languages may have found further information on patient access, innovation, clinical standards and access to capital.

6.4 Results

6.4.1 Methods for allocating capital (Objective 1)

Capital allocation systems of Australia and 17 OECD countries were examined to assess which systems most effectively fund patient access to efficient public hospital care. Examining the system of capital funding (Table 6.5) found that most of the countries reviewed have transitioned to capital aligned with the DRG-type payment (CaDRG). Slightly fewer nations use traditional government project grants (Table 6.5). Half the nations surveyed had multiple methods for funding hospitals. Centralised government project funding, through grants or subsidies, was less common than funding closer to the clinical level (Capital aligned with the DRG (CaDRG), mixed government–PPP and private funding). Additionally, borrowing funds for hospital capital was found in the UK to 2015 and where public hospital services are privately funded.

Table 6.5 Source of capital funds for hospitals, Australia and 17 countries, 2015

Source: WHO Health Systems in Transition (Appendix E) Chapter 4

Capital system Nation	DRG- aligned	Government Subsidy	Government Project Grant	Mixed Government/PPP	Private Funding
Australia			✓	✓	
Austria	✓	✓			
Belgium		✓	✓		✓
Canada			✓		✓
Denmark		✓	✓		
Finland	✓				
France	✓		✓		
Germany		✓			
Italy	✓				
Japan				✓	✓
Norway	✓		✓		
Portugal			✓	✓	
Spain			✓	✓	
Switzerland	✓				

Capital system Nation	DRG- aligned	Government Subsidy	Government Project Grant	Mixed Government/PPP	Private Funding
Sweden	✓				
The Netherlands	✓				
United Kingdom				✓	
United States	✓				✓
Total	9	4	8	5	5

6.4.2 Assessing the ability of hospitals to fund patient access to efficient care (Objective 2)

Measures of capital representing hospitals' access to funding (Table 6.2) with patient access to hospital care (Table 6.6) and efficiency (Table 6.4) have been combined to assess countries ability to fund patient access to efficient care.

Table 6.6 Hospital access to capital, patient access to hospitals and efficiency scores for Australia and 17 countries

Source: WHO Health in Transition Reviews and Scoring of Evans (2000), Murray (2001) and Tandon(2002)

Country	Capital	Access	Efficiency	Total
France	2.75	3	2.67	8.42
Norway	2.75	3	2.28	8.03
Japan	1.75	3	2.61	7.36
Germany	2.75	3	0.89	6.64
Sweden	1.75	3	1.78	6.53
Austria	2	2.3	2.11	6.41
Italy	1.75	1.3	2.44	5.49
Average				5.09
Netherlands	1.75	1.3	2	5.05
Switzerland	1.75	1	1.89	4.64
Denmark	2.75	1.3	0.39	4.44
Spain	1	1.3	2	4.3
Portugal	1	1.7	1.5	4.2
Australia	1.25	2	0.89	4.14
Belgium	1.25	1.3	1.22	3.77
UK	0.25	1.7	1.67	3.62
Canada	1.25	1	1.28	3.53
Finland	1.25	1.3	0.44	2.99
USA	0.5	0.3	0.39	1.19

Hospitals ability to obtain capital (Capital) scored lowest for the UK where access to capital is highly constrained for investment in public hospitals. (NHS TDA Board 2014;

World Bank 2010; Dunhill 2019) (Table 6.6). Australia ranked eighth for access to capital whereas the best performing national systems were France, Norway, Germany and Denmark.

Patient access (Access) to hospitals scored lowest for the USA and Spain (Table 6.6). The highest-ranking countries were France, Norway, Germany, Japan and Sweden. . The Australian score (2 out of 3) for patient access to hospital, ranking seventh of 18, aligns with Chapter 5, Productivity Commission Reports and the hospital component of a study of access to medical care where access was found to be enhanced for higher income patients due to private health insurance. (Van Doorslaer 2008; Productivity Commission 2009e, 2010, 2015, 2017b)

Efficiency scores of the international efficiency studies (Evans 2000; Murray 2001; Tandon 2002; Medeiros 2015)(Table 6.4) identified most countries with high levels of efficiency except Denmark and the USA.

Bringing the three measures together (Table 6.6) identified France, Norway, Japan and Sweden funded the best access to efficient hospital care for patients. Lowest score for funding patient access to efficient care was the USA recording score significantly below all other nations. The international comparative studies echo Productivity Commission reports that Australia (scoring 4.14) ranked below the average (5.04)for funding patient access to efficient care(Productivity Commission 2009e, 2015, 2017b).

For efficiency, countries using CaDRG funding for capital were 70% of the top 10 ranked countries. Aggregating countries by funding system for efficiency, DRG-aligned funding ranked highest, regardless of the inclusion of the United States. Subsidies ranked above average however market-based funding systems did not provide superior access to capital for hospitals than government funded systems. Predominantly private capital funding and mixed government-PPP systems provided significantly less access to capital than the CaDRG and government subsidy systems. Private systems scored lowest for funding patient access to efficient care.

Assessing which system of capital distribution best funds patient access to efficient care, nations are grouped by funding system (Table 6.5) in Table 6.7. Capital aligned with the DRG (CaDRG) systems gained the highest scores for (timely, flexible, affordable and fairly distributed) capital allocations for hospitals. Government subsidies were ranked as the next most appropriate capital funding method. Private funding scored below average. The least effective system for funding patient access to efficient hospital care was mixed

government–PPP funding. Australia’s score (Table 6.6) of 4.14 is below that of Government Project grants (4.7) and private public partnerships of 4.4 but above private funding score of 3.8.

Table 6.7 Funding patients access to efficient care by system of capital allocation

System	Access to Capital	Patient Access	Efficiency	Total
CaDRG minus USA	2.1	2.1	2.0	6.2
CaDRG including USA	2.3	1.9	1.8	6.0
Government Subsidy	2.0	2.0	1.2	5.1
Government Project Grants	1.6	1.6	1.5	4.7
Mixed Government/ PPP	0.7	1.8	1.9	4.4
Predominantly Private	1.0	1.4	1.4	3.8

To determine if the finding that diagnosis-based capital was the most effective form of funding a broader sample of countries were examined for the effectiveness of medical equipment distribution.

6.4.3 Major medical equipment (Objective 3)

Data on the distribution of eight major medical technologies (per million population) across 24 OECD nations permits a broader comparison across the wider range of nations for which data is available (Table 6.8). Access to major medical equipment varies significantly between countries, Chile, Mexico and Israel had consistently below average equipment ratios while the USA, Switzerland, Belgium and Luxemburg had the highest ratios across most modalities. The USA was the most abundant in each modality with ratios for CT Scanners, MRI and PET scanners at 1.5, 1.8 and 2.4 times the OECD averages respectively (Table 6.8) (Papanicolas 2018). Australian data is scant. Across and between nations the patterns of distribution are not consistent and may be influenced by a range of issues including reporting time, economic conditions and the national acceptance processes for technologies.

Table 6.8 International Comparison of major medical equipment in hospitals per million population, 24 OECD nations, 2013-14

Source: OECD. Stats extracted 16 November 2015¹⁴

Per million population	Computer-ised Tomography Scanning	Magnetic Resonance Imaging	Positron Emission Tomography	Gamma Cameras	Digital Subtraction Angiography	Mammography	Radiation Therapy	Lithotripters
Australia	-	15.05	-	-	16.69	-	-	-
Austria	18.75	10.38	1.89	9.08	-	3.07	4.95	
Belgium	22.18	10.82	2.24	23.52	9.12	17.44	16.81	8.32
Canada	-	-	-	-	-	8.66	-	-
Chile	8.6	3.76	0.34	1.25	3.59	6.38	1.37	1.25
Czech	13.7	6.09	0.86	10.37	8.27	6.75	7.32	3.42
Denmark	37.7	-	6.06	16.74	-	14.25	13.36	-
Estonia	18.21	8.35	1.52	2.28	7.59	8.35	3.79	2.28
Finland	21.7	22.06	2.21	8.46	18.57	28.31	9.56	0.55
France	12.39	8.04	1.23	5.01	6.38	-	9.89	1.86
Germany	18.7	11.59	1.59	6.72	10.47	-	5.08	4.02
Greece	17.08	7.21	0.37	6.3	10.96	15.99	5.66	1.83
Ireland	-	-	-	6.29	-	-	-	-
Israel	8.55	10.63	1.1	7.7	3.42	-	0.37	0.5
Korea	27.43	21.48	3.59	5.56	8.9	22.37	5.66	5.99
Luxemburg	22.58	12.59	1.84	14.39	14.72	8.99	5.52	1.84
Mexico	5.29	2.06	0.06	0.47	0.63	7.3	1.69	1.6
Netherlands	11.31	10.65	3.21	9.22	8.28	-	-	2.08
Poland	11.67	4.05	0.42	2.97	10.04	7.78	3.23	4.26
Portugal	20.27	6.5	0.77	2.68	9.05	10.9	4.11	2.96
Slovak Republic	13.3	3.51	0.18	4.99	8.25	12.19	11.82	5.91
Slovenia	11.64	6.31	0.97	8.24	5.19	9.7	5.83	0.48
Spain	15.19	10.68	1.33	5.79	16.94	13.11	4.68	1.8
Switzerland	23.86	19.9	3.46	8.41	-	-	6.43	4.2
United States	26.48	20.32	4.28	-	-	-	-	-
Average	16.8	10.55	1.8	7.57	9.3	11.86	6.4	2.90

To assess if the method of funding (Table 6.5) influenced the distribution of MME (Table 6.8) the data on machines per million population by nation was aggregated by the system of funding. The average of each funding group was compared to the OECD average of 25 nations in Table 6.9.

¹⁴ Information on CT scanners, MRI, PET scanners, Gamma Cameras, DSA units, mammographs, radiation therapy and lithotripters in hospitals per million population were not available in the OECD data for Australia or New Zealand.

The OECD approach to compare the average of OECD nations was used¹⁵. Endowments of major medical equipment varied significantly (Table 6.8) but when grouped by funding system (Table 6.9):

- DRG funding sits closest to the OECD average distribution with five categories of equipment near the OECD average, two below average and one above average,
- National funding had six equipment types over the OECD average (by 25% for CT Scanners, 45% for mammography and over 50% for Gamma Cameras), two in the average range and none below average
- Regional funding tended to have lower allocations with two above average, one in the average range and five below average
- Block grants and PPPs had only one category over average, two in the average range and five below average.

Across the eight modalities it would appear that Regional funding, Block grants and PPP's more commonly fund below the average, national funding most commonly funded above the average and DRG funding tended to most commonly fund major medical equipment near the average (Table 6.9).

Table 6.9 Funding systems for Major Medical Equipment and the OECD average, per million population

Source: Calculated from OECD Stats extracted 16 November 2015 and WHO HiT studies

Per million population	Computerised Tomography Scanning	Magnetic Resonance Imaging	Positron Emission Tomography	Gamma Cameras	Digital Subtraction Angiography	Mammography	Radiation Therapy	Lithotripters
<i>OECD Average</i>	17.6	10.5	1.8	7.6	8.4	11.9	6.1	2.8
DRG funding	16.9	11.8	2.4	9.3	4.1	2.5	4.7	2.4
National funding	22.3	13.0	2.0	12.4	10.9	18.4	8.4	4.5
Regional funding	16.1	12.2	1.4	5.8	12.4	18.0	6.9	2.7
Block grants and PPP	17.7	8.6	1.1	4.2	13.0	12.0	4.4	2.4

¹⁵ A discussion of the reasons for and limitations of this approach is in Section 6.3.7

6.5 Discussion: identifying an effective system of investment for public hospitals

The first aim of this chapter was to identify the effectiveness of systems of investment for public hospitals by examining approaches in comparable OECD nations in terms of their ability to obtain capital, patient access to acute care and the efficiency of that care. Two types of assets, public hospitals and major medical equipment, were reviewed. The second aim was to identify the most effective system of capital investment for public hospitals based on evidence. Internationally accepted standards to measure capital allocation were not identified nor were measures to determine the effective distribution of MME.

In the absence of a standard, the definition of capital as *funding patient access to efficient care* was used to test effectiveness. Scoring four elements of capital funding effectiveness (Ch.2.6.4) with patient access and efficiency sought to determine which systems fund patient access to efficient care. Based on the definition capital allocation aligned with DRG funding provided superior funding for patient access to efficient care when Australia and 17 health systems were reviewed. Tested for both capital allocation and medical equipment the results also suggested that DRG-aligned funding provided superior patient access to efficient care and medical equipment funding closest to the OECD average. The strength of this analysis is that it encompasses allocative effectiveness (through timely, flexible, affordable and fairly-distributed capital), patient access and the efficiency of care to provide a more contemporary patient-focussed and technologically relevant measure of capital than the traditional measure of hospital beds.

Three aspects of DRG-based funding relating to appropriateness are likely to have influenced improved acute care efficiency and access for patients. The first recognises that technological change necessitates more frequent capital allocation for all acute hospitals. Individual hospital project-based capital funding can be expected to provide local rather than national benefits. As effective acute care is increasingly aligned with technological advances inequalities in access to contemporary medical equipment, systems and facilities may adversely affect patients, effectiveness and costs (Chaudhry 2006; Australian Senate Community Affairs and References Committee 2018; Productivity Commission 2017b). This analysis has changed the focus from viewing capital as funding individual hospital projects to address the role of capital funding for national health outcomes.

The second is that the nature of hospitals has changed. Hospitals are no longer funded to function as single entity collections of bedded wards in the 21st century (AIHW 2018a;

IHPA 2018b). They are multi-product services providing different forms of highly specific acute care for an extensive range of patient groups. Patient diagnosis and treatment may require different community, outpatient, imaging, inpatient and treatment options for hours or days(IHPA 2019b). DRG's are designed to capture the specific resource requirements for appropriate care for the extensive range of diagnoses and treatment options. Specifying capital for DRG's allows for innovation, the substitution of more effective modalities and the redundancy of outmoded equipment, systems and facilities.

The third aspect is patient-focussed funding. Nations like Australia have moved to patient-centred care from a clinical specialty-based industrial models of hospital service delivery for improved effectiveness and efficiency(Rechel 2009a; NHHRC 2009; Australian Commission on Safety and Quality in Health Care 2011). Alignment of capital resourcing with clinical care funding at the patient, rather than the institutional, level was found to be associated with higher levels of efficiency. Sustaining patient care through capital funding, rather than institutional investment, calibrates investment to align with patient outcomes. One reason for the poor outcome for market-based funding methods may be that predominantly-private and private-government funding models are project-focussed on specific buildings rather than patients. DRG-aligned capital funding provides funding for all patients across the nation equitably, thus potentially influencing the higher efficiency scores.

Despite the alignment of DRG funding with patient access and efficiency, European DRG-aligned capital funding has a limitation regarding the value of the capital payment. The capital payment is based on depreciation determined by the age and mix of hospital buildings and medical equipment. The limitations of a depreciation-based capital cost (retrospective in nature, asset rather than patient focussed and technologically unresponsive) have been previously discussed in Chapters 3.4.3, 4.4, 5.5.1. and 5.5 (Deeble 2002a).In Europe payments to different hospitals for patients in the same DRG will vary depending on the depreciation value of previous investments of the hospital. As technology and clinical practice change, funding for newer models of care can be restricted by a backward-looking depreciation-based capital values reflecting older institutional investments particularly for the mix of built capital, medical equipment and ICT(Vogl 2014; Busse 2011; Lennarts 2010).

Data scarcity has limited the opportunities to measure some capital dimensions including appropriateness and ICT. Analysis of the effectiveness of funding incorporated four key attributes of allocative efficiency (timely access to capital, flexibility of funding, affordable capital and fairness of distribution) that influence the cost and the effectiveness

of clinical care(Tandon 2002)(Murray 2001(Hellowell 2012a)). While the limitations of the efficiency measures are acknowledged, the Data Envelope Analysis approach includes inputs and recognises outputs in terms of population health measures. Using three efficiency studies provided for a range of health measures (Disability Adjusted Life Years, mortality rates and morbidity data) to be compared with cost information across the nations studied (Table 6.3). Further research in this area is required to update the results of DRG-aligned capital funding(Medeiros 2015).

Research is also required on the economic sustainability of the DRG-aligned funding systems (which were not analysed in this study) and their ability to manage adverse events(Thomson 2014). Technological change as a significant characteristic of evolving clinical care and factor influencing both cost and efficiency is an important area for further research(Medeiros 2015).Translational funding for the adoption of innovations in clinical care including ICT funding for acute care also invites further research when data inconsistencies can be resolved at an international level(Cylus 2017).

In addition to the attributes of effective capital allocation previously identified in Ch.2.6.4 and used as part of the analysis in this chapter, DRG-aligned capital funding offers additional benefits. The research has identified an effective DRG-aligned capital funding system can:

- accurately cover the cost of the capital consumed in providing patient care to prevent funding incentives and disincentives(Shaoul J 1998; Vogl 2014)
- be resilient in economic crises (McKee, Basu and Stuckler 2012; Clemens 2014; Thomson 2014)
- be linked to population health outcomes (Deeble 2002a; Smith 1998; Medeiros 2015; Choi 2017), and
- display transparency and reliability(Murray 2001).

Chapter 7 considers how a DRG-aligned system of capital funding incorporating these qualities could be developed for Australia.

Chapter 7 A Model for Diagnosis-based Capital Allocation

7.1 Background

This study has found that Australian capital funding systems were not tailored to support current system aspirations (Research Question 1). Rather capital funding systems were found to be sensitive to political and budgetary priorities but disconnected from clinical requirements (Chapter 4). Australian models of capital allocation do not facilitate appropriate, sustainable, patient-centred clinical care (Chapter 5) however DRG-aligned capital has been found to fund superior patient access to efficient acute care(Chapter 6) (Kerr and Hendrie 2018). Advantages and disadvantages arise in the international experience of DRG-aligned capital funding as outlined in Chapter 6.5. The European system of depreciation-based capital allocation is considered for application the Australian context (Ch.7.1.1) prior to addressing the literature on designing a model for effective capital allocation (Ch7.1.2) and the foundations of model development (Ch.7.1.3). From these positions the research question and tasks are developed (Ch7.2-3) and detailed in the Methodology (Ch.7.4). Additionally, drawing from clinical standards and clinical expert advice (Ch7.5) a model is developed (Ch.7.6) and discussed (Ch.7.8) for application in Australia.

7.1.1 Depreciation-based capital costs

An advantage of the US DRG-aligned system of capital funding (Table E2.17) is a national transparent formula for the cost of capital and the European DRG-aligned systems have medical equipment and ICT systems nationally funded (Ch.6.4.3). However, four issues can be identified that make using DRG-based hospital depreciation costs to estimate hospital capital costs problematic in the Australian context, namely accuracy, appropriateness, accountability and equity.

- *Accuracy.* Depreciation payments are based on past capital investment, and Australian authorities acknowledge that capital information for hospitals is unreliable as:
 - “nobody knows exactly how much capital is currently used by public hospitals” (Productivity Commission 2009e)page 303)(Victorian Department of Health 2014; Travis 2015; Kerr 2015) and

- capital for public hospitals has “financial reporting issues that have affected the accuracy and comparability of unit costs” (SCRGSP 2011)page 10.57)including for high value medical equipment (Queensland Audit Office 2017).

Attempts to identify capital per patient episode have foundered on the issue of accuracy (Productivity Commission 2009e, 2010). However, the Report on Government Services calculates public hospital Capital Cost per Separation based on state-wide depreciation and the cost of money (UCC). This estimate of the cost of capital used per patient in Australia is based on unreliable data, incomplete data as figures are not available for every year (2012-13)(SCRGSP 2015), costs unconnected with varied patient requirements but primarily dependent on the age and value of assets. However, the value of assets is not in relationship with patient care or clinical standards but aligned with asset replacement (Section 5.5).

- *Appropriateness.* In Australia depreciation-based capital cost estimates draw on:
 - earlier decisions about capital allocation (up to 50 years ago) that were dependent on political factors (Chapter 5, Appendix D) and reflect different capital and recurrent funding environments (Chapter 4)
 - averaged state-wide estimates for depreciation
 - one averaged cost for the diverse range of diagnosis groups- day only and multi-day, procedural or non-procedural, and,
 - historic standards, demand and technology projections and decision-making processes rather than contemporary environments, clinical requirements, quality measures and technology.

To estimate capital costs per DRG the Productivity Commission uses IHPA DRG weightings as an approximation for capital consumed by diagnosis groups (Chapter 2.6.2) (Productivity Commission 2009e, 2010; IHPA 2017c) However, this is an unproven concept assuming capital use and recurrent costs are correlated. Chapter 4 findings would not support that assumption. Recurrent costs are dominated by salaries (IHPA 2015b)page 69-70) ((Kruk 2018) which have no direct or documented relationship to capital costs.

Deeble argued that an appropriate capital cost would have relevance for health service managers and clinicians (Deeble 2002a). Neither depreciation-based costs of capital consumption or Productivity Commission weighted estimates equip

managers and clinicians to appropriately resource contemporary clinical standards for efficiency at the DRG level.

- *Accountability.* There is minimal accountability for the cost of capital in Australian public hospitals after construction (Queensland Audit Office 2017). The Report on Government Services dismisses the importance of accountability for capital costs arguing “asset measurement effects were relatively small, because capital costs represent a small proportion of total [health] cost” (SCRGSP 2011) page 10.57) Concerns regarding accuracy, data collection and reporting quality for public hospital capital have been mentioned. (Kerr 2015) Reporting at the local hospital level and for the value of assets has been found to be below expected standards of transparency (Auditor General Australia 2019; Victorian Auditor-General 2017).
- *Equity: Standards of access and equity.* Australian hospitals providing care to similar patients have different capital endowments based on factors including heritage (Chapters 2 and 4) and political influence (Chapters 4 and 5) (Deeble 2002a). Equity of access to clinical services for special needs groups and rural Australians is a key performance indicator for Australian governments providing public hospital care (SCRGSP 2017). However, reports are silent on the equity and access issues for patients in regard to the allocation of capital for hospital services. Indeed the Report on Government Services identifies that a low or decreasing capital cost per separation “...can reflect more efficient service delivery in public hospitals.” (SCRGSP 2017) page 12.29). Alternatively, it could reflect capital that is old with an absence of recent investment and replacement and underinvestment (Chapter 2.6.3). So a depreciation-based value for capital reimbursement would not address any existing issues of underinvestment identified in Chapters 4 and 5. Similarly a depreciation-based capital cost payment would not address issues of resource maldistribution, or support innovation and could be seen to perpetuate institutional rather than patient-centred investment (Tudor Hart J 1971; Deeble 2002a).

Accuracy, equity and accountability with appropriateness, sustainability and innovation have been identified as significant characteristics of an effective Australian capital allocation system. If Australia were to adopt a system of capital funding based on diagnosis groups and contemporary standards for clinical practice, rather than depreciation, how would it work and what would it cost? The next section examines the literature on these key aspects.

7.1.2 Literature to guide model design

The grey and peer reviewed literature were scanned (using the same parameters set in Chapter 2) applying the search terms “Capital” AND “estimation model” AND “hospital*” however no new references were found.

Previous literature reviews (Chapter 2, 4 and 6) had identified two Australian and five international approaches to estimating costs. The two Australian approaches were:

Australian Productivity Commission capital cost estimation

The appropriate measure for costing hospital services was identified as ‘Cost per patient episode’ or separation (Council of Australian Governments(COAG) 2011c; SCRGSP 2017; SCRGSP 2018). However, the Productivity Commission modelling approach is limited for accuracy, weighting and as a depreciation-based figure as discussed in 7.1.1 and for:

- *Timeliness*; Estimates of capital costs per weighted separation have a two to three year lag due to data availability.
- *Assumptions*; The method (dividing total capital by all separations) assumes State-level capital allocations are equally distributed for all patients. This assumption has been disputed at State level (Bansemer 2014; Garling 2008b; Deeble 2002a; Menadue 2003; Richardson 2004; Travis 2015), and
- *Relevance*; The capital allocation calculation has no connection to appropriate clinical standards (effectiveness) or sustainability(SCRGSP 2017).

Australian Independent Health Pricing Authority depreciation per DRG

The IHPA includes depreciation for buildings (Dep. B) and medical equipment (Dep. E) in the National Hospital Costs Data Collection(IHPA 2014a) costing AR-DRGs (IHPA 2019b). However, depreciation costs are not included in the National Efficient Price for Services¹. Capital costs by state are aggregated depreciation costs from total hospital buildings and equipment allocated to inpatient episodes assuming all patients have the same access to capital resources(IHPA 2014a).

Analysis of capital in the Australian system is silent on the value and distribution of IT and communications systems and electronic medical records systems.

¹ Advice from the IHPA Director of Pricing 2 January 2018.

International capital cost estimation models

Five different approaches to modelling capital costs were identified from the literature for capital cost modelling for diagnosis-based allocations. The first two sought alignment with patient demand, the second two were asset-focussed and the fifth was determined by political issues:

- Set a notional value for capital of about 8% of recurrent costs (Vogl M 2014)
- Fund capital costs for imaging and other diagnostic technologies allocated by resource consumption (using the number of tests as an allocation factor). (Sánchez-Martínez 2006)
- The German system is based on hospital-level accounting of capital costs, with specific cost centre and cost category accounting to provide transparency. (Vogl M 2014)
- The English approach combines operational and capital funding in one payment for patient care. Capital estimates are focussed on estimating the capital charge- i.e. the exact dividend hospitals are required to pay on publicly provided capital or the rent to the private finance (PFI) provider. (Vogl M 2014; Shaoul 2011; Wright 2010)
- The USA uses a formula to determine the capital payment for public hospital costs to cover depreciation, interest, rent, insurance and taxes. The formula reflects a number of political considerations in adjustments. The formula is DRG capital payment = (Standard Federal Rate) x (Geographic Adjustment Factor for wage rates) x (Capital Cost Of Living Adjustment for Hospitals Located in Alaska and Hawaii) x (1 + Disproportionate Share (of uninsured people) Hospital Adjustment Factor + Indirect Medical Education Adjustment Factor) x (MS-DRG Weight) (Centers for Medicare and Medicaid Services 2018).

While DRG-aligned capital allocation systems were identified as promoting the ability of hospitals to fund patients access to efficient services (Chapter 6), none of the systems of capital funding directly referenced contemporary clinical standards, sustainability or evidence-based innovation. The primary research question objective is to combine the characteristics of an effective capital allocation system (Ch.2.6.4) with the advantages of a DRG-based capital allocation system.

7.1.3 Foundations for capital funding model development

Previous chapters have identified the criteria for a capital system that funds hospitals that are appropriate, sustainable and innovative:

- Recognise national standards, evidence-based innovation and be patient-centred (Chs.2.5, 2.6-7, 2.9, 2.10.3-4, Figure 3.2),
- Provide for the efficient delivery of services (Ch.2.8, 4.5, Figure 3.1),
- Provide patients with equitable access to services (Chs.1.1, 2.6.3, Figure 3.1)
- Provides transparency in the decision-making on hospital capital (Chs. 4.6, 6.4)
- Aligns with contemporary clinical standards rather than historic investments (Chs. 1,2.6.2, 2.6.4 .2.7-10, 4.4-9, and 5.5-6.) and
- Displays allocative efficiency through regular, flexible, affordable, fairly distributed and consistent access to capital funding (Ch.6.4.2, 6.5, Figure 6.2(Kerr and Hendrie 2018))

An effective model for capital allocation would also allow capital inputs be related to patient outcomes and recognise differing severity or acuity levels for patients.(Burgess 2007)

7.2 Research question and aims

The aim of this chapter is to develop a model of capital cost allocation (Research Objective 2) that:

- Is appropriate to contemporary care in Australian hospitals as defined by diagnosis-related groups,
- Relates to Australian hospital and building standards and clinical guidelines,
- Responds to clinical practice and technological developments, and,
- Reflects accurately the capital cost of providing care per patient.

In order to address the second research objective (Ch.3.2), which is to create a model in which the capital amount required for each patient care episode using DRG's can be estimated to facilitate appropriate and sustainable, acute care, requires the following question to be addressed: for a typical patient episode (in a range of DRG's) what capital is:

- a. directly involved in patient care
- b. indirectly required as part of the common facilities in a hospital and
- c. required for key activity areas (imaging, ICU/HDU, operating theatres etc.).

7.2.1 Tasks

To achieve the research objective, ten tasks were identified to develop the model for estimating capital costs:

- Task 1: Select a sample of DRGs to use as test cases to develop a model representing a significant numbers of public hospital separations.
- Task 2: Chart the patient's clinical pathway for the selected DRGs according to Australian standards of care.
- Task 3: Identify the capital elements (facilities, medical equipment and ITC) directly required for an appropriate episode of care for the selected DRGs.
- Task 4: Identify the capital elements (facilities, medical equipment and ITC) indirectly required for an episode of care for the selected DRG. This involved Identifying the capital required for a hospital providing the appropriate level of service for all the selected DRGs.
- Task 5: Identify direct clinical and patient requirements for access to theatres, ICU/HDU/CCU, procedure rooms, imaging suites and other key activity areas.
- Task 6: Identify the patient spaces directly-required for appropriate clinical care including accommodation with bathrooms, provisions for carers, bariatric rooms, isolation spaces, waiting areas, short-stay beds and chairs,
- Task 7: Establish a method for estimating costs for capital elements within the hospital.
- Task 8: Cost the capital elements directly required in an episode of care and conduct sensitivity testing
- Task 9: Cost the indirectly-required capital elements and conduct sensitivity testing
- Task 10: Identify the patient capital requirement for the selected DRGs based on summed costs of direct and indirect requirements of capita for facilities, medical equipment and ITC.

Figure 7.1 is a diagrammatic representation of Tasks 1 to 6 with key activity areas identified in purple and areas less commonly recognised but essential 'back of house' areas coloured in green. A diagrammatic representation of Tasks 7 to 10 is presented in Figures 7.2 and 7.3 (Section 7.3).

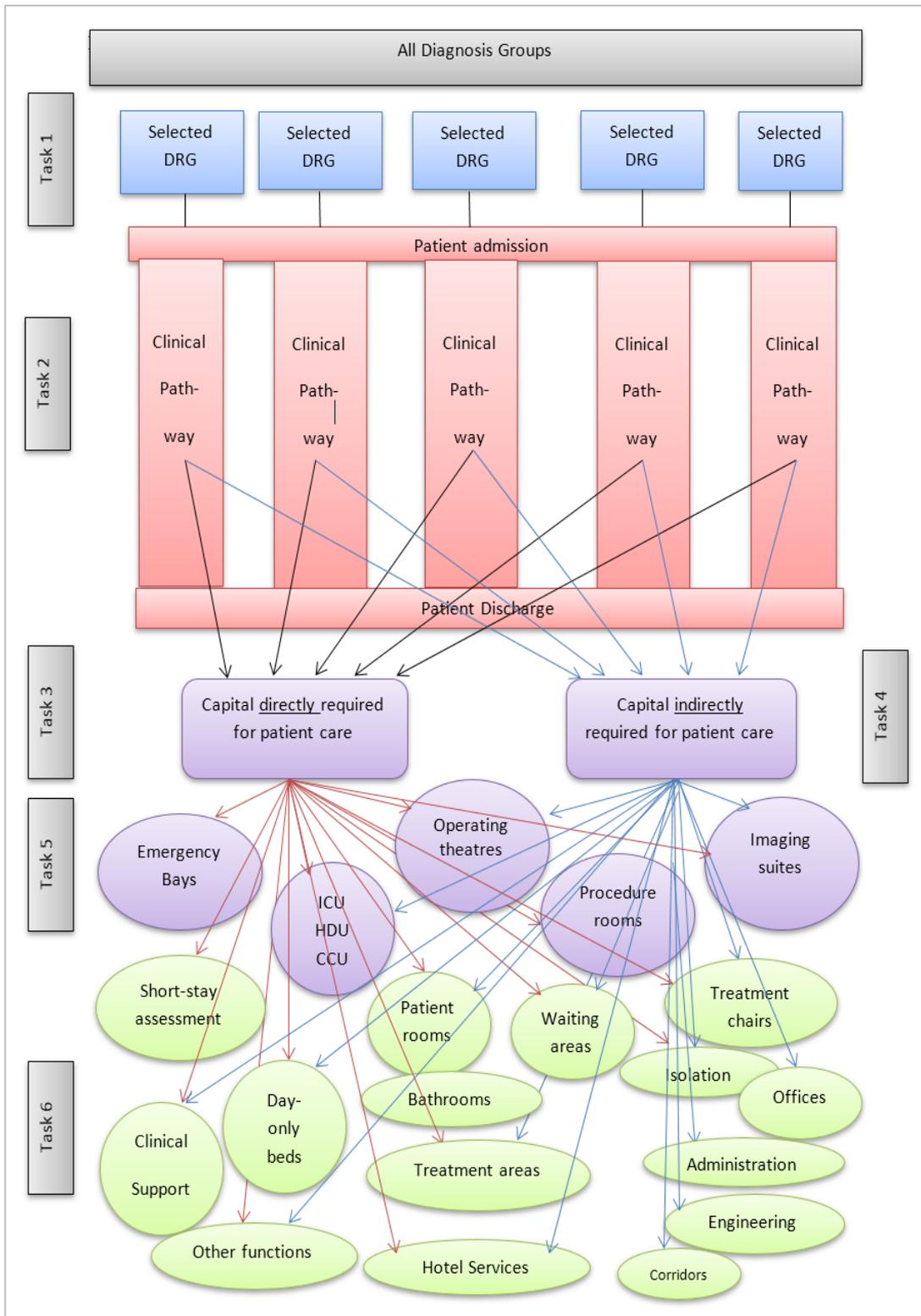


Figure 7.1 Capital elements directly and indirectly required in an episode of care for specific Diagnosis Related Groups by task

7.3 Methodology

The methodology for developing a model for valuing capital costs is outlined in this section with detailed information presented in sections 7.4 to 7.8. The proof-of-concept testing of the patient-based system of capital costing for high volume DRGS are presented in Chapter 8. Development of a diagnosis-based model for capital allocation adopted three methods:

1. Construction of a formula to outline capital requirements for patient care in a transparent, manner and incorporating appropriate standards of care through guidelines, standards and clinical advice based on an inpatient clinical pathway (Section 7.7). The model includes:
 - Directly-required patient and clinical areas for individual DRGs:
 - specified by type of area and
 - apportioned by utilization evidence to the patient level.
 - Areas indirectly-required for patient care apportioned to the DRG based on a model hospital developed to approximate an appropriate hospital setting (see Section 7.7)(NSW Health 2016c)
 - key activity areas required by patients within the DRG (e.g. ICU, CCU, Emergency Department, operating theatres, imaging, procedure rooms)
 - Medical equipment requirements and
 - ITC requirements.

A process for verification of the model used is in section 7.5.3.

2. Interviews with clinical and other authorities (Section 7.6):
 - Semi-structured interviews were conducted with clinical authorities based on clinical pathways and guidelines to define the patient clinical pathways and the capital elements required during an admission, and
3. Costing- models of costing were considered and a costing model adopted (Section 7.8). For each of the selected DRG's the cost of capital per patient was the sum of:
 - directly and indirectly required capital areas per DRG apportioned to the patient level
 - Medical equipment costs
 - ITC costs.

7.3.1 Formulae for model of capital estimation

The cost of capital to provide care for each diagnosis group is established based on the following equations for an individual patient(i) in a specified diagnosis group (j):

$$\begin{aligned} K_{ij} = & \text{Areas}_{ij} \text{ (Direct}_{ij} \text{ and Indirect)} \\ & + \text{Medical Equipment}_{ij} \text{ (Direct}_{ij} \text{ and Indirect)} \\ & + \text{ICT Systems}_{ij} \text{ (Direct}_{ij} \text{ and Indirect)} \end{aligned}$$

Major elements of K_{ij} (areas and equipment) are apportioned to the patient level(i) and then costed. ICT system costs are apportioned across all patients. Apportionment factors, based on utilization and functional lifespan, are identified for each DRG costed in Chapter 8, Sub-section 4 (8.2.4, 8.3.4, 8.4.4 and 8.4.4)

The formula for calculating the capital cost is similar in form to the formula used by the IHPA to calculate the price weights of the National Efficient Price for recurrent funding of ABF which distinguishes between types of patient care using buckets for direct and indirect costs (IHPA 2016). Each of the main elements of the formula (Areas, Medical Equipment and ICT) are discussed in more detail below.

Areas

Drawing from the AHFG the Direct Areas element of capital was defined as follows:

$$\begin{aligned} \text{Direct Area}_{ij} = & \text{Entry area}_{ij} + \text{assessment area}_{ij} + \text{diagnosis area}_{ij} \\ & + \text{treatment areas}_{ij} + \text{patient accommodation}_{ij} \\ & + \text{clinical support}_{ij} + \text{critical care}_{ij} + \text{staff areas}_{ij} \\ & + \text{amenities}_{ij} + \text{circulation}_{ij} + \text{outpatient clinic}_{ij} \end{aligned}$$

Descriptions of these areas are in the glossary (Appendix 1). Further details are presented below.

As an apportionment factor, lifespan is defined as the projected viable use of the facility or equipment so costs reflect both structure and fitout. No Australian research has been published on hospital functional area lifespans but 50 years is accepted as the viable lifespan (Deeble 2002a; Australian Taxation Office 2016). Little is written about the lifespan of hospital buildings but Dutch research on hospital lifespans has identified a range of lifespans for functional components of a hospital (Netherlands Board for Healthcare Institutions 2007b). It is recognised in Norway, Germany, France, the UK and the USA that lifespans are determined by differing degrees of functional specificity, technical

construction and maintenance costs (Bjorberg 2009; Joe 2013; Schinko 2016; Dodswell 2009; Sun 2009; Ward 2019). These lifespans vary in the level of technology required in the building areas and the degree to which areas can be adapted for other purposes.(Netherlands Board for Healthcare Institutions 2007b) Lifespans were identified as:

- Hospital structure as 40 years
- 50 years maximum for office and hotel services
- Clinical areas (hot floor and industrial areas) 20 years (Netherlands Board for Healthcare Institutions 2007b)page 31).

The international evidence based standards are used where there is no Australian determination(Australian Taxation Office 2016). Unit construction cost is taken at current levels as outlined in Section 7.8

Determining the indirect costs for patients required development of a typical or standard model hospital relevant to the care needs of most patients admitted to Australia hospitals. The schedule of areas (SOA) was created for a standard or general hospital able to provide most clinical services excluding highly specialized care for small numbers of very unwell patients such as a transplant or burns unit or high-level trauma. The model hospital is identified as the Girt-by-sea General Hospital.

Australian hospital services are described in terms of the complexity of cases, range of supporting services (pathology, imaging, intensive care, operating theatres and trauma), staffing levels and qualifications and facilities in nationally recognized role-delineation standards.(NSW Health 2002, 2016c; Health Department of WA 2010). Model development aimed to identify areas based on the lowest-cost appropriate environment for care. The most commonly used DRGs conformed to the care provided in general hospitals designated Level 4 hospitals (Appendix A Glossary). Areas and equipment specified conform to this standard.

The Indirect Areas component for a model or standard Level 4 hospital were created by summing the standard Level four services listed below.

Indirect Area = Standard Level 4 hospital benchmarked area sums the following areas:

- administration and executive-medical records, pastoral care, divisional offices, medical staff room, education and training,
- inpatient wards-medical and surgical, obstetric, paediatric, psychiatric acute , psychogeriatric, high dependency unit (HDU), coronary care unit (CCU), intensive

care unit (ICU), neonatal care including NICU, palliative care and sub-acute-rehabilitation and geriatric,

- day-only-chemotherapy, day medical, day surgical, renal dialysis,
- clinical- emergency bays, endoscopy suites, operating theatres, cardio-vascular intervention labs, labour delivery recovery(LDR), ESSU, Central Sterilizing Supply Department(CSSD), imaging, CT scanning, fluoroscopy, general x-ray, mammography, ultrasound, magnetic resonance imaging(MRI), nuclear medicine, pharmacy, pathology, mortuary, biomedical engineering, hydrotherapy pool,
- day-only - allied health including audiology, dietetics, occupational therapy, orthotics, physiotherapy, podiatry, speech pathology, social work/counselling casework, other rehabilitation day area, Aboriginal and Torres Strait Islander Unit and outpatient clinics,
- hotel- kitchen-receiving cook/chill, engineering, environmental services, linen services (receiving only), supply/materials management, waste management, information technology, archive, public/staff cafeteria, main entry/public areas, staff amenities and security.

The summed indirect cost figure was modified in three ways. The first was to calculate the areas for Plant (areas for building equipment such as air-conditioning, boilers, pumps, electricity supply etc.) and Travel (corridors outside departmental spaces) as 12.5% and 15% of gross departmental area. These margins are specified in the AHFG. These additional areas were added to the summed value of indirect costs.(Australasian Health Infrastructure Alliance 2004-2018)

The second modification was to subtract areas that will never be required by patients in the DRG (j) or that would otherwise be double counted. For example uncomplicated obstetrics patients would not be anticipated to require psychogeriatric areas or geriatric rehabilitation. The obstetrics department and Labour-Delivery-Recovery rooms are subtracted to avoid double counting as they are counted in direct costs. The result for each DRG is called the Indirect Residual Area.

The third modification was to calculate the indirectly required areas for patient (i) per day by:

- Categorising the residual areas into areas aligned with the Dutch layers approach (offices, patient accommodation, Critical care, Clinical/ Industrial areas)(Netherlands Board for Healthcare Institutions 2007b) as each have different construction costs, degrees of technological specificity and flexibility of use and lifespans
- Dividing by the relevant lifespan in years and operational days,
- Dividing by the number of patients per day then
- Dividing by recommended occupancy level for the area.

The result is the area required per patient in metres containing specifications for specific areas (including ICU, operating theatres and Emergency department).

Medical Equipment_{ij} (Direct_{ij} and Indirect_{ij})

The direct costs of medical equipment required for patient care are listed and costed under each DRG.

The Indirect costs for most medical equipment were included in the indirect area costings. However, the aim to have major medical equipment including Computerised Tomography Scanners (CT Scans), Magnetic Resonance Imaging scanner (MRI), Positron Emission Tomography scanners (PET), Gamma Cameras, Digital Subtraction Angiography X-ray equipment, Mammography equipment, Radiation therapy equipment (e.g. Linear accelerators), and Lithotripters separately indicated and costed was not achieved due to an absence of evidence-based reliable data. As a factor is held in the equation for indirect medical equipment costs the apportioned costs for medical equipment indirectly required can be added when reliable data becomes available.

IT and Communications Systems_{ij} (Direct and Indirect_{ij})

Specific requirements for ITC indicated in guidelines or by clinical experts are listed under each DRG. However, while ITC system strategies are published, ICT costs for most hospitals are not published.

No reliable information was found for Level 4 hospital development IT costs. A factor is held in the equation for an indirect cost hospital ICT cost to be apportioned to patient(i) across all DRG's when access to cost information is achieved.

Summing these three components of the capital used in patient care captures all the categories of capital present in the literature and therefore should ensure all capital costs associated with inpatient care are included. To test this assumption experts were asked to review the data as outlined in the following section.

7.3.2 Data source selection

Six methods of data collection were examined for gaining reliable and appropriate information on the capital requirements for diagnosis groups. The information-gathering methods considered were:

1. expert opinion (seeking the advice of architects, engineers, project managers, hospital managers and senior health officials)
2. mixed specialist focus groups (group discussions including medical practitioners, specialist nurses, allied health practitioners, hospital administrators and patients)
Specialist focus groups (or user groups) are commonly used in hospital planning (Eagar 2001; Queensland Department of Health 2012) however they are focused on a single facility outcome and are constrained by facility-specific operational protocols.
3. clinical practice guidelines (adapting the information in clinical guidelines to physical areas),
4. clinical pathways (In Australia clinical pathways are used in coordinating care, describing accepted clinical processes and to minimize clinical practice variation and risk (Allen 2008; Padman 2016; Müller et al. 2009; Guerrero 2009) aligning with documentation points within the patient medical record (Hyett et al. 2007) (Queensland Health 2015d). Clinical pathways can be used to plan health facilities (Shibeika 2009; Barbagallo 2015; Rechel 2010; Netherlands Board for Healthcare Institutions 2007b)(Chapter 5)
5. replicating recently constructed hospital projects (drawing from the capital costs of recently opened general hospitals), and
6. contemporary hospital building standards (creating schedules of accommodation for patient spaces from building standards).

Criteria for evaluating the method for gaining advice on the capital needed for patients were that the information was:

- evidence-based, approved and peer-reviewed (Evidence)
- a standard recognised on a national or state basis (Standard)
- able to be replicated on a national or state basis (Replicable)
- reflecting contemporary clinical standards of detail not covered by standards (Clinical) and
- able to provide the detailed level of information required to populate the model (Detailed).

The methods were set against the criteria in Table 7.1. Clinical pathways were assessed as best meeting the criteria (5 criteria fulfilled) while providing a broader patient-centred platform to gain expert clinical opinion (4 criteria), attach clinical guidelines (3 criteria) and adopt contemporary hospital building standards (3 criteria). Clinical pathways permit inclusion of external standards and practice guidelines, expert opinion and post-occupancy evaluations for a less institutionally constrained result.

Table 7.1 Criteria of methods for informing the capital estimation model

Method	Criteria					Criteria Fulfilled
	Evidence	Standard	Replicable	Clinical	Detailed	
Expert opinion	✓	✓		✓	✓	4
Mixed specialist focus groups				✓	✓	2
Clinical pathways	✓	✓	✓	✓	✓	5
Clinical practice guidelines	✓	✓		✓		3
Replicating recent hospitals			✓		✓	2
Hospital building standards.	✓	✓			✓	3

7.3.3 Clinical Pathway as a platform to identify capital requirements

The approach adopted was for the higher ranking information gathering methods to inform the clinical pathway. The clinical pathway is closely defined for this study to mean the 'patient journey' in hospital, from admission to discharge (Figure 7.1)(Appendix A Glossary)(Kinsman 2010) The clinical pathway (for selected DRGs) has been grounded in approved clinical guidelines and health facility standards. Guidelines can be out-of-date

without clinical expert review(Productivity Commission 2015). So expert clinical advice has supplemented published guidelines to (i) ensure the guidelines remain appropriate and (ii) detail clinical practice and patient requirements. This approach reflects the methods used to determine AHFG using clinical guidelines, expert clinical advice, research, building standards and consultation(Australasian Health Infrastructure Alliance 2004-2018; Centre for Health Assets Australasia 2010) (Interview 13 February, 2016).

7.3.4 Data sources for Direct and Indirect capital

While the clinical pathway captured the capital directly required for contemporary inpatient care, additional hospital resources are required to fully support appropriate clinical care. To capture these and ensure all capital costs were included model development followed the form of AR-DRG costing – using direct and indirect costs associated with patient care (detailed in Ch.7.7.2.) (Australian Consortium of Classification and Development 2014; Australian Consortium for Classification and Development 2016; Duckett S 1994a)The direct and indirect method of identifying capital requirements (for built capital, medical equipment and ICT) was adopted to:

- align with the National Hospital Costs Data Collection (NHCDC) method for aggregating costs into cost buckets
- as an aggregating framework for cost identification and inclusion (a proforma) and,
- to connect with the DRG-based efficient price mechanisms for allocating recurrent funds.

Beginning the process Australian clinical standards and guidelines were used with Australasian Health Facility Guidelines to chart the spaces required for a draft clinical pathway for specific diagnosis groups. The draft patient clinical pathways, areas and medical equipment schedules were presented and discussed in semi-structured interviews with clinical experts (Ch.7.6) (Figure 7.2)

Directly required capital elements

Areas and equipment directly required for contemporary patient care, guidelines and standards (and contemporary peer-reviewed studies) formed the basis for the draft clinical pathways. As outlined in Section 7.6 expert clinical opinion was used to provide practice detail verifying and augmenting the guidelines.

For built capital the information on directly-required built spaces was listed by room (including plant and travel) and summed in the form of a list of required spaces or Schedule of Accommodation. The time patients require access to specific areas was obtained through expert clinical interviews, guidelines and other data sources including national clinical data collections, the ATO, AIHW and ABS. This data informed both:

- the Patient Space Allocation Tool shown in Figure 7.2 and detailed in Figure 7.3, and
- the allocations of medical equipment and ITC (Access and Apportionment) of Figure 7.2.

Utilization of an area and the time a patient required access to an area were the allocation factors (Ch.7.7.6). When the apportioned capital requirements (in terms of built spaces, equipment and ICT) were costed and summed, an amount for capital per patient for that DRG was determined (Figure 7.2).

Indirectly required capital elements

Indirect capital required to be available for contemporary patient care from shared facilities and equipment (administration, air-conditioning, allied health, catering, cleaning, corridors, emergency department, ICT, imaging, ICU, linen, pathology, reception, sterile supply, stores, waste, water supply etc.) was allocated to the DRGs based on the time patients were in hospital.

Again utilization and time were allocation factors (Section 7.8). When the apportioned capital requirements (in terms of built spaces, equipment and ITC) were costed, an amount for capital per patient for that DRG was determined (Figure 7.2).

Patient space allocation (Figure 7.2 and Figure 7.3) was based on clinical guidelines, the advice of clinical and expert interviews for the time areas and equipment were required. Apportionment of the time patients or clinicians required equipment or facilities was from the same sources (Figure 7.2 and Figure 7.3) and is described in Section 7.8. with specific applications in Haemodialysis in Section 8.2.4, Obstetrics in Section 8.3.4, Hip Replacement in Section 8.4.4 and Knee replacement in Section 8.5.4. Costing indices are discussed in detail in Section 7.7.8

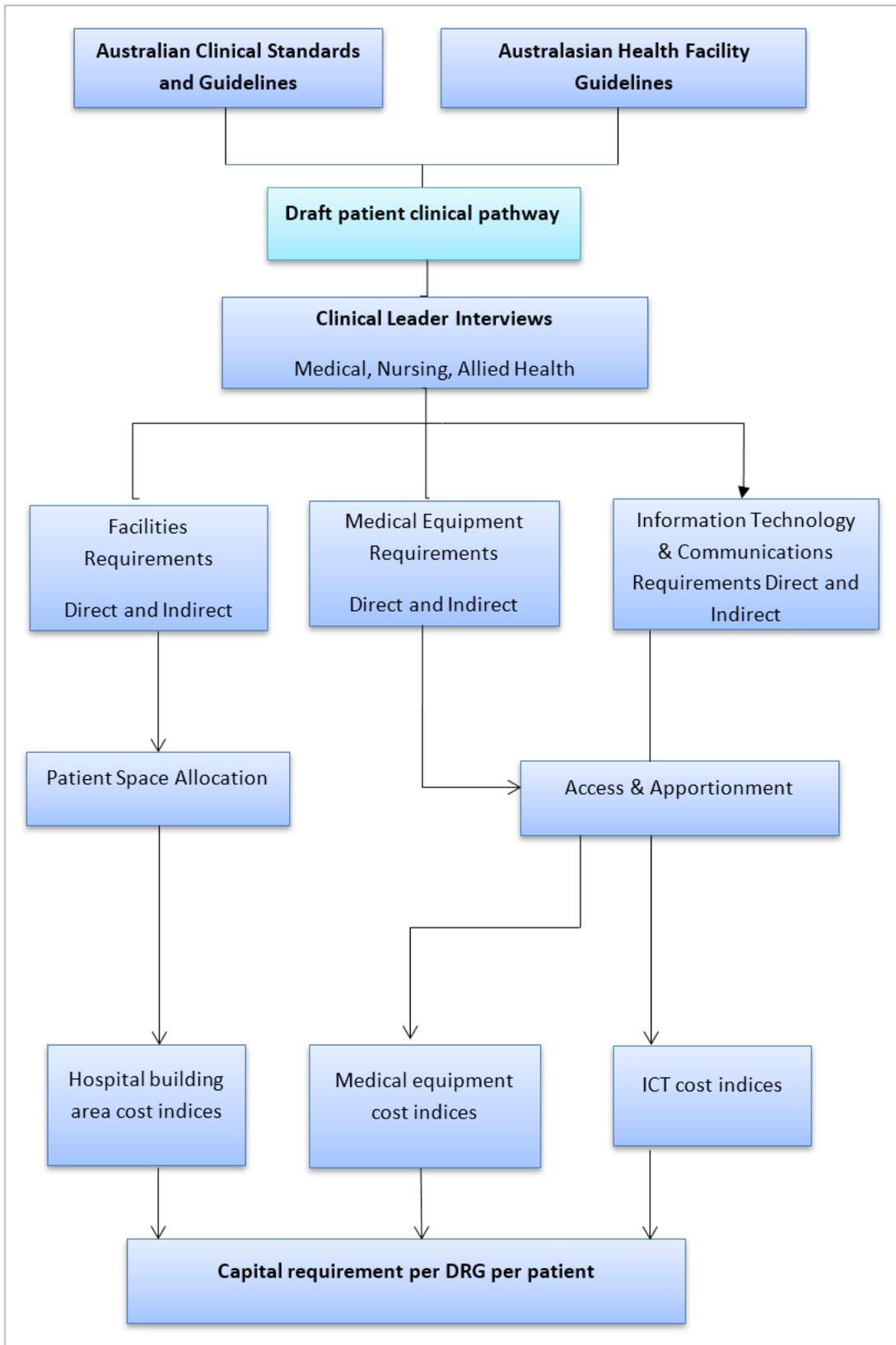


Figure 7.2 Process for identifying the cost of capital required for an Australian DRG

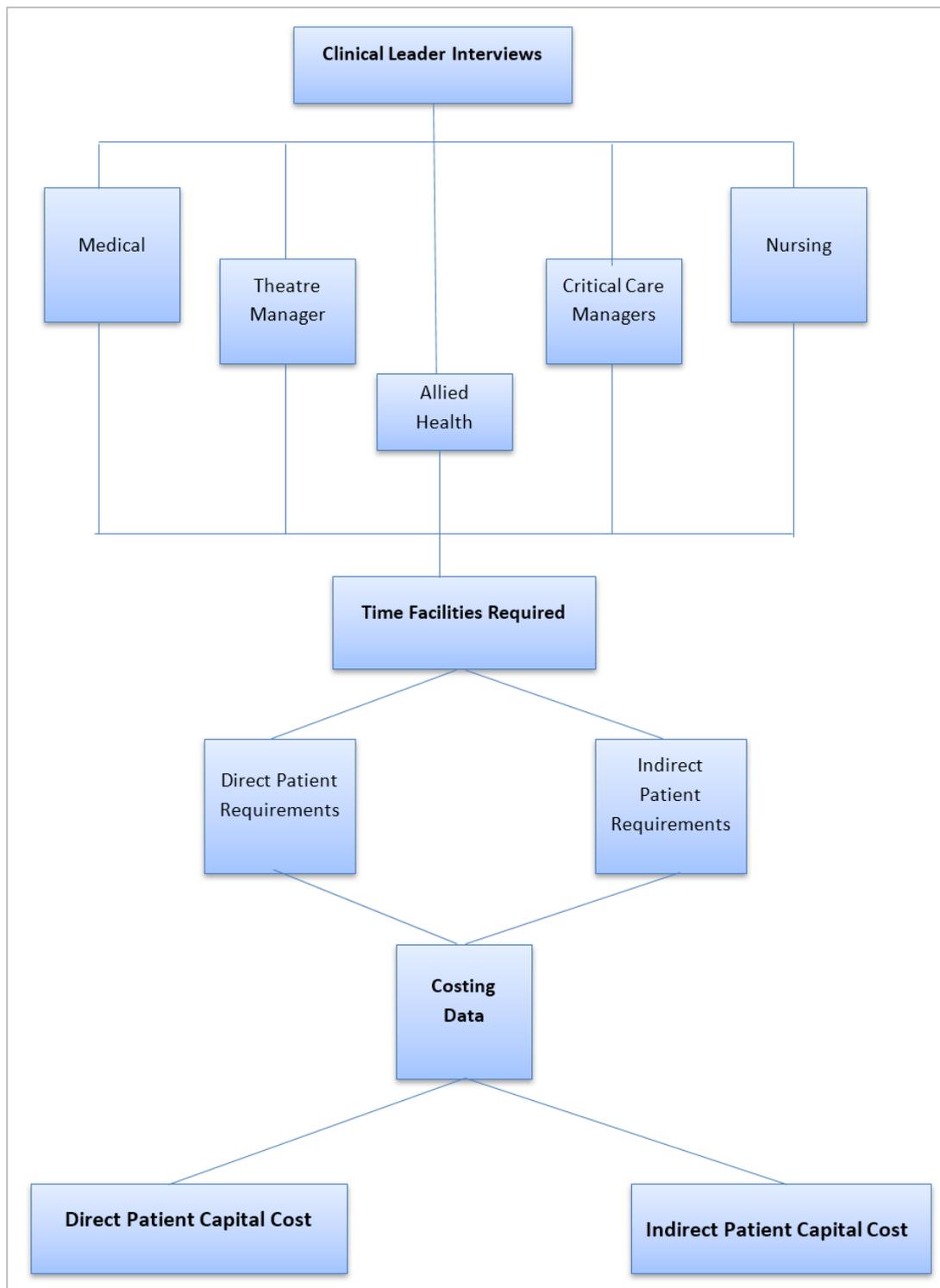


Figure 7.3 Patient Space Allocation Tool for facilities

Costing capital using clinical pathways by DRG is new. Evidence has been used to collect information and verify clinical advice. Adaption of the National Hospital Cost Data Collection method of cost identification for DRGs into direct and indirect costs endeavors to capture all known costs. However, some hospital-based capital costs such as motor vehicles may sit outside the categories of built, equipment and ICT capital. Similarly, areas

and costs for multi-storey hospitals will differ from single storey hospital buildings. Specific bottom-up costing of capital for hospital departments, including administration and vertical transport is required to ensure costings are comprehensive. Advice on the verification of some methods and data was sought from specialists in DRG application, categorisation and costing at the National Centre for Classification in Health (NCCH), health leaders (the Australian Council on Healthcare Standards, the Australasian College of Health Service Managers), Health and Treasury officials and Australian and US health architecture experts (listed in Appendix G). The methods were also presented at three international conferences. No changes were required to the methods based on the expert advice.

7.4 Selection of the Sample of Diagnosis Related Groups (Task 1)

7.4.1 Selection Criteria

An appropriate selection of DRGS was required to test the validity of the method for a proposed system for costing the capital for patient care. Using criteria from Ch.7.3.2 the number and range of DRGs were selected using a filter or sieve approach asking if there was:

- sufficient evidence for charting a clinical pathway(Evidence)
- a common standard of service to be delivered in each state(Standard)
- ability to replicate the research for each state (Replicable)
- defined clinical standards and outputs available(Clinical) and
- a sufficient level of detail required to populate the model (Detailed).

To meet these inclusion criteria DRGs considered were:

- high volume DRGs present in most acute public hospitals across Australia,
- DRG's representative of the requirements for acute care of over 25% of Australian public hospital presentations,
- relevant to a range of care facilities normally found in a general public hospital,
- DRGs for which clinical advice from a range of expert medical, nursing and allied health professionals could be accessed from across Australia and
- Experiencing changes in model of care relevant to innovation and dynamic efficiency.

Exclusion criteria were DRGs with:

- low patient volumes
- limited access to expert medical and clinical advice
- complex medical governance (more than one medical specialty routinely managing significant components of care)
- an absence of clinical guidelines.

7.4.2 Selection method process

AIHW data for the 20 most common AR-DRGs for separations in 2011-12 to 2015-16 were examined to determine the most frequently used DRGs in Australian public hospitals(AIHW 2013a, 2014a, 2016a, 2017b).

The seven high volume DRGS met the criteria for:

- A range of care facilities normally found in a general hospital. Treatment for these DRGs utilised operating theatres, emergency departments, procedure rooms, wards, day-of-surgery-admission (DOSA), day-only chairs, ICU, rehabilitation, clinics and a range of clinical and general support services.
- Each of the DRG's was found to be experiencing technological and model of care change relevant to innovation and dynamic efficiency.

These DRGS were selected at the time of research and subsequently there may be other higher volume DRGs. Other high volume DRG's with clinical guidelines were assessed (chest pain, stroke and chemotherapy) but were not pursued through a series of national clinical interviews due to time and cost limitations. The model approach was amenable to determining capital costs for chest pain, stroke and chemotherapy.

Seven DRG's comprising 36% of all public hospital separations in 2014-15(AIHW 2016b) were identified:

- AR-DRG L61Z Haemodialysis represented 19% of all public acute separations(AIHW 2016b)
- Obstetric DRGs O01B and O01C for caesarean delivery and O060B for vaginal delivery was 9.6% of public hospital separations. (AIHW 2015c)

- AR-DRG O60C (overnight and day-only) represents 7% of all public hospital separations for 2013-14 .(AIHW 2015a)
- AR-DRG I03B Hip replacement, minor complexity
- AR-DRG I04B Knee Replacement, minor complexity.

To fulfil the criteria a literature scan for guidelines pertaining to these procedures was conducted.

7.4.3 Literature scan for clinical guidelines for selected DRGs

Grey and peer reviewed literature was scanned for clinical standards and guidelines for the DRGs selected. The search strategy from earlier chapters was maintained using the processes, databases and parameters of the previous reviews. Search terms used were:

1. “Australian Obstetric* Guidelines” and “Australian Obstetric* Standard*”
2. “Australian H*emodialysis Standard*” and “Australian H*emodialysis Guideline*”
3. “ Australian Knee Replacement Standard*” and “ Australian Knee Replacement Guideline*”
4. “ Australian Hip Replacement Standard*”and “Australian Hip replacement Guideline* and
5. “ Austral* clinical pathway*.

Government websites and publications (Commonwealth Health and agencies, NH&MRC, State governments) were searched for guidelines and standards supplemented by National and State professional and association websites.

Exclusion criteria for the reviews eliminated references previously identified, for singular hospitals or departments, other definitions of capital (social, human or intellectual capital) and articles on hospital ownership.

7.4.4 Literature scan results

Detailed Commonwealth, national professional and state guidelines(n=27) were identified for the seven DRGs listed in 7.4.2. The clinical guidelines are discussed in clinical pathway development for each DRG (Ch’s 8.2 Haemodialysis, 8.3 Obstetrics, and 8.4 and 8.5 Hip and Knee replacements). Little variation was found between the state guidelines although some provided more detail of the clinical pathway. Eleven journal articles were identified from the literature and standards were identified from the Australian

Consortium for Classification and Development, the Independent Health Pricing Authority, and the Australasian Health Facility Guidelines.

Building from the clinical guidelines a draft clinical pathway was prepared for each of the seven DRGs. Clinical experts from across Australia were asked to consider the clinical pathway and capital required for that pathway for their patients

7.5 Expert Interviews

Semi-structured interviews based on draft clinical pathways were used to determine the capital direct and indirectly required for the selected DRGs. Draft clinical pathways for each DRG composed of capital elements (areas, equipment and ICT) were prepared from clinical guidelines. Advice on contemporary standards of care was sought from professorial clinicians, professional body leaders and the clinicians they recommended as performing at Australian practice standards. This section outlines the selection of interviewees (7.5.1), the design of the clinical pathway questionnaire (7.5.2) interviews and transcription (7.5.3) and verification (7.5.4)

7.5.1 Selection of Interviewees

Clinical professors of medicine, surgery, nephrology, nursing, physiotherapy and midwifery in NSW, Queensland, Victoria and WA were approached for interview by email. The invitation specified the DRG for discussion and outlined the method. Professors were asked for recommendations of clinicians in active practice if they were not actively practicing in the diagnosis group.

Many clinical experts were approached (17 medical specialists, 24 nursing and 6 allied health experts) and a majority agreed to be interviewed (55% of medical specialists, 71% of nurses and 80% of allied health experts). Clinicians interviewed were in contemporary practice in capital cities (69%), outer metropolitan hospitals (13%) and regional centres (18%). A saturation approach was adopted as the clinicians were being asked yes/no questions on facilities and equipment.

Haemodialysis

Three Professors of Nephrology recommended five Dialysis Unit medical and nursing leaders for interview but, despite eighteen attempts, interviews were not achieved. The Australasian Health Facilities Guidelines access clinical advice through the NSW Clinical

Excellence Commission clinical network for clinical advice on the physical requirements for haemodialysis. Forming user groups of clinicians involved in haemodialysis they examined contemporary research, models of care, data and evidence on performance, clinical and patient requirements and Post-Occupancy Evaluations (POE) to determine draft health facility guidelines. Recommended guidelines were advanced to the Health Infrastructure Alliance (an official committee reporting to AHMAC and COAG) for approval. Guidelines on the capital requirements for haemodialysis were issued during the study and have been adopted in lieu of interview advice.

Obstetrics (n=18)

Interviews were requested of professorial level obstetricians, midwives and physiotherapists in active practice in NSW, Queensland, Victoria and W.A. Three professors of obstetrics and two professors of midwifery were interviewed from three different states. Five experienced practicing midwives and nurses and two specialist obstetric physiotherapists from two states were interviewed.

Table 7.2 Obstetrics interviews

Clinical expertise	Number
Obstetricians	3
Midwife manager- ward	3
Professor of Midwifery	2
Nurse manager- theatres	2
Nurse manager- DOSA	1
Midwives	5
Physiotherapists	2
Total	18

Orthopaedics (n=13)

A professor of orthopaedics specializing in hip and knee replacement procedures, the President of the Arthroplasty Society of Australia and the head of a Level 4 hospital orthopaedics department were interviewed. A Professor of Nursing recommended Directors of Nursing in four hospitals (public and private) over two states who identified experienced nurses involved in care for hip and knee replacement in four hospitals. Nurses were from major metropolitan public and private hospitals and two regional hospitals. A professor of physiotherapy specialising in hip and knee care, an academic specialist physiotherapist and an orthopaedic clinical specialist (operating room prosthetic advisor) were interviewed. Clinical specialists over three states were interviewed.

Table 7.3 Clinical experts interviewed

Clinical expertise	No.
Orthopaedic surgeons	3
Nurse manager- ward	3
Nurse manager- theatres	3
Nurse manager- DOSA	1
Nurse manager	1
Physiotherapist	2
Total	13

7.5.2 Interviews and transcription

Interviews were conducted in person (n=21) and by telephone (n=10). Interviewees received questionnaires prior to interviews and the questions followed sequentially. Notes were made during the interview and were transcribed into an Excel spreadsheet under the relevant questionnaire headings for facilities and medical equipment. A word document was created for each DRG recording additional comments, contextual information and opinions.

7.5.3 Verification

Within three days answers to questions were returned to individual clinicians for their verification or correction, with no corrections subsequently requested. Reports to the Directors of Nursing for four of the hospitals were prepared and sent. There were no adverse comments.

7.5.4 Design of clinical pathway interview questions (Task 2)

Interview questions were designed to elicit expert clinical opinion on capital directly required following the clinical pathway for the relevant DRG's for:

- the individual rooms a patient would access
- the length of time a patient would use that space
- the medical and other equipment required to be present in that room
- ITC requirements for best-practice patient care.

Information was also sought on access to facilities that are indirectly required to:

- to be available should there be an adverse event or
- are common facilities or equipment required in an acute care setting.

Clinicians were encouraged to identify requirements to access other services, equipment and areas relevant to contemporary clinical care. The questionnaire for obstetrics and orthopaedic DRGS can be found in Appendix E.

The next section describes how the results of the interviews were modelled for direct (7.6.1) and indirectly-required (7.6.2) capital, key activity areas (7.6.4) and other non-bed areas (7.6.5). In the absence of a standard for a Level 4 hospital, a process for verification of the estimated areas for indirect capital using three measures has been developed using Australian and European hospitals as comparators (Ch.7.6.3). The measures are used to gain a sense of proportion rather than a definitive standard due to the paucity of published data.

7.6 Modelling of Clinical Advice (Tasks 3-6)

7.6.1 Directly-required capital elements (Task 3)

All areas directly required for patient care were listed by type of area according to the AHFG along the sequence of the clinical pathway. Sequentially for the obstetrics DRGs O60 B and O60C the direct care areas were Entry, Assessment, Birthing Unit, Inpatient Post-natal, Post-natal Clinic, Clinical Support and Staff Areas and Amenities.

The draft clinical pathway for directly-required services used for interviews with clinicians detailed rooms, areas and equipment from the most recent AHFG (Australasian Health Infrastructure Alliance 2016b, 2016m). Clinicians accepted the clinical pathways provided and the AHFG template requesting some additional areas be included or changing models of care decreased areas required. Obstetric areas were modestly increased (additional storage space, additional family waiting areas, more linen bays) to reflect clinical requirements in specific hospital areas (Ch.8.3.2 Sensitivity analysis). Some orthopaedic clinicians identified less space was required for orthopaedic patients with new models of care (Ch.8.4.5 Sensitivity analysis).

Areas specified by the AHFG for a Level 4 hospital were discussed and agreed for assessment, treatment and patient accommodation rooms with prevailing circulation spaces for each category. When each area plus circulation (corridor areas) was totalled for direct costs a standard allowance for Plant of 12.5% of gross floor area and 15% of gross floor area was added for Travel (corridors external to the department).(Department of Human Services Victoria 2010; Australasian Health Infrastructure Alliance 2004-2018) The same standards for Plant and Travel were applied to indirect areas.

7.6.2 Indirectly-required capital elements (Task 4)

As previously discussed (7.3.4 and hospital clinical role delineation Appendix A Glossary) clinicians interviewed for the selected DRG's identified that the DRGs reviewed comply with a Level 4 range of hospital services for both direct and indirect capital.(NSW Department of Health June 1991; NSW Health 2016c, 2002; Health Department of WA 2004; Tasmania Department of Health and Human Services 2015a) Clinicians interviewed were able to identify additional services their patients may require (ICU/ Coronary Care/Mental health services etc.) and those necessary to ensure safe clinical care. Their statements on specific indirectly required facilities and equipment were transcribed to an Excel Spreadsheet (Indirect Costs Sheet 1) for that DRG. All clinicians expected the common acute, hotel and service framework of a Level 4 hospital, supporting the work of individual clinical areas, would also be present.

Task 4 (determining the indirect capital elements required to support appropriate and sustainable care) involved modelling the capital elements required for a contemporary Level 4 public hospital.

7.6.3 Modelling the capital elements for a Level 4 public hospital (Task 4)

An Indirect Services model was required to cover the range of services expected to support a contemporary Level 4 public hospital. Design for the model of general hospital services was researched and a model was developed for a contemporary Australian Level 4 hospital (Girt-by-sea General). Design of the model drew on studies of capital allocative effectiveness from the Netherlands and the USA.(Boluijt 2005; Netherlands Board for Healthcare Institutions 2007a; Sadler 2011). First hospital departments were identified then data sources for hospital department areas were determined. Three Australian sources were used to identify relevant departments, relative bed numbers and indicative areas:

- AHFG list of Health Planning Units and non-clinical services
- Role Delineation statements and planning guidelines for hospital services (NSW Health 2016c; Queensland Department of Health 2010; Victorian Department of Health 2013; Department of Health WA 2013) and
- Area Schedules for three Australian hospitals opened between 2010 and 2016.

A list of departments, bed numbers and areas for a model Level 4 hospital (Table 7.1) were examined and agreed by:

- the President of the Australian College of Health Service Managers²
- an experienced senior NSW Health Infrastructure official,
- an adjunct Professor of Health Architecture³, and
- the immediate past Director of the Centre for Health Assets Australia at University of NSW (Appendix G)⁴.

As with the clinical pathways, the literature and standards used to develop the model hospital were supplemented by clinical advice to maximise the appropriateness of capital allocations. During interviews clinicians identified areas and equipment expected to be available in a Level 4 general hospital (purple ovals in Figure 7.1) but did not refer to the range of background clinical support and hotel services ‘generally required’ for the effective functioning of the facility (green ovals in Figure 7.1). So these were detailed from expert consultation (Appendix G), literature, guidelines and standards. This process was necessary to ensure the comprehensiveness of the capital estimate and therefore the costing in the model.

In common with directly required capital for each DRG, there are some areas and equipment that are irrelevant to the DRG such as obstetrics or paediatrics departments for adult knee replacement surgery patients. These areas were removed to improve the specificity of the capital requirements. The process for capture of the less obvious areas is outlined on the right of the following diagram (Figure 7.4).

The capital model (Figure 7.4) for indirectly required facilities and equipment considers all facilities generally available in a Level 4 hospital and subtracts those service areas patients from that DRG will not require. Areas required in direct costings are usually not included in indirect costings to avoid double counting.

² Correspondence 5 March 2017

³ Telephone confirmation 27 February 2017

⁴ Correspondence 13 January 2017

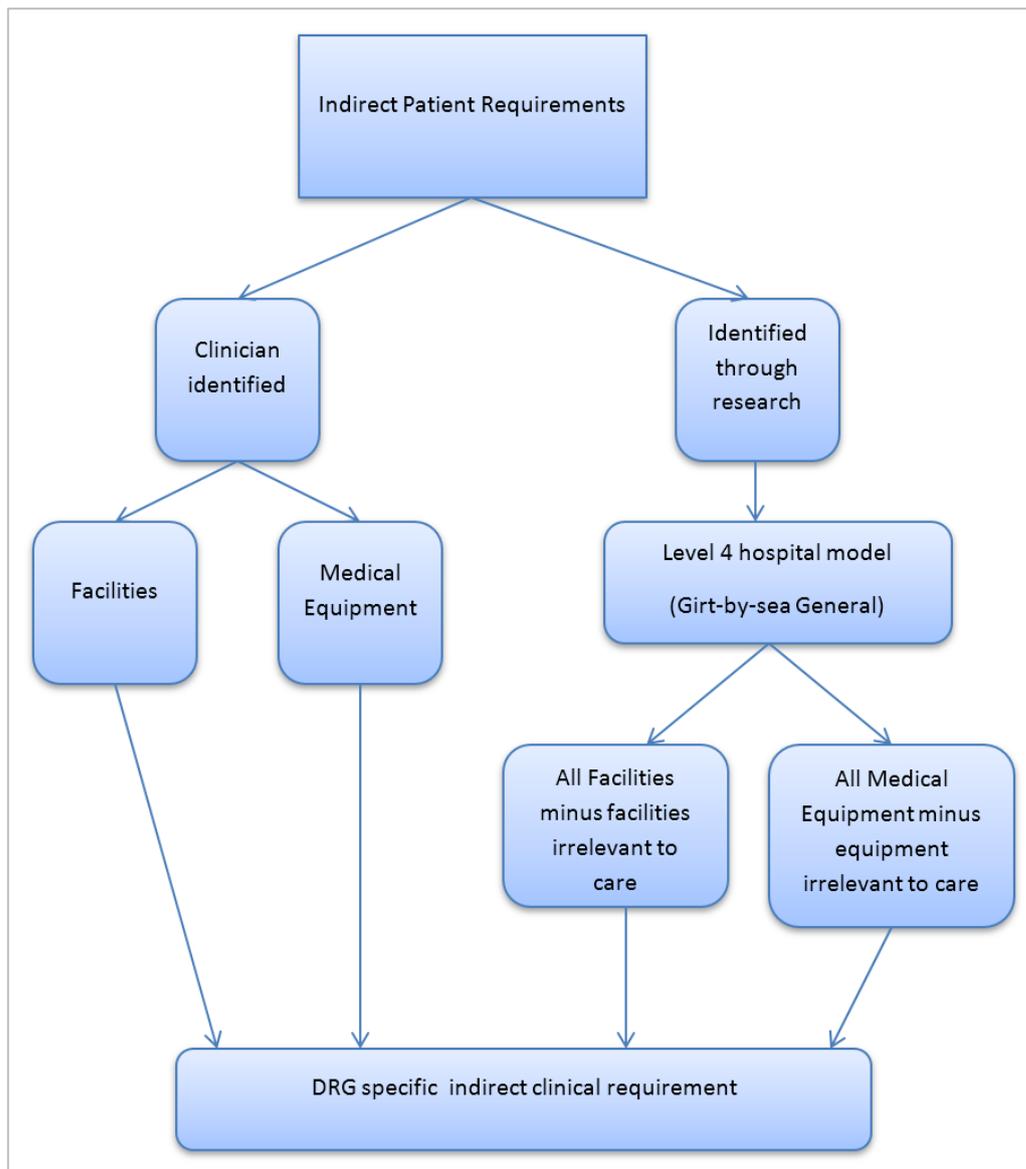


Figure 7.4 Method for identifying indirectly-required capital by DRG

Building on the model previously used in the Netherlands and USA to test capital investment changes for hospitals, (Netherlands Board for Healthcare Institutions 2007b) (Sadler 2011; Boluijt 2005) a Level 4 hospital of 304 beds was modelled using the Schedules of Accommodation (SOA) of three Australian Level 4 hospitals completed between 2010-2016. The Gross Departmental Area (GDA) totals the floor areas in square metres (M²) for each hospital department not including Plant and corridor spaces between departments (Travel). Modelling of bed numbers and areas was reviewed by NSW Health Infrastructure for accuracy.⁵ Departmental areas and bed numbers for the model hospital (Girt-by-sea General Hospital) are listed in Table 7.4.

⁵ Correspondence with NSW Health Infrastructure 8 May 2017

Table 7.4 Girt-by-sea General, an Australian hospital of level 4 services

Department	Benchmark M ²	Bed/place
Administration and Executive		
Administration & Executive	400	
Medical Records	600	
Pastoral Care	55	
Divisional Offices	200	
Medical Staff Room	50	
Education & Training	200	
Inpatient Wards		
Medical & Surgical	4200	90
Obstetric	1110	30
Paediatric	640	16
Psychiatric Acute	1624	28
Psychogeriatric	450	10
High Dependency Unit (HDU)		
Coronary Care Unit (CCU)	282	6
Intensive Care Unit (ICU)	720	12
Neonatal Care incl NICU	114	6
Palliative Care	282	6
Sub-acute-Rehab and Geriatric	1548	36
Day-only		
Chemotherapy	384	12
Day Medical	560	8
Day Surgical	640	32
Renal Dialysis	384	12
Clinical		
Emergency bays	1920	40
Endoscopy Suites	700	4
Operating Theatres	2320	8
Cardio-Vascular Intervention Labs	300	1
Labour Delivery Recovery	450	6
ESSU	270	10
CSSD	460	
Imaging	1000	
<i>CT Scanning</i>		2
<i>Fluoroscopy</i>		2
<i>General X-Ray</i>		2
<i>Mammography</i>		2
<i>Ultrasound</i>		2
<i>Magnetic Resonance Imaging</i>		

Department	Benchmark M ²	Bed/place
Nuclear Medicine	160	1
Pharmacy	300	
Pathology	275	
Mortuary	100	
Biomedical Engineering	75	
Ambulance station	100	
Hydrotherapy Pool	320	
Day-only		
Allied Health	1450	
<i>Audiology</i>		
<i>Dietetics</i>		
<i>Occupational Therapy</i>		
<i>Orthotics</i>		
<i>Physiotherapy</i>		
<i>Podiatry</i>		
<i>Speech Pathology</i>		
<i>Social Work/Counselling Casework</i>		
<i>Other</i>		
Rehabilitation Day Area	1000	
ATSI	60	
Outpatient Clinics	500	
Hotel		
Kitchen-receiving cook/chill	400	
Engineering	165	
Environmental Services	55	
Linen Services (Receiving Only)	135	
Supply/Materials Management	275	
Waste Management	90	
Information Technology	90	
Archive	200	
Public/Staff Cafeteria	460	
Main Entry/Public Areas	200	
Staff Amenities	140	
Security	40	
Total GDA	28453	
Plant 12.5% GDA	3557	
Travel 15% of GDA	4268	
Total	36278	304

Assumptions have been made about services indirectly required for patients. These are:

- Laundry is assumed to be provided off-site as is common in NSW, Victoria, Queensland and WA. Linen bays, stores, receiving and distribution areas, including dirty linen, are included in hospital capital costing.
- Pathology is assumed to be in-house for capital purposes although many pathology services are centralised. The areas assumed are at 2015 technology for pathology testing equipment in hospitals.(Australasian Health Infrastructure Alliance 2016h).
- Most general overnight patients were accommodated in single patient rooms with ensuite bathrooms.
- Provision has been made for isolation and infectious diseases through negative pressure rooms with anterooms on the wards, in emergency and in the obstetrics delivery suite.
- It is assumed that patient-centred inpatient care requires the support of Ambulatory care to complete the episode of care. Ambulatory services are included in indirect capital costs.
- Many hospitals have food prepared off-site and delivered however it is assumed that most hospitals require some food preparation facilities on site.(Mibey 2002; Australasian Health Infrastructure Alliance 2016e)

7.6.4 Verification of beds and areas for Level 4 model hospital

Four measures were used to verify the estimates for Girt-by-sea General hospital as a representative of a contemporary Level 4 Australian hospital. The aim was to verify if Girt-by-sea General could be considered to be the template for appropriate Level 4 clinical services. As previous chapters identified, general hospitals developed at different times to differing standards in different places across Australia (Ch's.2.6.1-3, 4.4-5, 5.4.1-4, Appendix D).

First the SOA was tested independently with five experts (7.6.3) who agreed with the schedule. Second the ratio of day only beds to overnight beds was checked as conforming to the 2015-16 Australian average.(AIHW 2017) Third, the appropriateness of the estimated areas for the model of indirect costs was sought through comparison to other Australian hospitals for which data was available using area (m²) per bed (Copeland 2013). This indicative comparison is not a comprehensive analysis of all Australian hospital developments for the period 2001 to 2016, but merely those projects for which data is available(Copeland 2013). The fourth comparison was also with square metres per bed in

European hospitals completed since 2001. Average square meters per bed is a sub-optimal but widely used comparison which does not allow for technological differences between hospital projects.

Average square metres per bed (red line in Figure 7.6) was identified as 120 square metres per bed for Girt-by-sea General compared to 139 m² for other Australian hospital redevelopments and 126 m² for French, Italian and English hospitals developed after 2000 for which data was available (Figure 7.6). Girt-by-sea area estimates are considered to provide a conservative estimate of hospital areas but within one standard deviation of the averages of the hospitals for which data was available.

Like beds, the measure of beds-per-square-metre is beset with definitional issues and is dependent on investment context however in general terms the bed per square metre is used as an international comparator (Rider Levett Bucknall 2017). Figure 7.5 illustrates that the estimated areas for Girt-by-sea General are commensurate with the Australian, French, Italian and English average hospital areas (red line). The comparison of areas is a simple comparison of the available information; further research based on additional data would yield stronger results.

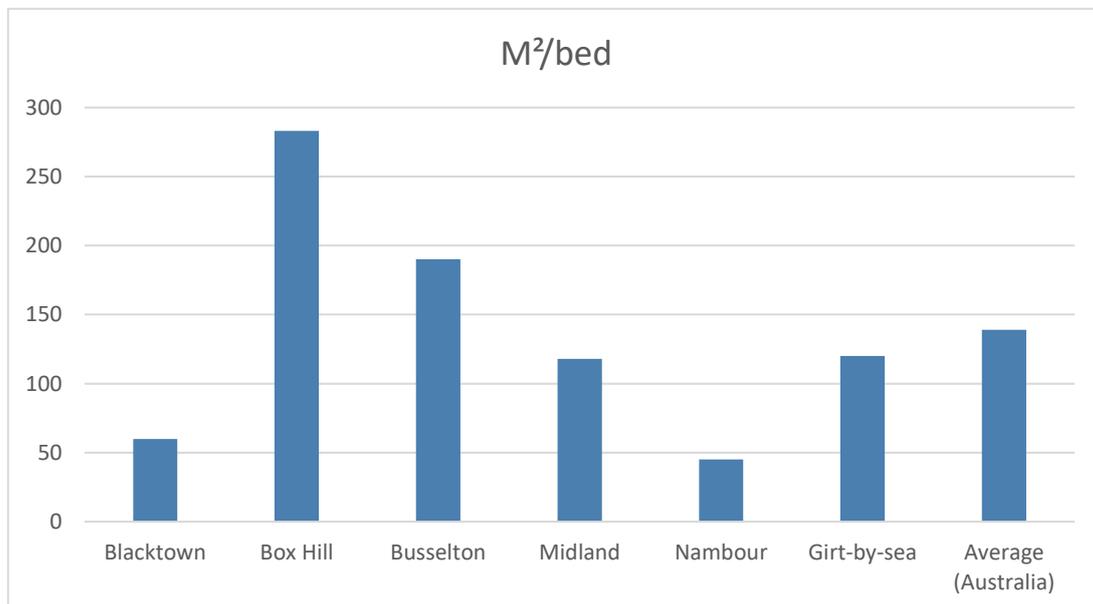


Figure 7.5 Australian hospitals square metres per bed, Australian average 2001-2016

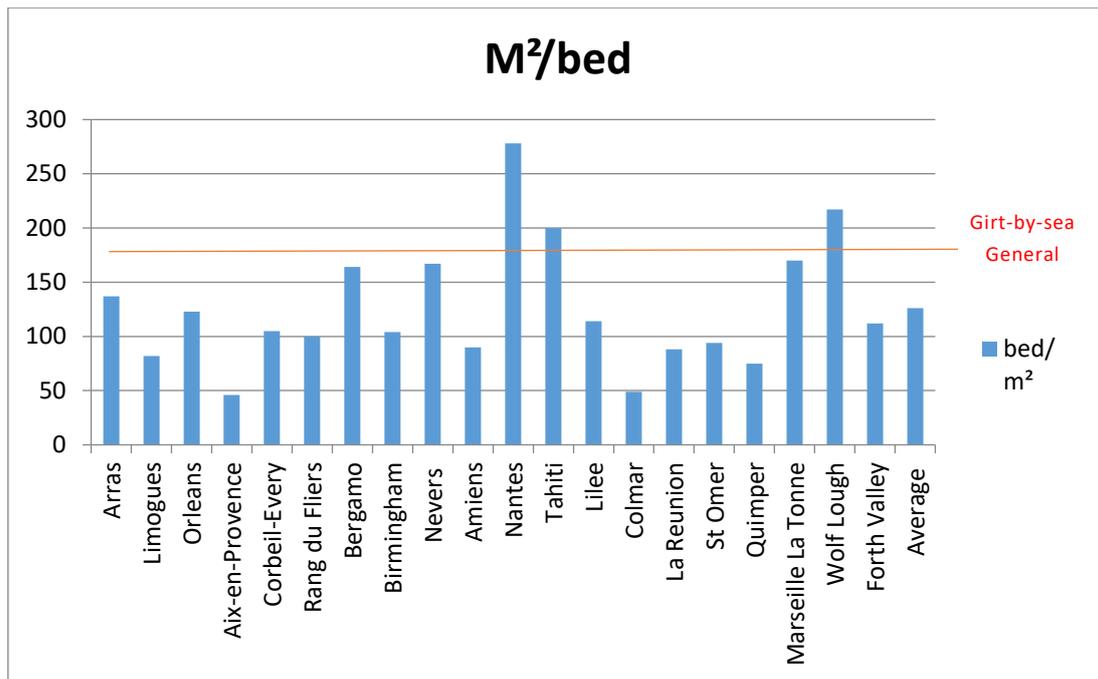


Figure 7.6 Square metres per bed in selected French, Italian and English hospitals 2001-2016

Source: Copeland, K. Australian Healthcare Design 2000-2015 and data on projects presented at the European Centre for Health Assets and Architecture Conference in June 2014

Having identified methods for estimating direct and indirect costs the next task was to identify patient requirements for direct access to key activity areas as part of the clinical pathway (Task 5) and then to identify non-bed spaces directly required for patient care (Task 6).

7.6.5 Counting key activity areas (Task 5)

Key activity areas are significant in the operation of a hospital but are not usually counted. The direct cost of capital per patient episode may include the requirement for access to key activity areas (Figure 7.1 purple ovals) including operating theatres, ICU, CCU and imaging. The requirement for patient access to key activity area have been included in DRG clinical pathways and interview results. Clinical requirements for high technology, capital intensive diagnosis and treatment areas are increasing (Travis 2015). Standards for patient safety change over time to specify timely access to imaging and ICU facilities. (King Edward Memorial Hospital 2009) The high level of building specificity and low flexibility associated with these functionally-driven areas provide some of the highest cost areas to build, equip and maintain (Boluijt 2005; Schiaffonati 2009). However these key activity areas are rarely counted as critical resources for treatment.(Travis 2015; AIHW 2015c)

ICU beds are not reported (AIHW 2015c) although over the past 20 years ICU has become a standard clinical service within a level 4 hospital (Department of Health WA 2013; NSW Health 2016c; Tasmania Department of Health and Human Services 2015a; Queensland Health 2015c). Changing models of care and acuity have influenced the national annual growth in demand of 2.5% for ICU beds.(Australian and New Zealand Intensive Care Society 2017)

Tallying areas within DRGs included identification and costing of key activity areas required in the diagnosis and treatment of patients(Dodswell 2009). Averaged capital costs across all patients do not account for differing needs to access high cost, specific technologies and built spaces for different DRGs or identify changing patterns of use. Key diagnostic and treatment areas were identified for each DRG within clinical interviews as specific directly required areas. Similarly, indirect areas include these areas within the range of acute services provided at Level 4.

7.6.6 Identifying various non-bed patient spaces (Task 6)

Figure 7.1 showed the range of clinical and patient spaces used in contemporary acute care. Comprehensive capital costs would define bed types and include the non-bed spaces relevant to the clinical pathway (Figure 7.1 green ovals). Ward areas, day-only spaces and chemotherapy chairs, dialysis chairs, and various post-surgical recovery spaces are counted as beds(AIHW 2015c). However there are a variety of other spaces required for patients in evolving models of care that are not measured. Waiting and assessment areas are sometimes counted (observation wards, short stay accommodation, medical assessment units) and other times not (Day of surgery areas, level 1 and 2 recovery areas, medical testing). Bariatric beds and facilities loaded to manage more complex large patients (surgical tables, lifts, patient lifting equipment, theatre size) have greater cost implications for construction, maintenance and capital costs. The capital cost of providing the range of different patient spaces required for clinical care vary significantly.

Similarly, patient and family waiting areas are relevant to patient-centred care with some models of health service involving and relying on shared care with families such as paediatric and geriatric medical and day surgical. These models rely on family accommodated close to the patient(Davidson 2007). Non-bed areas required for patients will be identified in each DRG tested.

Guidelines were searched and clinicians questioned to include these areas in direct areas when required.

When the areas had been identified for each DRG the areas required apportionment to the patient level (7.6.7) and costing (Ch.7.7.8). Then major medical equipment (Ch.7.7.9) and ICT (Ch.7.7.10) are addressed.

7.6.7 Apportionment and Costing of Capital Elements (Tasks 7-9)

Apportionment of the identified areas to the patient level was examined through the literature, by clinical interviews and expert advice. Allocation factors were separately considered for directly-required (direct) and indirectly-required (indirect) capital and key activity areas. Non-bed spaces were included in these three categories.

Literature scan

In addition to the literature provided in earlier searches, peer reviewed literature was searched for apportionment of hospital capital to the patient level using the search terms “apportion*” and “capital” with “patient” and “hospital”. Data bases, inclusion and exclusion criteria used were the same as in Chapter 2. To determine the building costs of Australian hospital capital “Australian construction cost” and “hospital* “were searched for costing.

Government websites and publications (Commonwealth Health and agencies, NH&MRC, State governments) were searched for guidelines and standards supplemented by National and State professional and association websites and publications for costing and apportionment using the same terms.

Results Apportionment: No literature was found to relate capital to the patient. Previous searches had identified data relevant for apportionment (e.g. average length of stay by DRG) through government publications (Ch.7.6.8)

Results Costing: Costing methodologies to the patient level were not found. One Australian hospital capital costing index was identified (Australian Institute of Quantity Surveyors 2015) However access to the data was strictly limited to AIQS members.

Clinical advice

Clinicians interviewed provided advice on patient and clinical requirements for spaces and access to equipment and systems by length of time. These have been included in each DRG costed (Ch's 8.2.4, 8.3.4, 8.4.4, 8.5.4).

Expert advice

Advice was sought from the Australian Institute of Quantity Surveyors, two professorial level accredited quantity surveyors and three registered architects specializing in hospitals regarding costing methods.

Three models for costing were considered:

- Detailed costing the model hospital from architectural and engineering drawings,
- Differential costing of the model hospital based on floor areas of accommodation, offices, hot floors and industrial areas (Netherlands Board for Healthcare Institutions 2007b) and
- Costing based on national and state quarterly costs published by Australian quantity surveyors (Rider Levett Bucknall 2017)

While detailed costing based on architectural and engineering plans would provide a higher level of specificity of costing, a significant number (>350) of additional assumptions (Greenfields or brownfields site⁶, height and density, headworks, adjacencies, technologies, building form and materials, basement services, central plant and power supply options etc.) would be factored into the model which may compromise the generality of the costings. In addition, the plan-based costing would be both time consuming and costly to acquire.

The second or differential costing method has not been used in Australian costings before and reliable costings index data is not directly available in this form. Similarly, life-cycle costing would be the preferred costing index but is not available in Australia at the time of research. So, the third method using contemporary aggregated costings of recently public hospitals reduced the risks to generality of the costings while sacrificing some measure of specificity. On balance it was judged that the third method, costing using the

⁶ A greenfields site has no previous construction and a brownfields site has existing buildings to design around or demolish.

published contemporary indices of professional Australian quantity surveyors would provide a reliable, transparent cost estimation basis and acceptable cost measurement.

The cost range per gross floor area includes special equipment, hydraulic, fire-protection, mechanical, vertical transportation, building management and electrical costs. They do not include taxes, land values or parking. The measure is not perfect as it is for all Australian hospitals with operating theatres and greater than 55m² gross floor area per bed. There are no specific costs for different areas or life-cycle costings published. Further research is required in these areas.

7.6.8 Allocation for direct and indirect costs

Direct

Government standards and clinician answers (to questions of time a facility was required in the clinical pathway) determined the allocation factors used in each DRG. Practical capacity Standards identified (Keel 2017) were:

- Direct capital costs follow Stage 1 and 3 of the IHPA Hospital Patient Costing Standards for the preferred methods of allocating capital costs based on actual usage, floor areas and occupied bed day equivalents and for the apportionment across multiple product cost centres((IHPA 2014a)pages 5 and 119) and
- Indirect costs follow the NHCDC allocation rule for excluding teaching and research costs, defining costs in or out of scope based on matching production and cost (IHPA 2014a) (Australasian Health Infrastructure Alliance 2016b)
- calculations for the lifespans for differentiated functions of hospital buildings use guidelines from the Netherlands for the building (Netherlands Board for Healthcare Institutions 2007b) and Australian Tax Office guidelines for interiors(Netherlands Board for Healthcare Institutions 2007a; Australian Taxation Office 2016)
- average length of stay uses AHFG standards for the operating times for specified clinical areas (Ting 2017)
- medical equipment adopts the Australian Government standard for depreciation as determined by the Australian Tax Office list of ‘effective life’.(IHPA 2014a)Appendix F)(Australian Taxation Office 2016)

For areas not covered by these standards, specific allocations of common areas were by the time the area was available for patients:

- AHFG specify hours of operation for specific operational areas in Room Data Sheets(Australasian Health Infrastructure Alliance 2004-2018)
- evidence from Dutch hospitals is that hospitals conform to office hours (Mondays to Fridays 8.00 am to 5.00pm) with the exception of ward accommodation, delivery suites and emergency department.(Netherlands Board for Healthcare Institutions 2007b)

In addition:

- Role delineation guidelines provide for afterhours operating theatres, laboratory, imaging and pharmacy supported by skeleton hotel and administrative services.(NSW Health 2016c; Department of Health WA 2013; Queensland Department of Health 2012)
- Medical records are progressing to an electronic environment but very few public hospitals have achieved this goal, this study assumes a mix of paper and electronic medical records. Therefore, patient assessment, accommodation and treatment areas have medical records stores, central medical records and archive areas included.
- Education for clinical staff for professional or corporate reasons is included in costings but not areas for students. Education areas in clinical environments are included in the direct costings and as corporate education and orientation are legal requirements of hospitals, education spaces, lecture theatres and corporate education areas are included in indirect costs. However, education for unregistered medical, nursing and allied health students is not included. Similarly, offices for clinical quality are included in direct costs and corporate occupational health and safety are included in indirect costs.
- Staff areas for clinicians treating the patient are included in direct costs while patient care assistant and porter staff areas are in indirect costs. Accommodation for on-call midwives and doctors is allocated to indirect costs.

Tasks 3, 5 and 6 identified areas required for direct care for every patient of that type in the hospital for the lifespan of the hospital. The areas identified were divided by key factors to arrive at the area per patient according to the type of space.(Netherlands Board for Healthcare Institutions 2007b; Rider Levett Bucknall 2017; Australian Taxation Office 2016)

The apportionment factors applied to areas to determine the per day cost for one patient were applied sequentially as follows:

- The gross floor area for the department (e.g. Assessment area)
- Divide by the number of rooms to reflect one patients' requirements of a standard layout unit
- Divide by the lifespan in years of that type of area
- Divide by the number of days the area operates allowing 4 days per year for maintenance and closure
- Divide by the number of patients per day at an efficient level
- Divide by the accepted standard for occupancy.

This method is shown for the allocation factors used for the apportionment of obstetric areas (Table 7.5)

Table 7.5 Apportionment of Obstetric areas directly required per patient for DRGs O60B and O60C

Areas Required for Direct Care Unit	m ²	Apportionment				Occupancy Standard
		Divide by Rooms	Lifespan Years	Days	Patients per Day	
Entry	72		20	360	8	75%
Assessment	162	4	20	360	2	75%
Birthing Unit	731	5	20	360	1	75%
Inpatient Postnatal	1,430		50	360	1	75%
Postnatal Clinic	106		20	360	12	75%
Clinical Support	134		20	360	1	75%
Staff Areas & Amenities	180		50	360	1	75%
Total Gross Floor Area (GFA)	2,816					0.167074
Plant 12.5% GFA			20	364		0.048353
Travel 15% of GFA			20	364		0.058023
Total Area						0.273451

The next section considered allocation factors for key activity areas and is followed by allocation methods for indirect areas.

Allocation factors for key activity areas

Operating theatres

There is little evidence on operating theatre efficiency or performance standards. AHFG identify that operating theatres work on an 8 to 10 hour day with some availability for weekend emergencies (Australasian Health Infrastructure Alliance 2016c). Operating theatres do not have measures to evaluate efficiency of use. There is no evidence of a systemic or hospital-based emphasis on operating theatre efficiency in NSW, WA or Queensland (WA Auditor General 2015; NSW Auditor General's Report 2013) page 25). There are data quality issues with theatre information in WA and with the quality of cost coding in Queensland. (WA Auditor General 2015; Queensland Audit Office 2015) Around 10% of time is used for turnover cleaning and preparation of theatres between patients according to a survey of WA hospital data. (WA Auditor General 2015) page 12) Accepted guidelines identify 85% occupancy in available hours as optimal utilization however definitional differences suggest 80% of available theatre time reflects Australian practice. (Queensland Audit Office 2015; WA Auditor General 2015) Fifteen minutes is the benchmark time between surgeries (Queensland Audit Office 2015) page 38) (NSW Auditor General's Report 2013) Clinical experts were asked for surgery times, session times and number of procedures to determine allocations. These factors are used to allocate areas to the patient level.

Imaging

Hours vary on the range of services provided in the hospital and operational policies. Based on AHFG it is assumed that:

- all imaging is available during business hours of 8.00 am to 5.00 pm weekdays
- an on-call system for emergency imaging is used
- interventional radiology in theatre is not included
- ultrasound and some mobile imaging are included for obstetrics, clinics and ED. (Australasian Health Infrastructure Alliance 2017a, 2016g)

Clinical experts were asked about imaging requirements in addition to those specified in guidelines.

ICU, HDU and CCU

These units are expected to provide a 24 hour seven day a week service.(ANZICS 2016; Australasian Health Infrastructure Alliance 2016f) The average length of stay in ICU was 93 hours per separation (AIHW 2017b). These factors have been used in allocation.

Procedure rooms, endoscopy suites, cardiac catheterisation suites and clinical measurement units

These are assumed to operate during business hours of 8.00 am to 5.00 pm weekdays.(Australasian Health Infrastructure Alliance 2016d)

Allocation of indirectly required areas to the patient

Areas for indirect costs have been estimated (Task 4) and the lifespan of building elements determined. In common with direct costs total indirect areas are costed and divided by lifespan, patient numbers (based on average length of stay) and occupancy(Keel 2017). The area required per patient was determined and then the total areas were costed. This task considers how the areas will be allocated to the patient level. Apportionment of indirect areas could be based on either:

- area per day for a level 4 model hospital, or
- area per patient episode for the same hospital.

Data for area per day was established using Victorian Health department standards benchmark information (Victorian Department of Health 2010a). Data on patient volumes for the model Girt-by-sea hospital was not sufficiently robust to reliably establish cost per patient episode for apportionment. Therefore, areas required per day (or fraction of a day) for the hospital was adopted to apportion indirect costs.

7.6.9 Costing and sensitivity testing

Direct areas were costed using the Rider Levett Bucknall 2017 costing index on a dollar per square metre basis. A national average cost per square metre including the ACT and Northern Territory was used. However, hospital building in the territories is small, infrequent and of high cost potentially distorting the national average. Therefore, sensitivity analysis addresses building cost (\$5,030) per patient excluding the ACT and Northern Territory.

Differential costings of ‘hot floors’ wards, office and industrial spaces was preferred but not available in Australia. Other Quantity Surveyor indices may have provided slightly different prices based on their range of projects.

To facilitate costing the indirect areas it was assumed that:

- the model hospital was organised into a cost efficient building form for a general hospital of 3 stories (Boluijt 2005; Ikkersheim et al. 2013; Sun 2009; Molenaar 2009)
- Standard building materials were specified (Australasian Health Infrastructure Alliance 2004-2018) and
- Technologies in the building were consistent with prevailing Australian standards. (Australasian Health Infrastructure Alliance 2004-2018)

Due to an absence of data, costings were based on differentiated lifespans rather than full lifecycle costings for sustainable and flexible facilities (Schinko 2016; Netherlands Board for Healthcare Institutions 2007b)

Sensitivity testing of areas and cost was conducted for each set of costings on:

- Additional areas and equipment recommended by the clinical experts,
- Model of care differences between clinical experts and,
- costings for areas have been tested in the DRG sections sensitivity analysis (8.2.5, 8.3.5).

The definition of acute care capital had three components- areas (direct and indirect), medical equipment (direct and indirect) and ICT. The final section describes how the latter two components have been allocated to the patient level.

7.6.10 Major medical equipment and ICT (Task 10)

The cost of major medical equipment has been separately identified in direct costs for each of the selected DRGs. To cost imaging the equipment identified by clinicians was specified to the most commonly used appliances and brands by Curtin University professional experts on medical imaging. The most commonly used equipment in a standard configuration was selected and 2016 prices and expected lifespan were identified by the recommended manufacturer⁷. The expected life-span and price were verified with the Australian Government Medicare Equipment and Diagnostic Imaging Capital

⁷ Correspondence with manufacturers Australian agent 25-30 January 2018

Sensitivity Guidelines (Department of Health Australia 2017). Capital sensitivity is a funding measure that “encourages [private] service providers to upgrade and replace (as appropriate) aged equipment with the aim of improving the delivery of quality of diagnostic imaging services” (Department of Health Australia 2017). Funding recognises lifespans of major medical equipment as part of the private patient reimbursement under the Medical Benefits Schedule and is used by hospitals for capital funding. (Queensland Audit Office 2017)

Indirect costs for major medical equipment including imaging equipment were not able to be established with confidence as medical equipment expenditure figures are not published and prices have been found to be inconsistent and not best value (Victorian Auditor-General 2015). Approaches to governments were made for medical equipment cost information but were unsuccessful. So the final cost estimate lacks the indirect medical equipment cost component.

ICT

Clinical interviews identified the need for ICT to be included in service provision for the patient. Remote access to electronic medical records, real time monitoring equipment, pathology and imaging results were considered important by some clinicians. ICT quality and operability were of importance for ICU clinicians. However the value of these systems as components of a comprehensive ICT framework within a hospital could not be defined.

ICT costs have been included in indirect costs. ICT services for Level 4 hospitals include:

- electronic medical records,
- pathology, pharmacy records and communications systems,
- eprescribing, electronic medication management,
- Electronic Record for Intensive Care (eRIC),
- data analytic systems,
- electronic systems security,
- imaging data storage and secure communications systems such as PACS,
- information and communications systems and
- audio-visual services including telehealth and patient entertainment systems (Auditor General Western Australia 2017).

Data centres, servers, storage and network device management can be managed at either a health system (state or region) or hospital basis. The Productivity Commission estimated

that ICT was 1%-3% of costs and could be expected to rise to 4-5% of costs(Productivity Commission 2005). Under existing arrangements with mixed PPP, public and hybrid systems per patient costs are difficult to untangle (Langoulant 2018)page 121). For example at Fiona Stanley hospital in WA, ICT costs are mixed into a non-clinical services contract(Auditor General Western Australia 2017; Langoulant 2018). ICT in Victoria is fragmented by hospital PPP development with concerns about system security and interoperability (Davis 2016). Anxiety about ICT has led to integration and security for major projects being left to vendors (Davis 2016). Health ministers and Auditors General have also noted problems with ICT cost estimates.(Auditor General Western Australia 2017; Auditor-General 2017; Hutchison 27 February 2018; S.A. Auditor General 2017) Issues have been identified with ICT complexity, change management and legacy systems.(NSW Auditor General 2017)

It has not been possible to identify funding for ICT in hospitals in Australia. Activity based funding does not include health ICT investment or maintenance(Auditor-General 2017; Victorian Department of Health 2015). States use grants for ICT projects (Chapter5). National or statewide plans of sufficient detail to cost are not evident in ICT (NSW Health 2016a; Victorian Department of Health 2015; Queensland Health 2015a; Health Department of WA 2015; Australian Digital Health Agency 2018). Policy advisors to State and Federal Governments have been contacted to identify ITC required for Australian care standards for 2017⁸ confirming there is no national approach to funding ICT in hospitals. Evidence on the cost per patient of ICT is not transparent due to a range of quality, service, cost and comparability issues. This variable is set within the formula for the valuation of capital and is regarded as important by clinicians. Extensive research is required to identify the value of ICT for patient care in a level 4 hospital.

7.7 Strengths and limitations

Strengths of the proposed model are:

- *Allocative efficiency*: the model provides capital funding equality for patients in the same diagnosis group according to evidence-based requirements

⁸ Personal communications with the Assistant Secretary, Digital Innovation & AHMAC Branch, Australian Department of Health 30 January 2018 and the Secretary, COAG Health Council Secretariat, 5 February, 2018.

- *Appropriate care*: the model links contemporary clinical standards for treatment and modalities of care with capital investment. Appropriate care in Australia was defined to be patient-based, clinically appropriate, accountable, efficient and accurate. Anchoring the cost model in clinical standards and clinical pathways and using ‘bottom-up costing’ based on direct patient utilization, provides costing more likely to be appropriate than existing capital cost estimates (Productivity Commission 2009e; SCRGSP 2018; Deeble 2002a). However, some data used will reflect prevailing issues of inequitable access and funding. Calculating capital costs at the patient level rather than the institutional level aligns with prevailing philosophies and recurrent models of funding. Top-down costing is used for indirect costs.
- *Contemporary*: Lifespans of hospital facilities have continued to change since 1968 as technological change and clinical practice have evolved. Allowing 50 years for the functional lifespan of a hospital built in 1968 does not encompass the pace of technological and clinical change. This model identifies the inherited assumptions on lifespan, incorporating research-based lifespan information, and through the formula, allows future changes to be integrated into the calculations on capital costs and capital replacement. As hospitals become more technologically involved lifespans for higher technology areas are likely to differ from lower technology areas. This formula allows for different investment strategies and replacement options. The development of tools for whole-of-life costing will permit asset lifespan, decay and decreasing value to be costed in the model. The method represents a method to update assumptions on building lifespans to contemporary standards offering a mechanism for dynamic change.
- *Costing*: Verifiable environmentally sustainable life-cycle costings for facilities have not been achieved. This method allow for higher specificity of costing enabling more detailed costing indices to be developed (Kerr 2019) including the costs of managing carbon emissions. It is recommended that when reliable costings are developed for Australia that these are adopted for cost estimation.
- *Definition*: Capital for hospitals has a range of meanings in different states and the Commonwealth. The detailed nature of this study connects capital for hospitals to clinical and building functions. Capital in this study is defined through relevance to patient care and therefore excludes items often included in capital for hospitals including:
 - repayment and payment rates

- The cost of consultants fees, building procurement processes and contingency factors for building,
 - Funding for car parks or roads near hospitals,
 - Medical research facilities,
 - Land, and
 - Furnishing, fittings and minor equipment (FF&E) which is usually purchased by the hospital in Schedule 3 during facility commissioning.
- *Dynamic*: the “inertia” found in existing capital allocation systems(Saltman 1997)page 202) that reimburse the costs of historic structures, can be reframed as funding for current and future patients, models of care and innovation. Under the proposed model the allocation for capital costs incorporates a process for system-learning based on patients, outcomes and clinical data.
 - *Efficiency*: Bottom-up costing provides the missing capital information contributing to a full range of inputs relative to outputs required to perform operational efficiency analysis. Technical efficiency calculations are limited when accurate capital costs are not available.
 - *Equity*: Equitable capital funding is possible for the treatment of all patients with the same diagnosis irrespective of the hospital’s political influence or the geographic location of the patient. Setting standards for the delivery of built, medical equipment and ICT requirements aligned with clinical practice for direct and indirect costs provides a mechanism to raise facility and equipment standards to a common level.
 - *Evidence-based*: Guidelines provide the most comprehensive synthesis of accepted practice information for the relevant population based on evidence and accepted standards of clinical practice. Trends in patient or practice requirements can be identified through expert clinical practice advice preceding clinical guideline changes. While providing strong evidence, the deliberative and consultative nature of guidelines modifies their dynamic responsiveness. Inclusion of high level clinical expert advice provides detailed and dynamic advice relevant to capital decisions. For example, clinical expert advice obtained on the implications of obstetric obesity pre-empted published articles(Cheney 2018a) and changes to obstetric guidelines.
 - *Flexibility*: The formula used for estimating capital costs involves a series of elements that can be varied as evidence arises. This provides a foundation for state-wide and national equity. Areas required are calculated and costing factors applied. So where there is evidence in the Australian Building Cost Index that building costs are

different (in rural and remote areas compared to metropolitan areas) factors based on the evidence can be applied. This is similar to the approach used for rural and remote patients in the ABF or the different cost structures in different states.

- *Inclusiveness*- A capital payment could also include maintenance costs although that has not been factored into this iteration of model. Maintenance of clinically-relevant assets at an appropriate standard is one of the unmet challenges of depreciation-based capital valuation and allocation based on budgetary and political priorities (Australian Senate Community Affairs and References Committee 2018; Audit Office of NSW 2017; Victorian Auditor-General 2017; Queensland Audit Office 2017; WA Auditor General 2017)
- *Innovation*: Payments for capital incorporating the adoption of evidence-based clinical and technological improvements, aligned with patients requirements, is designed to facilitate innovation. The model incorporates a dynamic quality to permit continuous evidence-based technological improvement for all patients receiving the same care. Using this model capital funding can respond to changing patient requirements, such as increasing demand for ICU or changes in the number of bariatric patients in obstetrics. It may also be possible to fund appropriate capital for rural acute indigenous health services in alignment with their diagnoses, particularly for dialysis, obstetrics and cardiac interventions(AIHW 2018c; Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017).
- *Linked capital*- for the first time all the capital components required for contemporary patient care are linked together with defined quantities and levels of investment based on the patients clinical requirements. The capital cost is linked to the patient.
- *Outcomes-based*: Alignment of capital cost payments with DRG's provides direct connection of capital inputs for acute care to patient outcomes (for a hospital episode of care). Capital costs have not previously been measured as contributors to obstetric, surgical or medical outcomes for inpatients.
- *Patient-aligned*: The model is patient- based rather than institutionally based. So if a modality of care can be better treated in another setting (such as chemotherapy provided as hospital-in-the-home) or in an outpatient clinic, capital can be identified for that treatment or as a saving,
- *Standards*: Where capital allocations occur on an infrequent basis, practice methods can become entrenched, particularly if the senior clinicians of only one hospital are the clinical advisors on the clinical and capital requirements for infrequent

redevelopments. Typically, senior clinicians on redevelopment projects have no previous experience of redevelopments⁹ The model developed has sought professorial level clinical advice from across Australia and included clinicians with national, and in many cases, international education and research profiles. This approach remedies the inertia of limited experience and distance from clinical and practice research.

- *Structure*: The formula has calculation points for key elements not identified in contemporary allocations including electronic medical records and data management. Depreciation-based capital estimates are unsuitable for predicting expenditure required for contemporary ICT and patient data management. Data generated by patient monitoring devices, electronic medical records, imaging, telehealth and wearable devices will require investment in ICT hardware, security and software to align with contemporary care(ENISA 2016).
- *Sustainable*: Acute health care is expected to utilize clinical and technological improvements progressively building capacity to continuously treat patients effectively and efficiently. It is generally expected that acute service delivery will progressively become more technologically advanced than it was in the past. The mechanism for achieving financially-sustainable technological improvement in Australian public hospitals is not evident. The value of existing investment in health technologies in hospitals is not known as data on hospital medical equipment costs and ICT investments is not reported or discoverable. The model separately identifies the cost of medical equipment and ICT be determined using the direct and indirect costing approach based on clinical guidelines, standards and expert clinical advice.
- Environmental sustainability in hospitals is not delivered in uniform programs in Australian public hospitals. The model developed has the capacity to adopt Greenstar standards and environmentally sustainable policies through cost indices when governments accept this responsibility.
- *Transparency*: Using a formula with capital costs based on evidence permits contestability and verification of data aligning medical equipment and ICT costs with patient clinical requirements providing the transparency recommended by Auditors General and the opportunity to vary them as conditions change. For example the transfer of medical records to a wholly electronic form will justify the deletion of the medical records paper storage spaces from indirect costs.

⁹ Carthey, J. Forth-coming publication from Doctoral thesis on clinical group advice health facility planning efficiency 2019

- *Technological change:* as new modalities of care (e.g. robotic surgery, 3-D printing in surgery(Rheinberger 2019)), improvements in service delivery (e.g. automatic guided vehicles for linen and meal deliveries), and communications (e.g. real-time linking of primary health medical records, community pharmacy and hospital records with remote patient monitoring) are approved, capital costs can support patient access to improved care across Australia in a timely manner.

Limitations

- *Accuracy:* Administrative area costs have been included but may underestimate actual areas depending on the degree of centralisation or regionalisation of administrative functions at a Level 4 hospital.
- *Double-counting:* Consideration was given to the issue of double counting for hip and knee replacement indirect areas and costs. Direct costs include access to ICU based on clinical advice, operating theatres and CSSD. These were not removed from indirect costs as additional access was considered important within indirect costs for unusual or adverse events including surgical revisions (Murnaghan 2010; King and Phillips 2016).
- *Costing:* MME indirect costs were identified within the formula but not costed as there is no transparency, benchmarking or standards around costing. State governments do not publish the data on medical equipment costs and suppliers have varying prices based on volumes, contractual relationships, leasing arrangements and financial contracts and geographic area(Healthshare 2017; Health Purchasing Victoria 2017)
- *Data:* Information could not be found on the cost of ICT in public hospitals (Auditor-General 2017; Health Purchasing Victoria 2017; Queensland Health 2015b; NSW Health 2016a; Health Department of WA 2015).
- *Exclusions:* The model does not address research and education or outdoor or parking areas although all have been discussed by clinical experts as important to clinical care. Teaching, training and research as part of DRG recurrent costing are being considered by the IHPA but there remain concerns about the quality of the data (IHPA 2015c)page 19). Quantifying and costing research, education, parking and outdoor areas could be later stage research.
- *Replication:* The DRGs are restricted to adult health care and may not be directly applicable to paediatric care or inpatient mental health services.

- *Sample size:* This is a study to determine if the model can be used for significant portion of Australian patients in high volume DRGs involving the range of specialist physical facilities used in a contemporary hospital. The focus has been on patient numbers rather than DRG numbers. Model testing involves more than one in three Australian patients but a small percentage of all DRGs. Application of the model can be extended to larger number of DRGs including high volume groups based on recent guidelines including chest pain, endoscopy, stroke, chemotherapy and colonoscopy.
- *Scope:* This study is limited to the inpatient period of care and clinically-indicated outpatient clinics covered by the DRG. Critically important patient care and treatment occur both before admission and after discharge in both hospital and community settings. The model costing method has been applied to emergency care and to some outpatient clinics but does not include prior testing or primary care.
- *Security:* During this study the practical significance of patient and staff security has been identified as an area not sufficiently addressed in the role delineation guidelines or the AHFGs. Clinical and expert advice was not sufficient to alleviate this problem. Further research is required.
- *Transitions:* Australian jurisdictions aim is to achieve electronic medical records however the translation has not been achieved at the time of writing. So both paper and electronic medical records are costed including the legal requirement of seven years of paper medical records to be held on site. As electronic systems are more fully adopted space and costs can be adjusted for each DRG through indirect costs and area allocation. Currently medical records areas and system funding are through one-off rather than regular capital funding so different hospitals will be at different points for the adoption of electronic medical records. Space has not been allocated for data infrastructure as there was insufficient data.

7.8 The Model

This approach to determining the value of capital required for acute care has the patient at the centre of allocations. The capital value is based on clinical guidelines, service quality standards and expert clinical advice. It aims to be a model to allocate funds to achieve government objectives for efficiency and effectiveness in the delivery of care. Alternative models of capital allocation and valuation have been considered (Ch2.6.2-3, 5.4.2, 6.4.1, 6.5, 7.1.1) but have been found to be asset, rather than patient, focussed.

Two Australian models of capital cost allocation (used by the Productivity Commission and the IHPA) were considered to have advantages and disadvantages. The approach used by the Productivity Commission to value capital identifies a capital cost per patient episode and the IHPA approach applies direct and indirect costings to multiple cost areas to value total costs. However, both of these Australian systems were found to be asset-based rather than clinically-focussed. Depreciation-based systems for capital allocation were assessed as unsuitable for Australian circumstances due to concerns of accuracy, appropriateness, accountability and equity (Ch7.1.1). The US system has national transparency. The German system was DRG linked at the hospital level but based on depreciation costings which were found to underestimate the cost of capital for buildings due to inappropriate life-span estimates thereby quenching investment in contemporary facilities and limiting funding for technological innovation. In contrast the model approach strives for the appropriate level of capital per patient based on clinical rather than asset requirements.

Similarly, other capital valuation models (Ch.4.9, 5.6, 7.1.1) have not demonstrated attentiveness to delivering contemporary standards of care. It is argued that the approach of this model is more comprehensive, transparent, adaptive and technologically attuned than retrospective asset-focussed models (Ch.7.1.1). Most importantly this model of capital valuation brings capital into the pursuit of efficiencies in hospital services by identifying the complete suite of inputs, in conjunction with DRG recurrent funding, to achieve patient treatment outputs. The model approach answers the question how much capital is appropriate to achieve system objectives of high-quality patient care. Cumulatively from the patient level, DRG-by DRG, the model approach can fund the capital required for a hospital appropriate for contemporary clinical care.

The model approach is tuned to evidence and the mechanisms which have been successfully deployed for the effective and efficient recurrent funding of Australian hospitals (Biggs 2018; IHPA 2016a). Evidence-based medicine and evidence-based design are well accepted in Australian hospitals. However, evidence is not the basis for Australian capital allocation (Ch.5.4.3). This thesis has examined the available evidence on capital allocation for model development but is constrained by the data and limitations of the existing system. The selection of data sources aimed to improve the quality of evidence to support funding decisions to align with evidence-based medicine and inform evidence-based design. Particular attention has been given to the specifications of the model (Ch.7.1.3), and quality of the data sources (Ch.7.3.2-4). Drawing on well-researched DRG

classifications and the tested NHCDC costing approaches also distinguishes this model from more retrospective models.

During this study the range and quality of clinical guidelines published has expanded to permit cost estimation of lower volume DRGs and clinical pathways including hospital outreach and community services. Were the proposed system adopted in Australia the authority of government would eliminate issues of access to clinical advice for DRGs as has been the experience of the AHFG (Australasian Health Infrastructure Alliance 2016m). Some very specialised low volume DRGs could utilise the method outlined placing greater emphasis on expert clinical opinion to define clinical pathways.

Based on clinical, health economic, health service, health planning, and architectural research the model method provides a greater level of reliability through specificity than other models. Drawing from these disciplines and Quantity Surveying to address the issue of effective capital allocation provides a broader understanding of the policy, funding, mechanisms and applications for specific service delivery requirements. One result is that levels of uncertainty at many points in the process of capital allocation are replaced with a theoretical framework and evidence.

Using the model approach clinically appropriate medical equipment and ICT systems would be funded as they were required for patients and, importantly, there would be no investment for redundant equipment or facilities not necessary for contemporary patient care. This would permit the removal of assets and de-investment in redundancy.

This chapter aimed to develop a capital allocation system for public hospitals that meets contemporary health system objectives for appropriate, sustainable and innovative service delivery. The model developed in this chapter identifies key elements of capital based on the patient pathway and clinical requirements. A fundamental characteristic of the model is that it makes explicit each element of the algorithm to allow cost transparency, and permit accountability. By making assumptions explicit in the model, future capital cost calculations can be adapted to respond to patient, technological or clinical changes. No evidence of any costing based on contemporary clinical standards in Australia or in comparable nations was found. This research demonstrates that it is possible to develop a model to estimate the cost of capital required per contemporary patient episode using Australian standards and predominantly bottom-up costing for direct capital costs.

However, the model is not without flaws (Ch.7.7) and remains theoretical. Chapter 8 uses the model approach to cost seven high volume DRGS comparing their results with recurrent costs and outlining how the model system could be adopted in Australia.

Chapter 8 Application of the Model to Fund Capital by Diagnosis Group

8.1 Introduction

Chapter 7 developed a model for allocating capital costs to the patient level by diagnosis group. Clinical guidelines and high-level clinical advice allowed the development of clinical pathways for patients in specific DRGs (Ch7.3.3). From admission to discharge the areas and medical equipment required on the clinical pathway were mapped (Ch7.6.1). Clinical interviews identified the length of time patients required direct access to specific areas including emergency department, operating theatres, procedure rooms, ICU, imaging and clinics (Ch.7.5.2-4). The types of patient accommodation and clinical support directly required for patient care were also chartered (Ch.7.6.5). To complete the range of services necessary for safe, high quality patient care the range of indirectly required patient services was determined based on length of stay (Ch7.6.2).

The aim of this chapter is to present a proof-of-concept by testing the model on selected diagnosis groups (selected in Chapter 7.4). These are AR-DRG:

- L61Z Haemodialysis
- O60B Vaginal Delivery, Intermediate Complexity
- O60C Vaginal Delivery, Minor Complexity (Day-only and overnight)
- O01B Caesarean Delivery, Intermediate Complexity
- O01C Caesarean Delivery, Minor Complexity
- I03B Hip Replacement for Trauma, Minor Complexity
- I04B Knee Replacement, Minor Complexity.

To test the model for each diagnosis group information has been identified from:

- Literature scans (Ch.7.4.3-4) to identify clinical guidelines, national and state standards, clinical pathways and information on patients, length of stay and use of specific facilities, medical equipment and ICT are shown in the first section for each DRG (Ch.'s 8.2.1, 8.3.1,8.4.1, and 8.5.1)
- Expert clinical interviews (Chapter 7.5) to verify the DRG, clinical pathways, and information on patients, length of stay, models of care, clinical requirements and use of directly required facilities by time required and requirement for access to other

acute (indirectly required) facilities, medical equipment and ICT are contained in the second section of each DRG (Ch.s 8.2.2,8.3.2,8.4.2and 8.5.2) and

- Building standards, including AHFG areas by function are in the third section of each DRG (Ch.s 8.2.3, 8.3.3, 8.4.3 and 8.5.3).

This information has been used to determine areas required for direct and indirect patient care). The modelling of these areas and the factors used to allocate areas to the patient level have been detailed and the costing index applied to the areas to derive capital cost per patient episode as outlined in the fourth section for each DRG (Ch.s 8.2.4,8.3.4,8.4.4 and 8.5.4). Sensitivity analyses have been developed around contentious areas for each DRG in the fifth section (Ch.s 8.2.5,8.3.5,8.4.5 and 8.5.5).

The chapter concludes with:

- a comparison of the capital costs derived from the model and recurrent costs for each DRG, and
- a discussion of the mechanism by which the proposed model of funding capital on a diagnosis basis can be applied in Australia.

8.2 Haemodialysis

Haemodialysis (hereafter referred to as Dialysis) was chosen as a test case as it is the most frequently used DRG. Sixteen per cent of all hospitalisations in Australia in 2015-16 were associated with chronic kidney disease with 10% of Australians affected. Haemodialysis rates are increasing across Australia and access to haemodialysis is of particular importance to indigenous women.(AIHW 2017d)

8.2.1 Literature

Guidelines for haemodialysis identified through the grey literature were:

- Australian Clinical Practice Guidelines (six results in the Guideline Portal search)(NH&MRC 2017)
- Commonwealth Department of Health and the State Departments of Health (one result for each of South Australia, Queensland, WA, the Agency for Clinical Innovation NSW)
- The Australian New Zealand Society of Nephrology (Guidelines regarding patient selection for dialysis) and

- Kidney Health Australia(two guidelines- Dialysis membranes and acceptance into dialysis)
- Caring for Australians with Renal Impairment (CARI) guidelines- clinical guidelines for biological targets(CARI 2016) and
- The Cochrane renal group

8.2.2 Expert Interviews

Eight senior nephrology specialists (three medical and five nursing) were invited to provide advice on the physical requirements of the patient pathway for AN-DRG L61Z Haemodialysis but none accepted. So the AHFG on haemodialysis recently developed by NSW Health Infrastructure were evaluated for the level of contemporary clinical advice and verification. Interviews with the guideline developers demonstrated a rigorous process with extensive research supported by professorial level clinical advice from medical, nursing and allied health clinicians. Draft guidelines had been based on contemporary clinical care and were approved by professional bodies in every state and New Zealand in association with the Australian and New Zealand Dialysis and Transplant Registry (ANZDATA.(Australasian Health Infrastructure Alliance 2016m)).(Australasian Health Infrastructure Alliance 2016a)

As clinical advice was both recent and of the highest standard, further clinical advice was not considered to be necessary with the AHFG for dialysis adopted for modelling (AHFG 2017). The AHFG provided detailed information on areas, medical equipment and ICT.

8.2.3 Building standards

The AHFG noted that in addition to the spaces outlined in the Schedules of Accommodation (SOA) areas for technical support, access to podiatry, heart disease and diabetes services, a water plant room for the five phased filtered water supply for dialysis machines, an isolation room for every five treatment bays and staff bays for every five patients were required. These areas have been included.

8.2.4 Allocation of capital

Directly required areas

Dialysis for AR-DRG L61Z typically is provided in Dialysis Units between 7.00am and 9.00pm each day allowing two sessions per machine per day for between three and seven days per week, usually six days. Units operate for 52 weeks per year or 312 days on a six day week. The AHFG for an 18 bay Dialysis Unit was standard with occupancy of 75%.(Australasian Health Infrastructure Alliance 2016m) Functional lifespans for the

activity areas of the Dialysis Unit were identified(Ch.7.6.9). Total areas in square metres (m²) was calculated based on the AHFG with additional support²⁵, waste²⁶ areas and medical records storage space in Reception for a hybrid medical records system.

From the Gross Floor Area (GFA) of the Dialysis Unit area for Plant (for water²⁷, power, waste, air-conditioning and other systems and equipment required) is calculated based on the AHFG standard of 12.5% of GFA. Similarly, the Travel area (for internal and external corridors) is 15% of the GFA using AHFG standards(Australasian Health Infrastructure Alliance 2016m).

Based on the areas required the allocation factors were applied sequentially to have a Gross Floor Areas (GFA) divided by lifespan, days, treatment bays, patients per day and occupancy rate. Plant and travel were calculated from the total sequential cost. Using the apportionment factors listed in Table 8.1;

- total areas were divided by the lifespan of that area to give area per year,
- by the number of days per year the unit operates (312) to give an area required per day,
- by the number of treatment bays in the unit to give an area per treatment bay per day,
- by the number of patients using the treatment bay per day to give an area per patient
- The per patient per day area was adjusted for the standard occupancy rate of 75%
- Resulting in an area required per patient of 0.004121m² of area.

²⁵ Temperature controlled storage space for large quantities of packaged liquids, disposable consumables is required with external roller door access from a loading dock suitable for a pallet lifter. Store area aisles have been calculated to accommodate the pallet lifter safely

²⁶ Waste management areas for both contaminated and general waste includes clinical waster bins, a dirty utility and a perimeter disposal room for the collection of linen and waste.

²⁷ The Water Treatment Plant Room is a lockable room for water treatment systems used in dialysis, including booster pumps, particle filters, water softeners, carbon filters and reverse osmosis systems. This equipment will incorporate a heat disinfection function, and water saving features. The Water Treatment Plant Room enables short tubing runs to each Treatment Bay, permitting staff to monitor and service the water treatment systems. Ventilation, exhaust and/or airconditioning must be designed to accommodate the heat loads of the specified equipment(Australasian Health Infrastructure Alliance 2017b).

Table 8.1 Allocation factors for capital directly required for Dialysis AN-DRG L61Z

Dialysis areas	Total M ²	Apportionment factors				
		Lifespan in years	Availability days	Treatment Bays	Patients/day	Occupancy standard
Entry/Reception/Waiting	218.4	50	312	18	2	0.75
Treatment Area	299.0	20	312	18	2	0.75
Support Area	147.5	20	312	18	2	0.75
Staff Areas	46.9	50	312	18	2	0.75
Gross Floor Area	711.8		312	18	2	0.75
Plant 12.5% GFA	89.0	20	312	18	2	0.75
Travel 15% of GFA	106.8	50	312	18	2	0.75
Total Areas	907.5		312	18	2	0.75

Table 8.2 Dialysis areas required for direct patient care

Direct patient care areas	Total M ²	Apportionment divided by				
		Lifespan in years M ²	Availability days M ²	Treatment Bay M ² s	Patients/day M ²	Occupancy standard M ²
Entry/Reception/Waiting	218.4	4.368	0.0140	0.00078	0.000389	0.000486
Treatment Area	299.0	14.951	0.0479	0.00266	0.001331	0.001664
Support Area	147.5	7.375	0.0236	0.00131	0.000657	0.000821
Staff Areas	46.9	0.938	0.0030	0.00017	0.000334	0.000417
Gross Floor Area	711.8	27.632	0.0886	0.00492	0.002711	0.003388
Plant 12.5% GFA	4.449	0.0143	0.00079	0.000396	0.000495	0.75
Travel 15% of GFA	2.135	0.0068	0.00038	0.000190	0.000238	0.75
Total Areas	907.5	34.216	0.1097	0.00609	0.003297	0.004121

Indirectly required facilities

Dialysis patients are likely to require other acute health services(Boscolo 2017). Patients require access to emergency department bays, hospital beds and ultrasonography(Australasian Health Infrastructure Alliance 2016m). A portion of patients require access to operating theatres or procedure rooms for vascular surgery with 80-90% of dialysis patients requiring surgical arteriovenous fistula creation and 10% requiring access to theatre for catheters(Gallieni 2009). NSW clinical practice standards found 25.3% of patients requiring access to operating theatres.(Thomas 2016) However dialysis patients would be admitted under additional DRG's for these procedures .Appropriate access to these facilities is covered by indirect costs per dialysis admission. Access to hospital facilities is based on length of stay per episode of care of 3-5 hours. So, indirect costs are based one half day at Girt-by Sea General per patient episode (Ch.7.6.3, 7.6.7-9).

Medical Equipment and ITC

The AHFG cover the range of medical equipment and departmental ICT required for dialysis. Major medical equipment for dialysis:

- hemodialysis chair, electric
- a 5008 Online haemodiafiltration(HDF) therapy system or equivalent
- equipment operational add-ons for blood flow volumes, temperature monitoring and pressure and data management systems transmitting clinical information.
- water filtration equipment.

Expert advice, supported by the Canadian experience, is that costs for dialysis equipment vary between companies, by purchasing arrangement, by volume, by optional extras and by area for delivery(Ferguson 2015).Dialysis machinery costs in satellite dialysis units varied considerably as a percentage of capital costs and of operational costs.(Ferguson 2015) ICT for electronic medical records could not be quantified.

As discussed (Ch.7.6.7 and 7.6.9) an Australian states hospital unit cost of \$5,030 per square metre(Rider Levett Bucknall 2017) has been applied to the area identified to convert the per patient areas required for dialysis to obtain the direct and indirect area costs.

Aggregating the area required directly and indirectly by dialysis patients (DRG L61Z) indicates a cost of capital required per patient episode of \$41.47.

Table 8.3 Total areas and costs for AR-DRG L61Z Dialysis per patient, 2017

DRG L61Z		
Per patient	Area M²	Cost \$
Direct	0.004121	20.73
Indirect	0.004123	20.74
Total	0.008244	41.47

8.2.5 Sensitivity analysis

A univariant sensitivity analysis in which the only variable tested was the unit cost per square metres for hospital buildings. Table 8.3 uses national average unit costs for the Australian states and the ACT and NT(Ch.7.6.9). However, there are fewer hospital projects in the Territories to provide cost information and prices are often higher particularly in the NT. Table 8.4 uses the state average cost excluding the ACT and NT (Rider Levett Bucknall 2017) resulting in a higher estimated capital cost per dialysis patient of \$43.38.

Table 8.4 Areas required for DRG L61Z per patient and cost, state average cost 2017

Per patient	Area M²	Cost \$
Direct	0.004121	21.68
Indirect	0.004123	21.70
Total	0.008244	43.38

8.3 Obstetrics- AR-DRGS O60B, O60C, O01B and O01C

The most common obstetric DRGs were selected for analysis: AR- DRGs: O01B and O01C for caesarean delivery, AR-060B, O60C (multiday) and AR-DRG O60C (sameday). AR- DRGs O01B and O01C for caesarean delivery, are with and without severe complicating conditions respectively, and O60B and O60C for vaginal delivery are without catastrophic or severe complicating conditions. All these diagnosis groups describe births encompassing the sequence of care beginning as the woman presents to the hospital and concluding six weeks post-natal.

8.3.1 Literature

Midwife group practice and shared midwife-obstetrician care are preferred models of care (Hartz 2012; Tracy 2014; McLachlan 2015) but have no additional implications for

facilities. Between 1992 and 2016 there have been six articles on improvements in medical investigation equipment for childbirth in nursing journals, all of which are included in the 2016 AHFG for obstetrics (Australasian Health Infrastructure Alliance 2016b).

Guidelines

National Royal Australian and New Zealand College of Obstetrician and Gynaecologists (RANZCOG) obstetric guidelines require facility planning to include:

- Accessible antenatal care facilities
- Facilities suitable for the special needs of women with disabilities and women of different cultures (RANZCOG 2016b)page 7)
- Timely access to:
 - a) operative care
 - b) specialist services including anaesthesia, neonatal paediatrics and haematology (RANZCOG 2016)page 27
- Parents' mental health needs (RANZCOG 2016)page 31)
- “Facilities for the management and support of families (and staff) who have experienced an early or mid-pregnancy loss, stillbirth or neonatal death.” (RANZCOG 2016)page 35)

Clinical guidelines were also available in some jurisdictions:

- NSW Clinical Guidelines emphasis patient-centred care and distinguishes between high risk and normal births clarifying role delineation for facilities for higher risk births. The guidelines envisage “electronic point of care documentation” (NSW Health 2010)page 15) to minimise time that midwives spend away from patients however they discourage centralised monitoring of patients .(NSW Health 2010)page 15)
- Queensland guidelines chart two clinical pathways for:
 - AR-DRGs O60C Vaginal Delivery without Complicating Diagnosis A (ALOS 1.83 days) B (ALOS 1.84 days) and AR-DRG O60B Vaginal Delivery with moderate complicating diagnosis A (ALOS 2.68 days) B (ALOS 2.51 days).(Queensland Health 2015b) and
 - AR-DRG O01C Caesarean Delivery without Complicating Diagnosis (ALOS 3.98 days)(Queensland Health 2015a).

- Clinical pathway care is woman-centred care taking account of the woman's physical, psychosocial, cultural, emotional and spiritual needs balanced with safety (Queensland Maternity and Neonatal Clinical Guidelines Program 2012).
- Clinical pathways for AR-DRG O60B and AR-DRG O60C patients were charted for midwives, medical officers and allied health professionals (Queensland Health 2015d)
- Victoria and Tasmania do not have state guidelines for obstetrics.
- South Australia has guidelines for shared GP-obstetrician-midwife care of patients, including mental health assessments. (SA Maternal & Neonatal Clinical Network 2015) Referencing both the national guidelines and clinicians from the major obstetric units the guidelines detail antenatal visits, antenatal classes (four) plus six additional clinics that may be required, 15 pathology samples including two complete blood tests, pharmacy supplied items and up to two ultrasounds as good standard practice. (SA Maternal & Neonatal Clinical Network 2015)
- WA Guidelines also reference the National Guidelines and focus on risk mitigation including guidelines on the physical security of mother and baby.(WA Womens and Newborn Health Service 2014(Australian Health Ministers Conference 2010) Improving Maternity Services for Western Australia builds on four key State reviews (Health Reform Committee(Reid 2004)), the Clinical Services Framework of 2004 (Health Department of WA 2004) including two reviews of maternity services (Cohen Report 2003) (Henderson 2007) conducted between 2000 and 2007 with an extensive consultation process (Health Department of Western Australia 2007)

All guidelines specifications have been included in the facilities and equipment requirements.

In 2014 the IHPA reviewed coding for AR-DRGs O60B and O06C clarifying coding conventions. (Australian Consortium for Classification Development 2014)Women's Healthcare Australasia benchmarking found that AR-DRG O01C has a consistent average length of stay across Australia. (Boardley 2015). The Australian Consortium for Classification Development and IHPA define the DRG's as birth and post-natal care to 6 weeks.(Australian Consortium for Classification Development 2014) Funding for the antenatal period is through Tier 2 payments to hospitals outside the DRG system thus not included in the cost of capital for inpatient obstetric diagnosis related groups.

8.3.2 Expert interviews

Experts who were interviewed confirmed the validity of adopting clinical pathways to chart the patient journey for AR-DRGS O60B, O60C and O01B and O01C. However, the obstetrics interviews highlighted divergence from the clinical guidelines might occur for a number of reasons:

- Presenting patient characteristics have a significant bearing on capital requirements (For example the increased percentages of bariatric patients has implications for operating theatre size, delivery suite and bathroom size, bedroom size, feeding chairs, lifts, hoists, monitoring, ensuite bathrooms, clinic facilities, allied health services and real time communications).
- Evolving models of care may vary some capital requirements to achieve clinical objectives and optimise care for local patient groups including the need to reconfigure departmental and facility configurations. (For example, point-of-care testing for ultrasound, blood gas and blood testing equipment was rated as important with the increased percentages of diabetic patients)
- Security is of greater importance in hospitals than the guidelines identify.
- Indigenous people have trouble navigating through existing health and hospital services.

These factors were included in the calculations of areas, corresponding costings and are discussed in the sensitivity analysis(Ch.8.3.5) .

Specialised facilities

Theatre and imaging requirements are included in the direct and indirect areas. Evidence regarding ICU admissions for low risk patients and patients with moderate complications internationally includes:

- A review of 33 studies conducted between 1990 and 2006 found ICU admission rates of 0.07-9.8% of deliveries (Singh 2016)
- A Canadian study identified 0.26% of obstetrics patients required ICU admission (Lapinsky 1997)
- Rates of ICU admission for Australian and New Zealand obstetric patients were between 0.4-16% of ICU admissions the equivalent of between 0.7 and 13.5 per 1000 deliveries (Nguyen 2011).

Due to variability in the evidence no specific allowance for ICU admission has been made in direct costings. Indirect costings provide for appropriate access to ICU facilities.

8.3.3 Building Standards

The AHFG Maternity Unit standard were used as the basis for clinical interviews. Guidelines used for identification of areas for direct costing were:

- maternity unit(Australasian Health Infrastructure Alliance 2016b),
- Central Sterile Supply Department (CSSD) (Australasian Health Infrastructure Alliance 2016j)
- Day of Surgery area (DOSA)(Australasian Health Infrastructure Alliance 2016d)
- operating theatres(Australasian Health Infrastructure Alliance 2016c).

Divergence of opinion between the standards, IHPA(IHPA 2017a) and ACCD(Australian Consortium for Classification Development 2014) and the clinical experts occurred regarding the inclusion of pre-natal testing, clinics or short-stay medical assessment areas for obstetric patients in WA, Victoria and NSW. To accord with the published standards these areas are defined separately within the DRG's costed(Australasian Health Infrastructure Alliance 2017a)

8.3.4 Allocation of capital

Obstetric DRGs include single day and multi-day hospital stays. The method used to calculate the costs is to calculate the cost for Day 1 and then each day following and to sum the areas required for the patient's length of stay.

Direct Costs

Table 7.5 outlined the process for allocating directly required areas based on the AHFG for the first day of an obstetric stay (Entry, Assessment, Birthing Unit, Inpatient Postnatal, Postnatal clinic, Clinical Support Staff areas and amenities, plant and travel). Life span of most built spaces was used to calculate area required per year, divided by 360 (representing a full year's operation minus five days annual maintenance). The AHFG specify a whole unit so unit patient numbers per day (Entry=8, Assessment=2, Birthing Unit=1, Operating theatre=8, Inpatient Postnatal=1) were applied to the patient areas to obtain the area required per patient for one inpatient day (Table 8.5).

Table 8.5 Areas and allocation factors for directly required Obstetric patient care Day One

Directly Required Areas Obstetrics Unit	m ²	Allocation factors				
		No. of Rooms	Lifespan Years	Availability Days/yr	Patients per Day	Occupancy Standard
Entry	73		20	360	8	0.75
Assessment	136	4	20	360	2	0.75
Birthing Unit	684	5	20	360	1	0.75
CSSD	391		50	250		0.85
Operating suite	1543	6	20	360	8	0.75
Inpatient Postnatal	1,347		50	360	1	0.75
Postnatal Clinic	106		20	250	12	0.75
Clinical Support	100		20	360	1	0.75
Staff Areas & Amenities	160		50	360	1	0.75
Gross Floor Area	4,531					
Plant 12.5% GFA	566		50	364		
Travel 15% of GFA	680		50	364		
Total Area	5,777					

Nationally 24% of births in public hospitals were caesarean in 2014. (SCRGSP 2016)Table 11A.9) Caesarean patients require operating theatre suite facilities in addition to the maternity facilities. Births classified as intrapartum (performed after the onset of labour) where patients use Labour /Delivery/Recovery suite areas were estimated to be 42% of caesarean deliveries with 58% of caesarians performed before the onset of labour.(Prosser 2014)Clinical advice was for an uncomplicated caesarian delivery of I to 1.15 hour theatre time required including anesthetic, cleaning and set-up.

Length of stay figures were identified through interviews and confirmed with AIHW data cubes for 2015-16(Table 8.6). For O01B, Caesarean after use of the Labour Delivery Recovery (LDR) rooms, directly required areas were calculated for each day to include:

- Day one =Entry + assessment +birthing unit +CSSD+ operating suite+ half day inpatient accommodation + clinical support areas+ staff areas.
- Day two =inpatient accommodation
- Day three = inpatient accommodation
- Day four = inpatient accommodation (0.7) + post-discharge clinic.

For O01C, Caesarean, directly required areas were calculated for each day to include:

- Day one =Entry + Day of surgery area (DOSA)+CSSD+ operating suite+ half day inpatient accommodation + clinical support areas+ staff areas.
- Day two =inpatient accommodation
- Day three = inpatient accommodation
- Day four = inpatient accommodation (0.7) + post-discharge clinic.

For O060B, for vaginal delivery without catastrophic (Cat CC) or severe complication conditions (SCC), directly required areas were calculated for each day to include:

- Day one =Entry + assessment + birthing unit +CSSD+ half day inpatient accommodation + clinical support areas+ staff areas.
- Day two =inpatient accommodation
- Day three = inpatient accommodation (0.4) + post-discharge clinic.

DRG O060C for vaginal delivery without severe complication conditions varied from O60B in length of stay.

- Patients who overnighted after birth had an average length of stay of 1.8 days so were estimated as:
 - Day one =Entry + assessment + birthing unit +half day inpatient accommodation + clinical support areas+ staff areas and
 - Day two= inpatient accommodation (0.8) + post-discharge clinic.
- Patients with a one day length of stay = Entry + assessment + birthing unit + clinical support areas+ staff areas+ post-discharge clinic.

Applying the allocation factors to the AHFG areas of Table 8.5 the areas directly required for patient care by diagnosis group are summed in Table 8.6.

Table 8.6 Estimated directly required areas per patient by day, 2017

DRG	ALOS* days	Day 1 m ²	Day 2 m ²	Day 3 m ²	Day 4 m ²	Total m ²
O01B	3.4	0.1709	0.12	0.12	0.09	0.50
O01C	3.4	0.1699	0.12	0.12	0.09	0.50
O60B	2.5	0.13	0.12	0.09		0.34
O60C	1.8	0.08	0.11			0.19
O60C	1	0.04				0.04

* Average length of stay

Assumptions have been made that:

- Post-natal patients will require an inpatient bed for half a day or overnight on day one.
- Operating rooms are used for 10 hours per day.
- For anesthetic in the theatre
- Patients are transferred to the Obstetrics unit after Stage 1 recovery.
- The Operating room suite is accessible for seven days per week.
- Post-natal clinic areas are required for all obstetric patients and are allowed for only once in the directly required areas.

ICU use by patients in these DRGs was too low to calculate areas. No additional medical equipment was specified.

Indirect Costs

To estimate indirect costs from the Girt-by-sea model hospital (Table 7.4), some areas were excluded to prevent double counting and as unnecessary for obstetric patients:

- obstetrics areas were subtracted from whole hospital areas
- geriatric spaces, palliative care, chemotherapy, renal dialysis, endoscopy suites, cardio-vascular intervention laboratories, nuclear medicine, x-rays and rehabilitation day area.

Using Dutch functional building lifespan estimates (Netherlands Board for Healthcare Institutions 2007b) with operating days per year from the AHFG's the remaining hospital areas allocation factors were applied listed in Table 8.7. Inpatients per day is equivalent to the number of beds/places of the model hospital.

Table 8.7 Allocation factors for areas indirectly required for Obstetrics patients

Department	Areas m²	Lifespan years	Days per year	Patients per day
Administration and Executive	1,505	50	260	304
Inpatient Wards	9,854	20	360	304
Critical Care	7,088	20	360	304
Clinical Industrial	3,060	20	360	304
Day-only	1,968	20	250	304
Hotel	2,250	50	360	304
Plant	3,557	50	360	304
Travel	4,268	50	360	304
Area Total m²	33,550			

Applying these factors to the areas identified an area of 0.01608 was required per day per obstetrics patient (Table 8.8).

Table 8.8 Areas indirectly required for Obstetrics patients

Department	Areas m ²	Lifespan years m ²	Area per day m ²	Area per patient m ²
Administration and Executive	1,505	30	1.158	0.00381
Inpatient Wards	9,854	493	1.369	0.00450
Critical Care	7,088	354	0.984	0.00324
Clinical Industrial	3,060	153	0.425	0.00140
Day-only	1,968	98	0.394	0.00129
Hotel	2,250	45	0.125	0.00041
Plant	3,557	71	0.198	0.00065
Travel	4,268	85	0.237	0.00078
Area Total m²	33,550	1330	4.89	0.01608

Direct and Indirect Costs

Summing direct and indirect areas and applying a cost per square metre, Table 8.9 identifies the capital costs for the DRGs reviewed. Capital costs for obstetric patients vary with length of stay from \$2,926 for caesarean patients using Labour/Delivery/Recovery and Operating suites to \$289 for day-only uncomplicated deliveries.

Table 8.9 Total areas and costs for Obstetric patients in AR- DRGs O01B, O01C, O60B, O60C multiday and sameday 2017

DRG	ALOS days	Direct m ²	Indirect m ²	Total m ²	Cost \$
O01B	3.4	0.50139	0.054680	0.5561	2,926
O01C	3.4	0.50043	0.054680	0.5551	2,921
O60B	2.5	0.34498	0.040206	0.3852	2,027
O60C	1.8	0.27702	0.028948	0.3060	1,610
O60C	1	0.03877	0.016082	0.0549	289

*Direct Admission to Operating Room,

** Operating room after onset of labour

8.3.5 Sensitivity Analysis

Clinical variation sensitivity

Clinical requirements by experts identified additional patient requirements and areas beyond those specified in the guidelines for 59 m² or 1.06% of the total area directly required for

obstetrics patients. Costing based on the clinical guidelines alone would return a cost per patient 1% lower than that including clinical opinion. Clinical experts argue that the lower cost would reduce the functional effectiveness of the unit and would not be patient-centred.

Price Sensitivity Analysis

The national unit cost of hospital buildings per square metre (\$5262) used in the base case analysis averages the costs for each state and the territories(Ch.s7.6.9, 8.2.5)(Rider Levett Bucknall 2017). A state average price, excluding the territories (\$5,030) resulted in costs \$232 per m² lower (Table 8.10). Costs per diagnosis group were therefore lower by between \$172 and \$ 24 using the state average price schedule.

Table 8.10 Areas required Directly and Indirectly per patient in Obstetrics DRGs O01B, O01C,O60B, O60C multiday and sameday, state averaged cost in 2017 prices

DRG	ALOS days	Direct m²	Indirect m²	Total m²	Cost \$
O01B	3.4	0.50139	0.054680	0.5561	2,797
O01C	3.4	0.50043	0.054680	0.5551	2,792
O60B	2.5	0.34498	0.040206	0.3852	1,937
O60C	1.8	0.19179	0.028948	0.2207	1,110
O60C	1	0.38776	0.016082	0.0549	276

*Direct Admission to Operating Room,

** Operating room after onset of labour

8.4 AR-DRG I03B Hip Replacement minor complexity

8.4.1 Literature

Multidisciplinary reviews of Australian guidelines and practice outcomes using the National Health and Medical Research Council (NHMRC) grades of recommendations for safe, high quality and cost-effective joint replacement surgery found the use of clinical pathways lowered length of stay and improved outcomes (Mak 2014).Clinical pathways have been tested, and are accepted, in Alberta Health (Canada) and the UK (Gooch 2009; National Institute for Health and Clinical Excellence (NICE) 2017; Department of Health 2010). The use of clinical guidelines and published outcome evaluations for hip replacement patients has reduced the incidence of adverse events for patients and lowered length of stay and hospital costs in the UK and Alberta. (Tucker 2017; Gooch 2009)

Guidelines have been developed in NSW, Victoria and Western Australia(Agency for Clinical Innovation NSW 2012; Victorian Musculoskeletal Clinical Leadership Group

2018). The WA guidelines draw on UK guidelines placing an emphasis on an electronic clinical pathway linked to Outpatient and GP service providers, multi-disciplinary assessments, infection control and risk management.(Department of Health 2010)

This DRG relates to patients with medium or moderate complicating conditions. Hip replacement surgery is a well-described procedure(Australian Consortium for Classification and Development 2016) with a level of risk including the incidence of:

- pulmonary embolisms in 0.2-0.4% of patients.(Murnaghan 2010),
- a 1-2% risk of infection,
- a risk of venous thromboembolic events (VTEs).(King and Phillips 2016)

8.4.2 Expert interviews

Semi-structured interviews were conducted with three orthopaedic surgeons specialising in hip and knee replacement, a professor of orthopaedic surgery, the president of the Arthroplasty Society of Australia and an orthopaedics department head of a Level 4 public hospital. All surgeons operate in both the public and private sectors and all are involved in research. An orthopaedic clinical surgical specialist involved in prosthetic fitting and two practicing academic physiotherapist were interviewed. Ten nurses from metropolitan and regional hospitals over two states were interviewed for advice on admission, operating theatre, inpatient accommodations including ICU use.

There was agreement between the surgeons and nurses that:

- Individual patient rooms and bathrooms were the contemporary standard for patient recovery and served to minimise infection.
- 55m² operating theatre was appropriate with laminar flow and HEPA filters
- A technology control desk is required for each theatre or shared by theatres
- PACS systems for reading and storage of x-ray and fluoroscopy images
- Bariatric rooms and bathrooms were not required
- Negative pressure rooms were not required
- Pre-operative appointments including blood tests and x-rays between one and two weeks prior to surgery
- Post discharge follow up appointments included surgical review and physiotherapy.

However, process differences were noted in treatment modalities. The modality of care most commonly reported is recorded here as Model A. Model B used by the older surgeon and identified by nurses working with older surgeons, is modelled and costed in the

sensitivity analysis (Ch.8.4.5). The differences between mid-career surgeons and older surgeons included:

- Younger surgeons admitted patients to a Day of Surgery Area (DOSA) for 2 hours before theatre; the older surgeons admitted patients to the ward for three to four hours prior to surgery,
- Younger surgeons used an anaesthetic preparation or set up area for the next patient while the theatre was prepared after a surgery; the older surgeon had the anaesthetic and catheter administered in theatre extending the time for each procedure,
- Younger surgeons rarely used ICU for post-operative patients(2-5% of patients compared to 33% of patients of the older surgeon)
- Younger surgeons reported shorter average lengths of stay for knee replacement patients of one day, and
- Younger surgeons reported slightly shorter length of stay for hip replacement patients (2.8 days compared to 3 days).

Length of stay varied from 24 hours to five days across the models of care.

Post-acute inpatient rehabilitation was suggested for social reasons for older patients, and patients with no home support by older surgeons. If an alternative, such as a medihotel, were available one older surgeon agreed post-acute inpatient care would not be necessary.

Significant IT demands for managing joint replacement operations with dual digital screens, picture archiving and communication system (PACS) online, and a control room were noted. Around 40 % of operations are now computer guided interviewees observed. Integrated operating suites with imaging were not considered necessary by most clinicians as imaging takes place before admission and on day one. One perioperative manager identified robotics and 3D imaging in theatre as impending technologies.

Rehabilitation during the acute post-operative stage was recommended to be in a 30m² physiotherapy gym on the ward. It would include an exercise bed, a physiotherapy frame, parallel bars and steps for four to six patients supervised by a physiotherapist. This would be shared by hip and knee replacement patients and other orthopaedics patients.

Areas deleted from the AHFG as not required were the perfusion room and store and the audiovisual workroom. Access to an emergency room and other specialist services is regarded as important due to the range of patient health issues including lung complications associated with pulmonary or fat embolisms.

8.4.3 Building Standards

The following AHFG elements were used for the clinical pathway for hip replacement patients:

- Entry
- Day of Surgery(Australasian Health Infrastructure Alliance 2016d)
- Inpatient Accommodation
- Operating Theatre(Australasian Health Infrastructure Alliance 2016c)
- Sterilizing Unit(CSSD)(Australasian Health Infrastructure Alliance 2016j)
- Imaging
- Rehabilitation Unit
- Clinic and
- Clinical Support.

National and WA requirements for level 4 surgery specify:

- Quarantined clean theatres (quarantined from other acute services)
- Laminar Flow
- Ultraclean air systems
- Appropriate facility design to minimise infection risk
- Equipment for immediate and late surgical complications
- Electronic referral pathway
- Designated high dependency unit (HDU)
- Suitable access to intensive care and coronary care unit
- Radiology including nuclear medicine, X-ray, CT, MRI, PACS availability, interventional radiology
- Onsite CSSD
- Microbiology
- Immediate access to pathology and laboratory services
- Transfusion
- Bioengineering
- Orthotics services
- access to allied health, and
- Outpatient clinics.(Health Department of WA 2010; NSW Ministry of Health 2018)

8.4.4 Allocation of capital

Clinical pathways of the two surgical DRGs involve additional support services including medical imaging, intensive care unit (ICU) and rehabilitation. First these are examined (with their major medical equipment and ICT requirements for direct care), then folded into the areas directly required for patient care (Table 8.13). Indirectly required areas, medical equipment and ICT follow.

ICU

Data on the use of ICU for hip replacement patients is inconclusive with orthopaedic patients using 4.5% of ICU and HDU space (ANZICS 2016). American and Korean studies identified 7.1% of total hip replacement patients have an average of 1.7 days in ICU post-surgery (Kamath 2012; Kim 2015). Allocation of ICU area was based on the propensity to require ICU care by any hip replacement patient. So the most commonly referenced (n=13) level of 2% of an average 3.88 day (93hour) average length of stay was allocated for hip replacement patients based on expert clinical advice. A second scenario of ICU utilization is applied in the sensitivity analysis.

Other areas

Previously subacute care was required for 8.64% of hip replacement patients (Gooch 2009), however clinical advice was that inpatient rehabilitation was rarely used in 2017 (Naylor 2017; Bharadwaj 2014). Two key activity and one support area were included, and their areas and apportionment factors are shown in Table 8.11-Table 8.13. They are:

- The medical imaging department (Australasian Health Infrastructure Alliance 2016g)
- operating theatre areas including Day of Surgery area (DOSA) (Australasian Health Infrastructure Alliance 2016d) and
- Central Sterilizing Services Department (CSSD) (Australasian Health Infrastructure Alliance 2016j)

Assumptions have been made for clinical support and staff areas based on estimates of patients per day for the whole department as these are shared areas including offices and storage.

Table 8.11 Imaging Department apportionment factors for areas directly required, 2017

Areas Required	Apportionment factors					M ² Occupancy Standard
	m ²	Rooms	Lifespan Years	Days/year	Patients per Day	
Entry /reception /clerical	98.6	8	20	250	50	85%
General X-ray and fluoroscopy	339.5	4	20	250	20	75%
Clinical Support	118.8	8	50	250	50	85%
Staff Areas	64.8	8	20	250	50	85%
Total GFA	621.7					
Plant 12.5% GFA	77.7		20			
Travel 15% of GFA	93.3		20			
Total Area	792.6					

Imaging Equipment

Clinical advice and guidelines for hip replacement specified x-ray equipment and a C-arm mobile fluoroscope for 20 patients per day. As outlined in Ch.7.6.10, the costs and lifespan of the specified equipment was obtained from the manufacturer.

Table 8.12 Imaging Equipment costs and allocation factors, 2017

Major Medical Equipment	\$	Apportionment factors \$			
		Lifespan Years	Days	Patients per Day	Occupancy Standard
General X-ray Allocation Factors		20	360	20	85%
\$ value	\$179,001.00	\$8950	\$24.86	\$1.24	\$1.43
Fluoroscopy Allocation Factors		20	360	20	85%
\$ value	\$76,145.72	\$3,807	\$10.58	\$0.53	\$0.98
Total value per patient					\$2.41

ICT

The importance of up-to-date imaging ICT and access to individual devices was emphasized by surgeons and nurses (n=9). ICT is an unknowable quantity in the equation and qualifies the capital estimate.

Average Length of stay (ALOS)

There is a range of information on ALOS for hip replacement patients from the literature and the clinical experts. National average length of stay for this DRG is 5.7 days(IHPA

2016b). However clinical expert advice agreed on an ALOS of 3 days. Length of stay for hip replacements can be 24 hours in one model of care or two days post-operative. (Department of Health 2010) Detailed research on clinical pathways for hip replacement patients identified an ALOS of 5.07 days.(Gooch 2009) For this costing the most commonly agreed ALOS by the majority of clinical experts (n=11) of 3 days has been adopted as the best practice standard.

Directly required areas

To determine the cost of a hip replacement, areas and equipment were identified using the patient pathway outlined in clinical guidelines, detailed in the AHFG and elaborated by clinical experts:

Directly required areas were calculated for each day to include:

- Day 1=pre-admission clinic +imaging +Day of Surgery Area(DOSA)+perioperative holding +Central Sterile Supply Department + operating unit+ half day inpatient accommodation + propensity to use ICU+ clinical support areas+ staff areas.
- Day 2 =inpatient accommodation +propensity to use ICU
- Day 3 = inpatient accommodation + propensity to use ICU+ post-discharge clinic.

Indirect areas included all areas of the hospital except Orthopaedic, Obstetric, Paediatric, Neonatal Care, Palliative Care, Chemotherapy and Labour Delivery Recovery.

Orthopaedic units require larger than average equipment stores for mobility aids and equipment. Bathrooms need to be larger for assisted patients and corridors wider to permit beds with poles and equipment to pass each other or patients on frames or assisted by staff. So 40% was allowed for plant and travel rather than 27.5% for non-orthopaedic wards(Australasian Health Infrastructure Alliance 2015). Rehabilitation areas also specify the higher circulation allowances.(Australasian Health Infrastructure Alliance 2016i).

Assumptions have been made for clinical support and staff areas based on estimates of patients per day for the whole department as these are shared areas including offices and storage.

Prior to surgery patients use the Day of Surgery Unit(DOSA). Operating theatres require the support of sterile equipment supply departments (CSSD).

Table 8.13 Areas directly required for Hip Replacement allocation factors

Directly Required Areas Obstetrics Unit	Rooms	Apportionment m ²			
		Lifespan Years	Availability Days/year	Patients per Day	Occupancy Standard
Entry	28	20	250	8	85%
DOSA	4	20	250	25	85%
Inpatient Accommodation	4	20	250	28	85%
Operating theatre	5	20	250	8	75%
CSSD		20	250	8	85%
Imaging		20	250	20	75%
Rehabilitation		50	250	28	85%
Clinic		20	250	8	85%
Clinical Support		20	250		85%
Staff Areas & Amenities		50	250		85%
Gross Floor Area					
Plant	12.5% GFA	20			
Travel	15% of GFA	20			
Total Area					

Direct costs were summed for each day and are presented in Table 8.14.

Indirect Costs

To estimate the areas hip replacement patients were deemed unlikely to need obstetric, paediatric, neonatal, palliative care, chemotherapy or access to Labour/Recovery/Delivery suites: these have been removed from total indirect areas. Using the method outlined in Table 7.7, and with the listed exclusions, Table 8.15 shows a total cost of areas for hip replacement of \$1410. Directly required areas were \$1,086, ICU access cost \$84 and indirect costs were \$239. Most costs were incurred on Day One through access to operating theatres and associated functions.

Table 8.14 Hip Replacement areas required and costs, 2017

Hip	Areas Direct	M² ICU	Indirect	Total	\$ Cost
Day 1	0.149847	0.005339	0.01517	0.17036	896
Day 2	0.027318	0.005339	0.01517	0.047827	252
Day 3	0.029217	0.005339	0.01517	0.049726	262
Total	0.206382	0.016016	0.04551	0.267913	1410

Medical Equipment and ICT

The major medical equipment added, based on clinical interviews, was:

- Day 1 X-ray and fluoroscopy
- Day 2 Mobile X-ray
- Day 3 X-ray and Fluoroscopy

ITC required for Day 1-3 PACS +electronic medical records including digital imaging.

Added to the areas are medical equipment costs of \$6.25 resulting in a per patient cost of capital of \$1416 in 2017 dollars. An ICT component cost per patient should also be added.

8.4.5 Sensitivity Analysis

The differences between the two models of care outlined in clinical interviews (Ch.8.4.2) are detailed in Table 8.15. Model A (costed above) had pre-surgical preparation and interviews in a curtained cubicle in the Day of Surgery Area (DOSA) and a 30m² physiotherapy gym on the ward. Model B advocated by an older orthopaedic surgeon used a hospital bed for pre-surgical preparations and interviews, had anaesthetics administered in the operating room rather than a set up room (potentially increasing theatre time per patient) and referred patients over 70 to inpatient rehabilitation for 5 days. Physiotherapy in model B would be walking in the ward or using hospital stairs. However, the most significant difference was the propensity to use ICU as model A has 2-5% of patients admitted to ICU and Model B has 33% of patients overnight in ICU

Table 8.15 Models of Care Hip Replacement

Area	Model A	Model B
Pre-surgery Theatre	DOSA 1-2 hours anaesthetic in set up room	Ward 3-4 hours 30 min's in theatre Anaesthetic + catheter
ICU Admission	2-5% of patients	33% of patients
ICU LOS	for up to 2 days	overnight (12 hours)
Ward Gym	30m ²	use corridors and stair
Length of Stay	2.8-3 days	3 days
Rehabilitation (Inpatient)		5 days Patients over 70

Capital costs for Model B were \$187,049 higher per patient than for Model A from:

- Surgery- higher accommodation costs for Day 1 (cost for half day inpatient accommodation minus DOSA admission) of \$39per patient. Theatre costs would be greater by 30 minutes.
- ICU- costs were estimated to be \$186,973 higher than Model A.
- Ward-A gym on the ward under Model A costs an addition \$12.94 per patient per day accessed for 2 days after surgery.
- Rehabilitation- Model B cost \$72.73 more for 5 days inpatient rehabilitation (Table 8.16)

Rehabilitation

Model B involved estimating rehabilitation accommodation costs for 33% of patients. A standard rehabilitation ward was calculated from the rehabilitation unit guidelines as a 28 bed unit with 3 x 4 bedrooms, 4 x 2 bedrooms and 8 single bed rooms (Australasian Health Infrastructure Alliance 2016i). Apportionment factors for inpatient care mirrored inpatient obstetrics with 360 days of operation, 85% occupancy and 50 year anticipated lifespan. It was assumed that physical treatment areas would be shared with the allied health department and outpatients. The area required presents an additional cost of \$14.55 per patient per day or \$72.73 for 5 days.

Table 8.16 Rehabilitation Area requirements per patient per day, 2016-17

Rehabilitation	M ²	Apportionment					M ² Occupancy Standard	\$
		Divide by Rooms	Lifespan Years	Days	Patients per Day			
Patient Area	900.2	32.15	0.643	0.001786	0.001786	0.002054	11	
Clinical Support	233	8.321429	0.166429	0.000462	0.000462	0.000532	3	
Total	1133.2					0.002586	14	

The additional requirement under Model B for direct ICU access for 33% of patients proved to be an additional cost of \$ 186,973. When ICU requirements are excluded, capital cost differences of Model B over model A were \$76 per patient.

8.5 AR-DRG I04B Knee Replacement and Reattachment.

8.5.1 Literature

Knee replacement guidelines have been adopted across Australia (Agency for Clinical Innovation NSW 2012; Queensland Health 2011; Victorian Musculoskeletal Clinical Leadership Group 2018; WA Department of Health 2010). Research has examined the evolution of models of care (Gooch 2009; Agency for Clinical Innovation NSW 2012; Murnaghan 2010) diminishing the value of inpatient rehabilitation (Naylor 2017; Schilling 2018). However, there is little research on ICU use by knee replacement patients. Orthopaedic patients are 4.5% of Australian ICU admissions and a small American study had 25% of total knee replacement patients requiring ICU care (Kamath 2013).

8.5.2 Expert interviews

Interviews were conducted with the same clinicians as for hip replacement. As with hip replacement there was clinical agreement on most items (Ch.8.4.2). However, practice differences between Model A (which has been costed) and Model B of the older surgeons were consistent with hip replacement (Ch.8.4.2). Average lengths of stay for knee replacement patients were 1 day shorter for knee replacement patients under Model A compared to Model B.

Expert interviews in 2017 suggested average lengths of stay for knee replacement were less than the average recorded for 2015-6 in by the IPHA. (IHPA 2016a) Physiotherapists noted the clinical risks and safety issues associated with using hospital fire stairs for acute rehabilitation when patients collapse or have cardiac events. A physiotherapy gym on the

ward would increase physiotherapy safety, effectiveness and efficiency as up to 6 patients could be supervised by one therapist in a 30m² gym appropriately equipped. Infection control (with hand wash facilities) and equipment management would also be an improvement. Equipment storage in the gym would reduce hunting and gathering of ‘borrowed’ equipment by physiotherapists.

8.5.3 Building Standards

Standards for knee replacement parallel those for hip replacement involving the following AHFGs:

- Entry
- Day of Surgery(Australasian Health Infrastructure Alliance 2016d)
- Inpatient Accommodation
- Operating Theatre(Australasian Health Infrastructure Alliance 2016c)
- Sterilizing Unit(CSSD)(Australasian Health Infrastructure Alliance 2016j)
- Imaging
- Rehabilitation Unit
- Clinic and
- Clinical Support.

Surgical standards for Level 4 clinical facilities, outlined in Ch.8.4.3 Hip Replacement, are required (Health Department of WA 2010; NSW Ministry of Health 2018).

8.5.4 Allocation of capital

Average length of Stay (ALOS)

Nationally average length of stay was recorded as 5.2 days(IHPA 2016b). A detailed study identified ALOS of 7.64 days as clinical best practice with 7.31% of patients requiring subacute care. (Gooch 2009) Length of stay for knee replacements can be as low as three days. (Department of Health 2010) but the clinical experts identified between four and five days average length of stay. A four day ALOS has been modelled as most clinicians agreed with only one suggesting five days.

ICU

ICU stays are required for 2% of patients for most clinicians however one clinician had 33% of patients overnight in ICU (discussed in the Sensitivity Analysis Ch.8.5.5).

Allocation of ICU area was based on the propensity to require ICU care by any knee replacement patients. So 2% of an average 3.88 day (93hour) average length of stay was allocated for knee replacement patients.

Other facilities

In a detailed clinical pathways review of operating theatre time for Knee Replacement was recorded as 111.64 minutes permitting a maximum of four procedures per theatre per operating day(Gooch 2009). However, clinicians advised that six to seven procedures per day per theatre was now standard. Rehabilitation for uncomplicated knee procedures was not recommended by most clinicians and has been found not to benefit patients.(Naylor 2017; Schilling 2018)

The same allocation factors were used for knee replacement modelling as for hip replacement (Table 8.13) areas. Capital costs for knee replacement were found to be \$ 1,914 per patient (Table 8.17). This cost comprised \$1,373 for directly required areas, \$140 for access to ICU and \$399 for indirectly required areas. Day 1 involving operating theatre costs is the highest cost for capital per inpatient day(Table 8.17).

Table 8.17 Knee Replacement areas required and costs, 2017

Knee Replacement	M ²			Total	\$ Cost
	Areas Direct	ICU	Indirect		
Day 1	0.149847	0.005339	0.01517	0.170360	896
Day 2	0.027318	0.005339	0.01517	0.047827	252
Day 3	0.027318	0.005339	0.01517	0.047827	252
Day 3	0.027318	0.005339	0.01517	0.047827	252
Day 3	0.029217	0.005339	0.01517	0.049726	262
Total	0.261019	0.026693	0.07585	0.363567	1914

If patients have post-acute support the surgeons identified no need for sub-acute inpatient accommodation.

Medical equipment and ICT

Medical equipment costs were identified from medical imaging based on clinical advice and costed based on inpatient time of use as with hip replacement (Table 8.12). A total cost per patient of \$6.25 was determined. ICT costs could not be estimated.

Capital cost

When medical equipment costs of \$6.25 are added to direct and indirect area costs of \$1,914 (Table 8.17) the total cost of capital for knee replacement is estimated to be \$1920 in 2017 dollars. ICT costs per patient should be added.

8.5.5 Sensitivity Analysis

There are two analyses in this section. The first addresses the different models of care between mid-career surgeons (Model A) and older surgeons (Model B). The second considers an alternative allocation factor for hospitals based on available days rather than operating days.

As with the sensitivity analysis for hip replacement (Ch.8.4.5) Model B represents additional costs over Model A. The areas of difference are outlined in Table 8.18, with one additional day length of stay for knee replacement patients in Model B compared to model A. Capital cost differences of Model B over Model A were \$125 per patient excluding ICU. Additional patients requiring ICU care were similar to hip replacement patients at \$186,973 per patient. Model B, the older model of care cost a total of \$187,098 more for capital per patient than the newer model of care costed in Model A. Inpatient rehabilitation has not been included in the cost savings.

One of the challenges of this analysis is determining the allocation factors. Operating times are common factors for staffing and recurrent resource; however, buildings and medical equipment exist in both operating and non-operating hours. Should the cost per patient episode reflect the full time rather than operating time? An alternative analysis considers the cost for knee replacement patients using 360 days of operation rather than 250 days. The result drops the area per patient and the dollar value for Day 1 of built capital to \$567, a 35% difference and decreases the total capital cost of knee replacement to \$1,584. However, costing for operating hours aligns with the costing methods for the National Hospital data collection. Operating time direct costing enables shared uses of areas beyond one DRG and normal hours. It is the preferred method for capital costing in this thesis.

Table 8.18 Changing allocation factors to 360 days per year for Day 1 for knee replacement

Area	m ²	Apportionment				
		Rooms	Lifespan Years	Days	Patients per Day	Occupancy Standard
Admissions / reception area	56		2.8	0.0077778	0.000278	0.00031944
Day of surgery admission	164	41	2.05	0.0056944	0.000228	0.00026194

Area	m ²	Apportionment				
		Rooms	Lifespan Years	Days	Patients per Day	Occupancy Standard
Preoperative holding area	123.2	24.64	1.232	0.0034222	0.000428	0.00049194
CSSD	391.2		19.56	0.0543333	0.054333	0.06248333
Operating room area	554.4	110.88	5.544	0.0154	0.001925	0.00221375
Inpatient accommodation	1245.42	44.022	2.2011	0.0061142	0.006114	0.00703129
Clinical support area	289.8		14.49	0.04025	0.001438	0.00165313
Staff Amenities	124		6.2	0.0172222	0.000615	0.00070734
Imaging	206.5	103.25	5.1625	0.0143403	0.001033	0.00118738
Clinic area	43.4		2.17	0.0060278	0.000603	0.00069319
Total	1561.3					0.07704274
plus Circulation 40%						0.10785984

8.6 Discussion

It has proven possible to develop a model of capital cost estimation based on Australian diagnosis groups for a range of DRGs relevant to a significant portion of Australian public hospital patients. Focussed on patient and clinical requirements, the model for allocating capital costs mirrors the approach for cost estimation for the recurrent funding system for hospitals (IHPA 2015c). The objective of both models is to provide access to efficient high-quality care for all Australians. The mechanism tested in this chapter has drawn on evidence from clinical guidelines, building standards and advice from clinical experts to identify a capital cost per patient. A prime quality of the model is that it creates a link between capital costs, patients, clinical practice and the outcomes of treatment. Using the model capital investments for specific facilities, equipment and ICT can be evaluated for patient volumes, treatments and outcomes using the model. The estimated costs per patient demonstrate the method rather than exactly identifying the capital cost per patient due to data limitations. Australia has a range of standards and evidence-based mechanisms that have been deployed in this model to support capital allocation by DRG to align with recurrent DRG funding.

8.6.1 Relationship between capital and recurrent costs

As with recurrent costing, based on clinical care requirements, this analysis identified significant divergence of capital costs between the selected DRGs. Capital costs as a percentage of recurrent costs varied from 8% for haemodialysis to 36% for vaginal delivery of minor complexity (Table 8.19) (IHPA 2019b). The capital cost estimates, combined in Table 8.19, challenge previous assumptions that:

- The cost of capital consumed by each patient in a diagnosis group can be meaningfully averaged across all diagnosis groups(SCRGSP 2018)
- Depreciation of buildings and medical equipment accurately reflects capital consumed(Productivity Commission 2009e)
- “Capital costs represent a relatively small portion of total cost” of acute care delivery (SCRGSP 2018)Chapter 1 part A).

Similarly, Deebles finding that a consistent percentage relationship existed for recurrent and capital costs based on 20th century data, (Deeble J 2002c) was not supported by the model results at a DRG level (Table 8.19). No consistent relationship was found between average recurrent costs and capital costs by DRG when 2016-17 average costs per DRG were compared(IHPA 2019b).

Table 8.19 Estimated capital costs as a percentage of the average recurrent cost per DRG, 2016-17

Source: National Hospital Cost Data Collection, AR-DRG Cost Weight tables V8.0x, Round 21 (Financial year 2016-17)

AR-DRG	Average recurrent cost	Estimated capital cost	Capital as a percentage of average recurrent cost
L61Z - Haemodialysis	575	41	8
O01B - Caesarean Delivery, Intermediate Complexity	12,084	2,926	24
O01C - Caesarean Delivery, Minor Complexity	9,919	2,921	29
O60B - Vaginal Delivery, Intermediate Complexity	6,145	2,027	33
O60C - Vaginal Delivery, Minor Complexity	4,532	1,610	36
O60C - Vaginal Delivery, Minor Complexity Day -only	4,532	289	6
I03A - Hip Replacement, Major Complexity	30,083	1,416	5
I04B - Knee Replacement, Minor Complexity	19,369	1,920	10

Deebles implicit assumption was that technology as a portion of capital costs remains constant. However, the estimated cost of capital by government has increased from 7.9% of recurrent costs (1990-2000) to 19% in 2017(IHPA 2016b; SCRGSP 2018; Deeble 2002a) When government estimates of recurrent and capital costs are compared with the modelled DRGS, capital costs as a percentage of recurrent costs are slightly lower for the

modelled DRGs (Table 8.20). The comparison is between the depreciation-based estimate of capital costs and the bottom-up costing method adopted in the model. The lower capital percentage may indicate some savings are possible in capital stock as Schumpeter would assert (Schumpeter 1942). However, caution should be used with the estimates in this broad comparison for a number of reasons including the limitations of the government capital estimates discussed previously (Ch.2.6.2-3, 7.1.1).

Table 8.20 Comparing estimated recurrent and capital costs per patient, 2017

Sources: Recurrent costs from IHPA Price Determination 2016-17; Depreciation-based capital cost from the 2018 Report on Government Services, Productivity Commission, Canberra

Costs	Recurrent \$	Capital \$	Percentage %
Government-based estimate	4,883	927	19
Guidelines-based estimate	9,676	1,443*	18

*Exclusive of indirect costs for medical equipment and ICT.

Investment for newer models of care provided recurrent savings at lower capital costs for hip and knee replacement in particular. Medical innovation applied to the facilities patients require permits capital investment to improve clinical effectiveness, productivity and safety this analysis has found (Ch.8.3-4). Patients and clinical care will continue to change. This model has proven able to include evidence-based change while maintaining appropriate support for clinical care.

There are costs in an inert system of capital costing that do not align with the dynamic nature of acute care (Productivity Commission 2015, 2017b). The sensitivity analyses of hip and knee replacement, in particular, documented changing models of care resulting in lower capital and recurrent costs. However, the analyses do not capture the costs or effects of ICT. Economic theorists have identified the effects of innovation to improve efficiency and the importance of creative destruction of outmoded methods(Solow 2005; Schumpeter 1942). This thesis has indicated some significant problems ranging from poor connection between capital and recurrent objectives to failures in accountability and investment for ICT. However, it has been demonstrated in this chapter that a transparent system of capital allocation by DRG is feasible and quantifiable in Australia. Patient care and clinical standards can be supported by appropriate investment in medical equipment and ICT directly and indirectly required in hospital facilities.

This chapter has identified that a nationally consistent value for capital funding per diagnosis group is feasible. How could it be delivered for Australian hospitals and their patients?

8.7 Proposed operation of the model system

The model could be implemented by the cost of capital consumed in an episode of care being paid to hospital capital accounts in arrangements based on the *National Health Reform Act 2011* from pooled public funds. Per patient capital costs would be transparently costed and reported in line with arrangements under the Act for the determination of the efficient price for patient care.

Capital costs per patient would be paid into a restricted hospital capital account from a discreet capital fund administered with the National Health Funding Pool system (Figure 8.1). The plan would be to have:

- Capital cost funds allocated in a timely, transparent and reportable manner
- Capital funding per patient to be shared by the Commonwealth and the states
- Patient capital payments to be separated from recurrent funding at all levels to prevent capital funds being used for other purposes (Duckett 1995) particularly as top-ups for recurrent budget shortfalls as in the UK (Wright 2010; Darzi 2018a).
- Funds accredited to the hospital providing treatment for the use of that hospital or regional health service.

8.7.1 Governance

Proportional funding arrangements for capital cost payments would need to be agreed by COAG. (Council of Australian Governments (COAG) 2018a) The cost of capital per patient episode could then align with the processes for activity-based recurrent funding for hospitals (described below). This would permit the cost of capital per patient episode to be managed through the systems established under the the *National Health Reform Act 2011* and the amendment to that act the *National Health Reform Amendment (Administrator and National Health Body) Act 2012* and matching state legislation- NSW Health Services Act 1997, Victorian *Health (Commonwealth State Funding Arrangements) Act 2012*, Queensland *Hospital and Health Boards Act 2011*, W.A. *National Health Funding Pool Act 2012*, S.A. *National Health Funding Pool Administration (South Australia) Act 2012*, Tasmania *National Health Funding Administration Act 2012*, ACT *Health (National Health Funding Pool and Administration) Act 2013* and the NT *National Health Funding Pool and*

Administration (National Uniform Legislation) Act 2012. Bills for the amendment of the legislation would need to be passed by the Commonwealth and each state and territory.

8.7.2 Process

The processes under the *National Health Reform Act 2011* provide for Commonwealth and state governments to meet the costs determined by the Independent Health Pricing Authority. It is proposed that capital be added as a separate identifiable funding element to the existing processes for recurrent funding for public hospitals detailed in Figure 8.1.

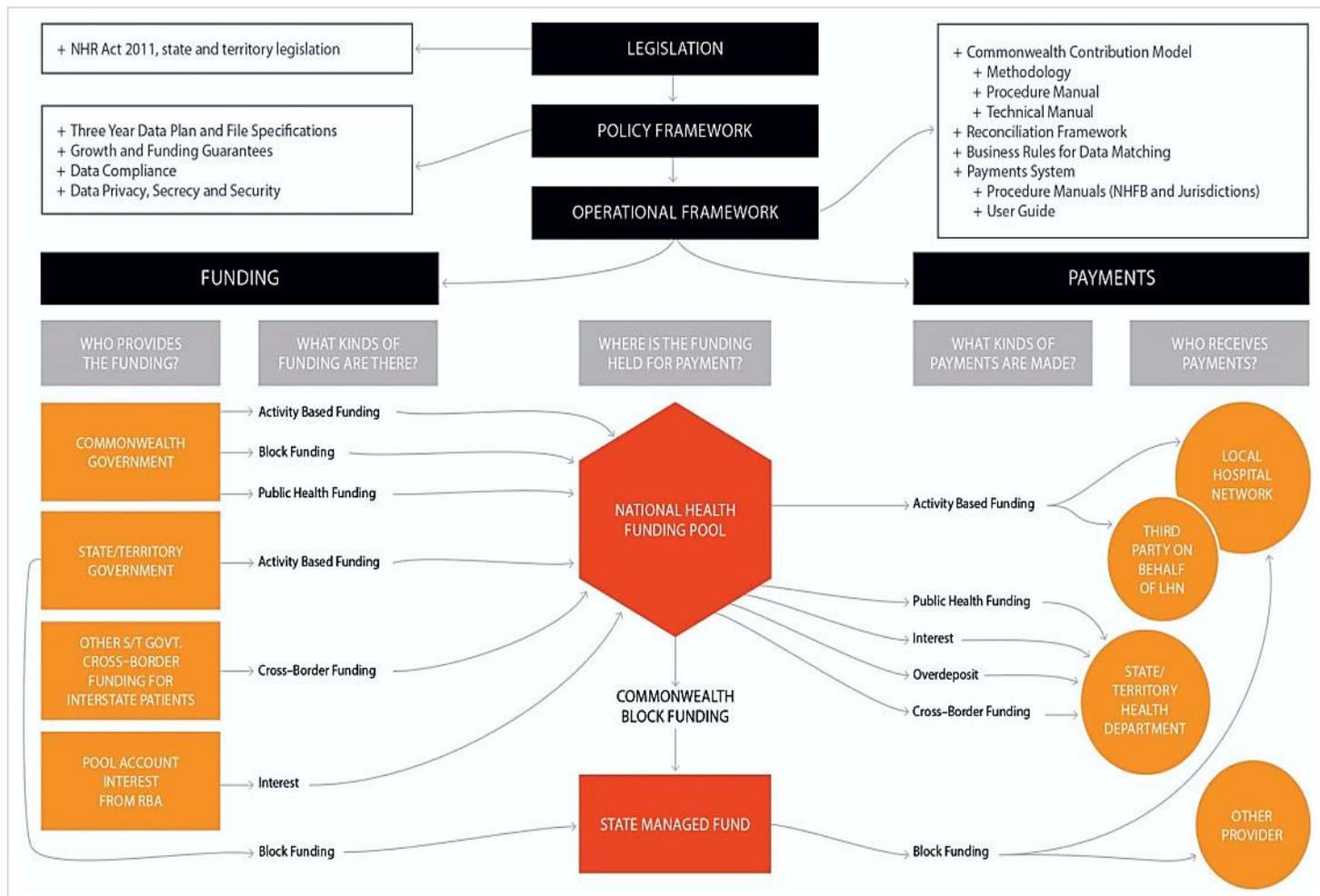


Figure 8.1 Australian public hospital recurrent funding and payment framework, 2018

National Health Funding Body (National Health Funding Body 2018b)

8.7.3 Accountability

Capital costs would be reported as in the IHPA Hospital Costs series but (i) at the patient level and (ii) to a broader range of capital elements to align with the formula set out in Chapter 7 (building areas- direct and indirect, medical equipment direct and indirect and ICT direct and indirect).

As with recurrent funding, the funding agency for the Commonwealth would report on capital cost payments to the National Health Capital Funding Pool or to state pools in the case of block grants. The hospitals or local health districts would also report on capital cost payments received and their applications. Processes, costs and funding would be reviewable by Parliaments, Auditors General, the Productivity Commission and provide accurate information for the annual report on government services.

8.7.4 Affordability

As with ABF, states would provide an agreed portion of capital funds and the Commonwealth would provide a similar share. It is expected that the portions agreed on by COAG may be close to 50/50 shares. Attention to the value of capital required to support effective and efficient clinical care would address the variations in investment identified in Chapter 4 (Table 4.2).

8.7.5 Innovation

Building on the expert-opinion approach used to develop the capital cost model it is proposed that advisors on clinical developments from the clinical colleges provide submissions to the IHPA for proposed changes or inclusions in the capital cost of the DRG.

8.8 Conclusions

This chapter has illustrated how the conceptual model developed in Chapter 7 can be applied to develop estimates of capital costs consumed per patient for selected DRGs that represent 36% of admissions in Australian public hospitals. This model can be extended across all DRGs to provide a system of capital funding of public hospitals that mirrors the model used for providing recurrent funding to public hospitals.

John Maynard Keynes identified that "The difficulty lies not so much in developing new ideas as in escaping from old ones" (Keynes 1936) Replacing the existing model of capital

funding with the proposed model will face difficulties arising from changing traditional methods and accepting shared responsibilities for capital funding. However, these difficulties can be overcome as were the difficulties with implementing the activity-based funding for recurrent costs.

Chapter 9 compares the prevailing Australian systems of capital allocation with the proposed model developed in Chapter 7 and applied in this chapter.

Chapter 9 Evaluation of Capital Allocation Systems

9.1 Introduction

Armed with an understanding of how a diagnosis-related model of capital costs can be developed and how it can operate, this chapter returns to the primary research question (Can diagnosis-related capital facilitate more appropriate, sustainable and innovative health care?) to evaluate the effectiveness of contemporary capital allocation systems when compared with the model. This is to examine the application and outcomes for Australian patients of the model for capital allocation compared to the existing capital allocation system. Measures, criteria and data used to evaluate the effectiveness of the proposed and the prevailing capital allocation systems are outlined (Ch.9.3) and the effectiveness of the two systems to fund appropriate, sustainable and innovative hospitals is assessed (Ch.9.4 and 9.5).

9.1.1 Evaluation

The purpose of this chapter is to compare the effectiveness of capital allocation as proposed in the model with contemporary practice in Australia asking if they embody the qualities and standards for capital allocation identified by government (from Chapter 1) repeated in Figure 9.1.

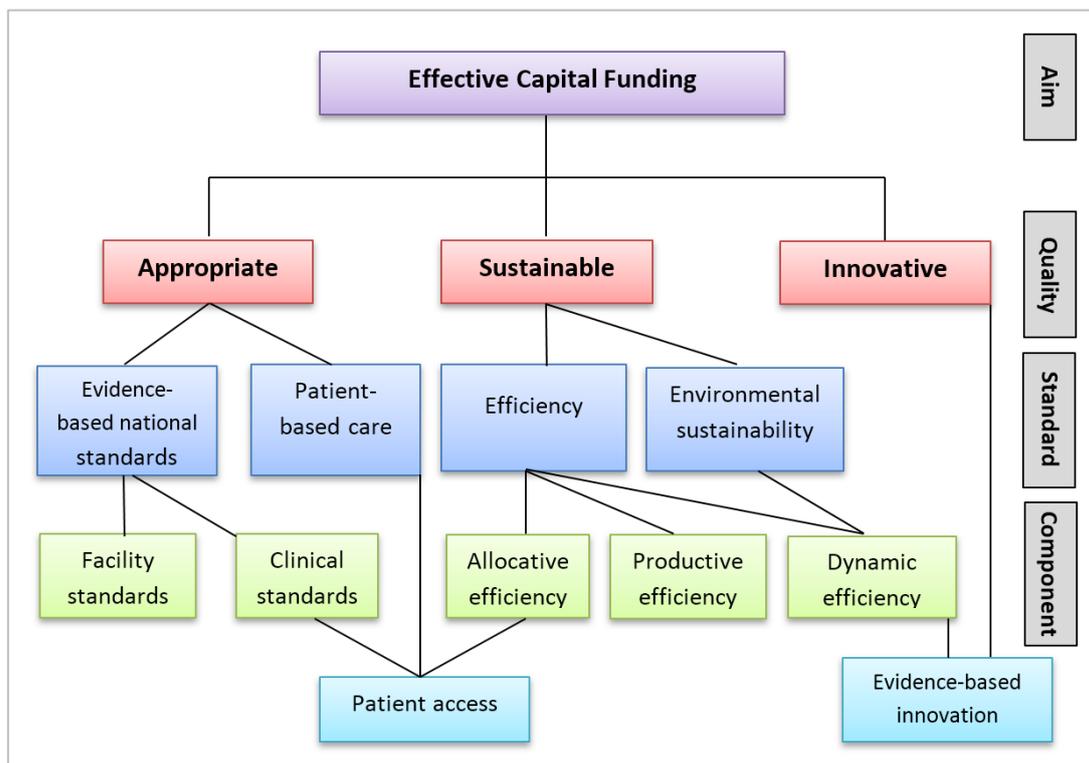


Figure 9.1 Effective capital funding for patient access to efficient hospitals

The objective of ‘effective capital funding’ incorporates funding qualities defined by government as appropriate, sustainable (SCRGSP 2018) and innovative (Council of Australian Governments(COAG) 2018a). These qualities are sub-divided into standards set by governments through standards and reporting frame works (Australian Commission on Safety and Quality in Health Care 2009, 2011, 2012; Australian Government 2011; SCRGSP 2016; SCRGSP 2017; SCRGSP 2018) Standards are further subdivided into components for measurement (Figure 9.1)

The performance of capital allocation is considered using the national Public Hospitals Performance Indicator Framework (PHPIF)(Figure 3.1) but with indicators relevant to capital allocation. The PHPIF is a robust and well-accepted Australian framework tested over many years but, for this study of capital systems, has some modest limitations as it does not have population access measures and has a single measure for efficiency, not addressing allocative or dynamic efficiency.

As a service evaluation model the PHPIF does not seek to address distribution and has only one financial measure. System performance evaluation for capital differs from the framework for services in the requirement for two characteristic dimensions for capital:

- evidence-based investment in future services (or innovation) and
- environmental sustainability.

To address these issues in the evaluation of capital the capital performance framework varies from the PHPIF as:

- Population and patient access measures have been added to provide a range of distributional measures
- Funding is assessed for each of the standards
- The qualities and standards have been considered in a different order, placing an emphasis on access and equity, and
- Sustainability has been divided into economic and environmental sustainability.

Capital is composed of different distinct components including specialised facilities, major medical equipment and ICT so the evaluation framework includes these distinctions. Figure 9.2 using the adapted Framework for capital measures identifies the indicator measures relative to performance qualities and standards.

From this framework a series of questions have been developed to identify output measures for evaluation to review effective capital allocation.

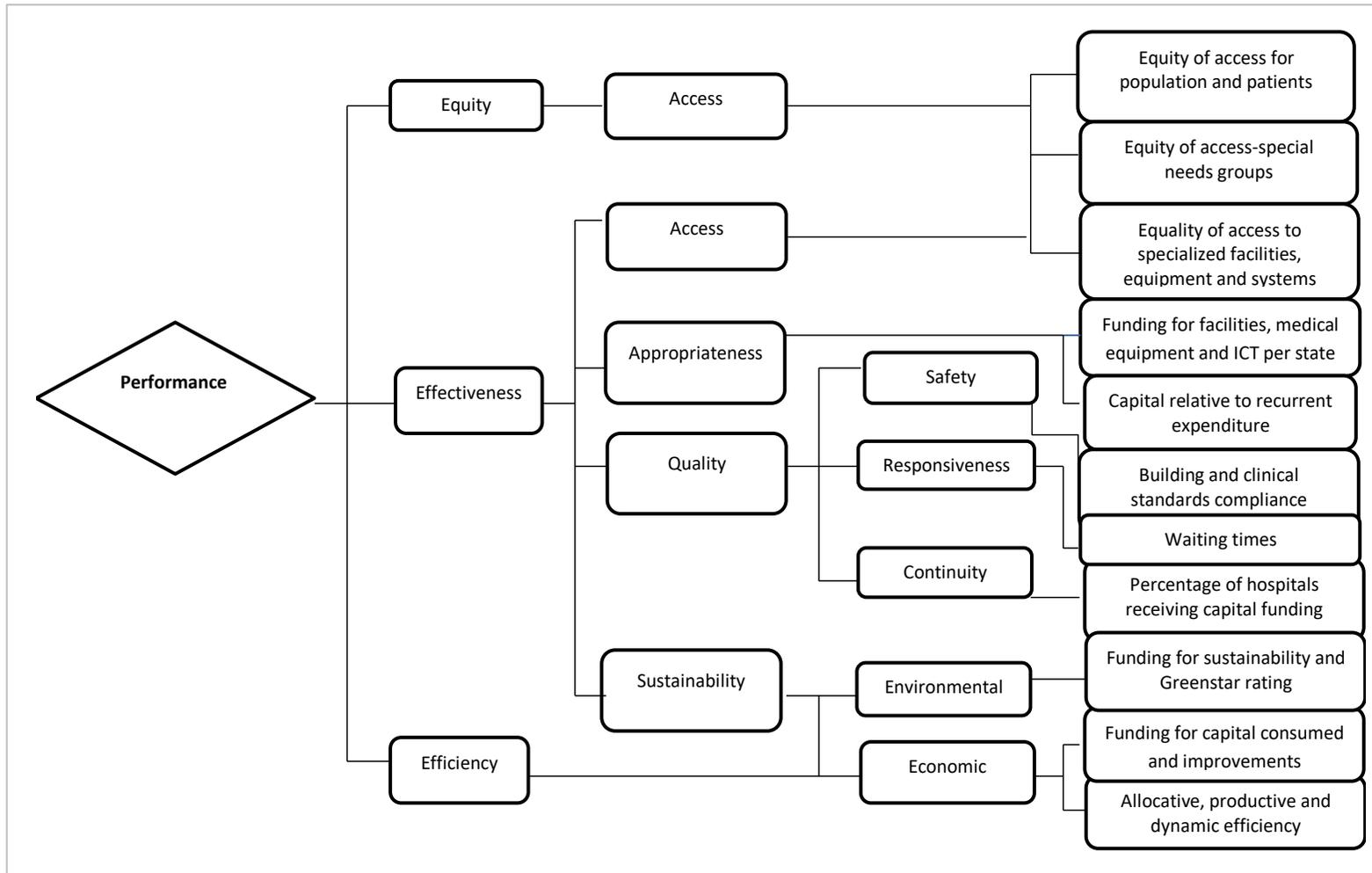


Figure 9.2 Public Hospital Performance Indicator Framework for capital measures

9.2 Research question and aims

This chapter aims to evaluate the effectiveness of capital allocation in the model and in contemporary practice in Australia asking if they embody the qualities and standards identified by government. To answer the primary research question “Can Diagnosis-related capital allocation facilitate more appropriate, sustainable and innovative health care facilities?” the third, and final, research sub-question aims to compare the model and the outcomes of prevailing capital allocation methods for the key standards of the PHPIF. So the third component of the primary research question seeks:

To compare the proposed method and the prevailing capital allocation methods for allocating capital for:

1. The effective facilitation of contemporary standards of care
2. Responsiveness to changes in patient demand,
3. Responsiveness to evidence-based improvements in clinical practice and
4. Equitable access to healthcare.
5. Efficiency particularly allocative efficiency and
6. Sustainability.

Responsiveness to evidence-based improvements in clinical practice is included as a measure of innovation matching Australian governments requirement for hospitals to be “driving best practice and performance using data and research.” (Council of Australian Governments(COAG) 2018a).

9.3 Methodology

This chapter focusses on the standards identified as significant for assessing capital allocation (Figure 9.2) with the proposed model (Ch.9.4) and the prevailing capital allocation system (Ch.9.5). Drawing on the analyses, Chapter 9.6 addresses the six components of the third research question. As data not available for the model, the operation of the proposed model is detailed against the standards and measures. Data selection, measures, extraction, limitations and analysis for the prevailing system are outlined in the following section (Ch.9.3.1, 9.3.2, 9.3.3, 9.3.4 and 9.3.5 respectively). A measure for identifying and estimating clinical need by jurisdiction is detailed in Ch.9.3.6.

9.3.1 Data sources

As previously noted reporting on public hospital capital expenditure, depreciation and capital cost estimates by AIHW ceased in 2015(AIHW 2015c; Kerr 2015). Commonly reports on hospitals referencing capital have acknowledged the problems of poor quality data, inconsistencies of inclusions between states and over time(Productivity Commission 2009e, 2010; AIHW 2017f; SCRGSP 2017). To address the data paucity and quality issues two data sources were used:

- Information from the clinical and expert interviews (Chapters 5 & 7) and
- Literature identified from literature reviews outlined in previous chapters with an emphasis on Budget papers for recent capital allocations and government reports.

Data has been identified from predominantly government sources based on (i) searches previously identified (Ch.2.6, 4.4-6,5. 4.4)and (ii) the annual reports on government services(SCRGSP 2018).

Equity, appropriateness and effectiveness are at the core of government reporting on health performance in Australia. Also important are the quality of services, their responsiveness and sustainability(Figure 3.1 and Figure 9.2)(SCRGSP 2018). There is overlap between the standards in the PHPIF and the measures outlined in Figure 9.1 and Table 9.1. An additional standard for innovation has been included as previously discussed. These measures align with the standards identified in Chapters 1 and 5 to answer the question ‘Can diagnosis related capital facilitate more appropriate, sustainable and innovative healthcare facilities?’

From the limited available data pertaining to capital allocation Table 9.1 expands on the indicator alignment of the reporting standards and the measures identified in Figure 9.2. The results of the measures aim to identify the relative strengths of the contemporary and proposed systems of capital allocation against the standards (Ch’s 9.4 and 9.5).

Table 9.1 Standards and measures for comparing the model and prevailing capital allocation systems

Standards	Data Sources	Data type	Measures
Equity	Commonwealth budgets	Capital expenditure	Capital per 1000 population Capital per inpatient episode Equality of access to MME Access for special needs population Equal access for births Equal access for knee replacement Equal access for caesareans Equal access to hospital ICT
	State and territory budgets	Capital expenditure	
	2016-17,2017-18, 2018-19	Capital expenditure	
	ACSQHC	Report	
	AIHW	Report	
	ABS	Statistics	
	ROGS	Report	
	Australian Digital Health Agency	Report	
	Senate Inquiry	Report	
	ANZICS	Report	
	Auditors General	Report	
Literature	Articles		
Appropriateness	AIHW	Patient Statistics	Estimated capital cost per state Access to specialised facilities Funding for ICT
	Auditors General	Report	
	ROGS	Report	
	State and territory budgets	Capital expenditure	
	2016-17,2017-18, 2018-19	Capital expenditure	
	IHPA	Determinations	
	Literature	Articles	
Effectiveness	Commonwealth budgets	Capital expenditure	Capital to recurrent expenditure
	State and territory budgets	Capital expenditure	
	2016-17,2017-18, 2018-19	Capital expenditure	

Standards	Data Sources	Data type	Measures
Quality	Auditors General	Capital expenditure	Funding for safety standards Building standards not met Access below clinical standards Continuity Percentage hospitals receiving capital Hospitals receiving capital over 4 years
	ACSQHC	Capital expenditure	
	AIHW	Capital expenditure	
	AMA	Report	
	Clinical expert interviews	Report	
	Literature	Statistics	
	State and territory budgets	Report	
	2016-17,2017-18, 2018-19	Report	
Responsiveness	AIHW	Waiting lists	Waiting list national variation Emergency Department waiting times Waiting lists for hip replacement Waiting lists for knee replacement Waiting lists by socio-economic status Equity of access to MME
	ROGS	Reports	
	ABS	Health survey	
	ACEM	Survey	
	Literature	Articles	
Innovation	Auditors General	Reports	Systematic funding for improvement Systematic technology adoption Planning for advanced technologies
	State and territory budgets	Capital expenditure	
	2016-17,2017-18, 2018-19	Capital expenditure	
	Clinical expert interviews	Advice	
	Productivity Commission	Reports	
	Senate Inquiry	Report	
	CSIRO	Report	
	ACOLA	Report	

Standards	Data Sources	Data type	Measures
Sustainability	COAG	Reports	Evidence for allocative efficiency Percentage hospitals with Greenstar rating Funding for sustainable hospitals Efficiency measured Evidence of efficiency improvement Distribution of efficiency improvements Identification of changes required Funding for improvements Distribution of improvements Funding for replacement of capital
	Interviews with health officials	Advice	
	Productivity Commission	Reports	
	ROGS	Reports	
	Auditors General	Reports	
	Clinical expert interviews	Advice	
	IHPA	Reports	
	ACSQHC	Statistics	
	Literature	Articles	
	AIHW	Statistics	
	Green Building Council	Statistics	

Abbreviations:

ACEM- Australasian College for Emergency Medicine,
 ACSQHC- Australian Commission on Safety and Quality in Health Care,
 AIHW- Australian Institute of Health and Welfare,
 ABS- Australian Bureau of Statistics, AMA- Australian Medical Association,
 ANZICs- Australian and New Zealand Intensive Care Society,
 COAG- Council of Australian Governments,
 IHPA- Independent Health Pricing Authority,
 ROGS- Report on Government Services (Steering Committee for the Review of Government Service Provision).

Based on the results of the analyses of the model and the prevailing system, two additional measures of capital investment pertain to the future are considered (i) ability to absorb short-term fluctuations due to reasonably foreseeable factors (Victorian Auditor-General 2017; Maresso 2015) and for capital allocation to (ii) provide a trustworthy base for future investment is considered for both the prevailing system and the model.

9.3.2 Data extraction

Drawing on the sources listed in Table 9.1 data was extracted from reports after 2010 in line with the concept of prevailing or contemporary funding.

Inclusion-Information drawn from State and Commonwealth Budgets was for general, non-specialist hospitals accessible to both adults and children.

Exclusion- criteria for data from state budgets were for health portfolio capital expenditure for car parks only, ambulatory care only, emergency department only, eye and ear

specialist hospitals, specialist children's hospitals, mental health facilities, aged care, residential facilities, nursing homes, regional minor works and acquisitions, maintenance, doctors accommodation, capital for health department office facilities and equipment, community or sport projects, roads to hospitals, nuclear medicine only, telehealth, Breastscreen only, project management contracts only, regional ehealth, research only facilities and land purchases.

No other sources had exclusion criteria.

Assessing the fitness for purpose of Australian hospitals required access to building standards compliance information. No published information could be identified to fulfil this indicator so inquiries were made of the Australian Health Design Council who concurred that no information was published in this area.

The productive efficiency of public hospitals is difficult to measure due to data problems (Productivity Commission 2009e, 2010). So this is a high level indicative review of available national reports on hospital efficiency rather than a detailed study of hospital efficiency (Hollingsworth 2008a) allowing for different measures, research objectives and output measures. Productivity Commission reports and state reviews were analysed.

No information was found on major medical equipment access. Funding for ICT in hospitals was extracted from the 2016-17 and 2017-18 state budgets and compared to population and patient numbers by state, for the mainland states and nationally.

The cumulative results of the analysis outlined in Table 9.1 are used as the basis for evaluating (i) ability to absorb short-term fluctuations due to reasonably foreseeable factors (Victorian Auditor-General 2017; Maresso 2015) and (ii) provide a trust-worthy base for future investment).

Information has been identified that is common to all states, uses common systems for capital allocation and is heterogeneous for expenditure inclusions, data collection, patient and hospital numbers. This chapter aims to be a systematic analysis of the available data (Table 9.1 and Table 9.2) around the standards, to minimise bias, no useful data has knowingly been excluded.

9.3.3 Limitations

Data-The analysis was based on available data; missing data, including areas where there was insufficient data to determine if a standard was met, have been acknowledged within the analysis and the tables.

Access to acute care is partially measured by access to emergency departments and elective surgery waiting lists. These do not cover access to some acute care services including access to chemotherapy, dialysis, imaging and outpatient procedural clinics or stroke services. Where data is available it has been included however no attempt has been made to estimate access for other services.

Averages-Capital per hospital and per patient measures are limited as they assume there is an equal distribution of resources between inpatients and hospitals. A further limitation of this averaged approach is that the cost of major hospital developments becomes less meaningful with small numbers of hospitals in Tasmania (22), the ACT (3) and the NT(5) disturbing national averages. Small numbers for hospitals, inpatients and population in the territories and Tasmania distort national averages so mainland state averages are used for comparisons along with, but in preference to, national averages. This method of analysis does not weight for NSW, Victoria and Queensland management of 72% of public hospitals.

Fluctuations- Due to the high price of major hospital developments capital allocations are recognised as ‘lumpy’ when viewed from year to year, particularly in less populous jurisdictions. Budget information over three-year periods and longer have been used to identify trends not available for one Budget period.

Model- As data is not available for the model, measures and criteria are applied to the operation of the model based on the information detailed in Chapter 8.

New measure-The cost of capital consumed per patient is used to measure investment rather than the relationship between depreciation and investment. This research seeks to align capital with patient care rather than asset stock. Conventionally investment is compared to depreciation(Victorian Auditor-General 2017) as a measure of the adequacy of assets. This research refutes that measure as an appropriate measure for hospital capital.

Environmental standards are not set for Australian hospitals by national policy. Standards for measuring environmental sustainability have been removed from assessment frameworks so policies have been used for assessment(AIHW 2018f). Policies adopted by

national health and building organisations do not have the authority of national standards used for the other assessments.

9.3.4 Analysis

Using the Public Hospital Performance Indicator Framework standards, the capital measures (Figure 9.2, Table 9.1) have been applied to each system of capital allocation. Data analysis methods continue those used in earlier chapters where simple quantitative methods (e.g. percentages and dollars per patient) were adopted to (i) aid the reliability of comparisons, and (ii) align with previously established comparators (Deeble 2002a; Productivity Commission 2009e).

9.3.4.1 Equity of Access

Analysis of this standard seeks to identify relevant measures to examine issues of access to facilities including specialised facilities and MME. The annual report on government services specifies equity of access as the measure of equity (Figure 3.1) (SCRGSP 2018). Australians use of diagnostic and inpatient clinical services is determined by factors including timely access to hospitals. (Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017) Access to sufficient and appropriate clinical facilities within the hospital has been identified as a critical clinical issue (Australasian College for Emergency Medicine 2018; Australian and New Zealand Intensive Care Society 2017; Australian Medical Association 2018). The National Health Survey of 2016 investigated access barriers to medical appointments but did not consider access issues to hospitals (ABS. 2017). Access issues associated with capital are not commonly reported (Bain et al. 2008).

Development of criteria for this standard involved defining what is meant by access to hospitals and special needs. ‘Access’ to hospitals for people who require acute care is defined as the opportunity to access to inpatient medical, surgical, obstetric, diagnostic and emergency treatments.

Equality of access to clinical services for patient groups modelled in Chapter 8 is examined to identify any implications for hospital facilities and equipment while acknowledging that patient access to acute clinical care is dependent on a range of factors including workforce, primary care and patient characteristics.

Equality of access for births has drawn on one study and one peer reviewed article to determine if there is equality of access for pregnant women across Australia to appropriate facilities for births. Patient access is a quality common to several indicators(SCRGSP 2019; AIHW 2018b).

9.3.4.2 Appropriateness

The appropriateness of hospital services is at the core of the standard to determine the effectiveness of funds spent across Australia on hospitals (Figure 9.2)(SCRGSP 2018). Appropriateness is assessed for capital, in this study, by identifying and quantifying prevailing capital allocations and assessing the appropriateness of those capital allocations for the delivery of services to patients. As the assessment relies on clinical and government standards (Figure 9.1), criteria are patient-based and dependent on published clinical assessments.

Interviews with officials included questions on clinical standards in capital allocation (Chapter 5). Data is not published on the appropriateness of facilities and medical equipment for patient care. So, based on the available data, a suite of measures have been used to determine how capital allocation and distribution relates to appropriate patient care:

- Capital cost per state is provided as a measure of fitness-for-purpose of the capital estimated to be required for patient care per state and nationally.
- Access to specialized facilities and equipment addresses the appropriateness of access to imaging, ICU, operating theatres and ICT
- Building on the assessment of equity, national equality of access for maternity care, and waiting times for hip and knee replacement are assessed against clinical standards.

9.3.4.3 Effectiveness

Determining the effectiveness of capital allocation systems is the thrust of this chapter and is measured in Deebles terms in relation to the services it is funded to deliver (the ratio of capital to recurrent expenditure). The role of capital is to effectively fund patient access to appropriate and efficient hospitals. Access to clinical services has capital and clinical dimensions. Clinical expectations and government expectations of access are used to assess access.

Access to hospitals relates to a range of services ultimately measured by population health and patient outcomes. Acute care access is either through an emergency department or bookings for elective surgery and other procedures(Duckett 2018b). ‘Accessible’ means

care is timely and appropriate. Timeliness, while not a comprehensive measure of access to all hospital services (Duckett 2018b), has comparable national measures in waiting times in emergency departments and elective surgery as a partial measure of access. (SCRGSP 2018) Measures for timely access for patients relate to clinical and government standards.

9.3.4.4 Quality

The concept of 'appropriate' standards (Figure 3.2 and Figure 9.1) affirmed that all Australians are entitled to access safe, high quality health care (Australian Commission on Safety and Quality in Health Care 2009). Ideally capital allocation could be analysed for quality connecting capital to the patient outcome by reference to the patient services facilitated, funded medical equipment and the quality of care supported by funding per patient. However, that level of data connection is not available. For this research a more limited range of measures are available, so the quality of capital allocation is determined to be the system outputs for building standards and safety, access to healthcare and continuity of funding. As information on hospital building standards and safety are not routinely published, the information has been gleaned through reviews and newspaper reports on these outcomes. Consequently, this aspect of the analysis of quality is less trustworthy than other measures.

Access to hospital for Australians is a primary function, and therefore measure, of the quality of capital allocation systems. Access to hospital measures have been discussed in equity of access (Ch.9.3.1) and will be discussed for difficulties in gaining access or waiting times (Responsiveness Ch.9.3.5.5). Access limitations that do not meet clinical standards identified in the review of other standards are précised.

Continuity of capital funding is a measure of the effectiveness of a capital allocation system as a measure of reliability and timeliness of funding (Chs.4 & 5) (Hellowell 2012b). Patient numbers, technological change and models of care are not static. A capital allocation system that facilitates appropriate patient access to high quality care will require appropriate adjustments of facilities, equipment and systems (Sun 2009; Schinko 2016; Samset 2009; Scheller Kreinsen 2011b) These adjustments are required to be equally distributed to achieve the standards of the Australian system and are likely to be more frequent as systems and equipment become more significant in the delivery of care (Table 4.4). Continuity of funding relates to the proportion of hospitals funded over time. It can be seen to relate to timeliness (assessed as part of allocative efficiency within sustainability Ch.9.3.5.7, 9.4.7 and 9.5.7.) (Hellowell 2012b).

9.3.4.5 Responsiveness

Responsiveness to patient needs is a measure of quality within the PHPIF. For capital allocation systems waiting times to access hospital services are considered the most appropriate output for evaluation. Waiting list data nationally and by state have been compared and data on emergency department waiting times, surgical waiting times and waiting times for hip and knee procedures. Waiting times for special needs patients aim to complete the context of access to hospital services. Maternity services, by their nature do not involve waiting lists. The criteria have been conservatively set as compliance with clinical and government standards.

Responsiveness to innovation is discussed in the next section.

9.3.4.6 Innovation

The primary research question invokes innovation as a parameter that aligns with Australian governments expectation for hospitals to be “driving best practice and performance using data and research.” (COAG 2018). Defined as as evidence-based improvements in acute clinical practice, the aim is to identify systematic funding of capital to support improvements in hospitals. Budget data is reviewed for systematic investment in technology and planning for future technologies. These measures have been identified in Chapter 4 as required for Australian hospitals(Deeble 2002a; Garling 2008b) and an expectation of contemporary hospitals(Guerrero 2009; Paslawsky L 2013; Joe 2013; NSW Agency for Clinical Innovation 2014; OECD Health Ministerial Meeting 2017; Dwyer and Leggat 2002; Tan 2018; Atkinson 2013). The criteria used are identification of a system of funding for improvement and technological adoption. Similarly, the criteria used for investment in advanced technologies are evidence of funding for planning systems for advanced technologies. This latter measure is less strong as funding may occur within departmental budgets but not be specified in publications such as annual reports. Auditors-General reports have been used to ensure any unpublished actions are not misrepresented.

9.3.4.7 Sustainability

The internationally accepted definition of sustainability unites three themes of social equity, environmental and economic sustainability (Brundtland 1987). Needs within the definition are considered as clinical and patient needs comprising clinical requirements and access equity:

- Clinical needs are reviewed in the following section (Ch.9.3.6) and clinical needs currently unmet by the funding system are discussed in Ch.9.5.7.
- Equity of access for all patients, special needs patients and the selected diagnosis groups is considered in terms of:
 - “the needs of the present” generation of patients (Brundtland 1987) (Ch.9.4.1 and 9.5.1) and the ability of
 - “future generations to meet their needs” (Ch.9.4.6-7 and Ch.9.5.6-7) (Brundtland 1987). Environmental sustainability approaches are assessed (Ch.9.4.7 and 9.5.7) against stated government policies and national standards(Australasian Health Infrastructure Alliance 2016b; Australian Building Codes Board 2017).

For environmental sustainability, capital investment as a proportion of capital consumed was an indicator of efficiency and sustainability under the National Health Performance Framework. (Council of Australian Governments(COAG) 2012; AIHW 2018f). The capacity of the hospital system to sustain infrastructure, to innovate and respond to emerging needs (AIHW 2018f) in terms of maintenance, renewal and efficiency remain within the national Health System Performance Logic Model but all measures were removed in 2013(AIHW 2018a). So national policies in relation to environmental sustainability are assessed as a proxy for government standards.(Australasian Health Infrastructure Alliance 2016k; Centre for Health Assets Australasia 2010)Australian Building Codes Board 2017) The policies examined were from the Australian Building Codes, the National Construction Code and the Australasian Healthcare Infrastructure Alliance.

Economic sustainability was considered for:

- allocative efficiency, comprehensiveness and continuity of funding for capital investment (Ch.9.3.5.4) in clinical facilities and equipment,
- efficiency improvement, capital investment supports efficiency in hospitals resulting in lower recurrent costs, distribution of funding for improvements and funding of capital consumed
- future access was assessed through the dynamic efficiency measured through funding for innovation(Ch.9.4.6, 9.5.6)

To summarise the measures from the right-hand column (Measures) of Table 9.1 each standard identified has had criteria determined to assess the standards (Table 9.2).

Table 9.2 Standards, measures and criteria used for analysis

Measures	Criteria for assessment
Equity	<i>Standard</i>
Capital to population	Similar distribution*
Capital per inpatient episode	Equal *
Equity of access to Major medical equipment	Equal *
Access for special needs	Equal *
Equality of access for births	Equal *
Equality of access for knee replacement	Equal *
Equality of access for caesareans	Equal *
Equality of access for hospital ICT	Equal *
Appropriateness	<i>Standard</i>
Estimated Capital cost per state	Evidence and patient-based
Access to specialized facilities	Evidence and patient-based
Funding for ICT strategies	Sustaining clinical standards and efficiency
Effectiveness	<i>Standard</i>
Capital to recurrent expenditure	Evidence based and patient aligned
Quality	<i>Standard</i>
Funding for safety standards	Integral
Building standards not met	Low (<5%)
Reports of access outside clinical standards	Within clinical and government standards
Percentage of hospitals receiving capital per annum	Clinical standards & access equity
Percentage of hospitals receiving capital over 4 years	Clinical standards & access equity
Responsiveness	<i>Standard</i>
National waiting times for ED	Sustaining clinical standards and efficiency
Waiting lists national variation	Within clinical and government standards
Waiting lists for hip replacement	Within clinical and government standards
Waiting lists for knee replacement	Within clinical and government standards
Waiting lists by socio-economic status	Within clinical and government standards
Innovation	<i>Standard</i>
Identification of systematic funding for improvement	System identified and process funded
Identification of systematic technology adoption	System identified and process funded
Identification of planning for advanced technologies	System identified and process funded

Sustainability	<i>Standard</i>
Allocative efficiency qualities evidence	Aligning with government standards
Per cent of hospitals with Greenstar ratings	Aligning with government standards
Funding systems for sustainable hospitals	Aligning with government standards
Efficiency	Aligning with government standards
Efficiency improvements	K supports efficiency for recurrent costs
Identification of changes required	System identified and process funded
Funding for improvements	Greater than replacement level
Distribution of improvements	Evidence based and patient aligned
Funding of capital consumed	Evidence based and patient aligned

*allowing for demographic, clinical-need considerations.
K=capital

Several criteria involve comparisons that include measures of clinical need. Assessment of indicators of clinical need based on Australian standards are considered in Ch.9.3.5.

9.3.5 Clinical Need

Within the Equity standard of Table 9.2 an allowance has been made for variations in clinical need (*) relative to capital allocations per state, per person, for access to medical equipment and for access by special needs patients and for specific procedures. This section aims to quantify areas of higher clinical need within Australia.

Measures-Clinical need combined with utilisation data was used as they measure expected demand and the value of supplied services. These measures provide nationally consistent comparators on populations. Commonwealth payments to the states are current (to three months) unlike to 2-3-year lag of morbidity data.

Data-To identify reliable data previous literature reviews and Australian government reports were scanned. The most recent report on recurrent payments by the Commonwealth to the states was used to compare per state and per person recurrent funding for hospitals(Administrator of the National Health Funding Pool 2018).

An allowance for national clinical variation has been considered based on:

- i. utilisation rates from:
 - o 2018 year to date (YTD) payments from per capita ABF funding (Administrator of the National Health Funding Pool 2018) per 1000 population and
 - o 2016-17 separations per 1000 population(AIHW. 2018)

ii. determinants of clinical need identified in:

- national health assessments(Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017)
- risk factors-age standardised rate per 100 population(Australian Health Policy Collaboration 2017) or
- standardised death rates per 1,000 population(ABS 2017).

Utilization rates and funding per 1000 population

Utilization was considered as average acute care payment rates per 1000 population for each state and separation rates per 1000 population. As it is the variation from the national average that is considered the important variable for comparison with capital funding, each rate per 1000 population was calculated relative to the national average (Figure 9.4). Both separation and Year To Date(YTD) payment rates record higher than average separations and payments for the NT, then the ACT and Queensland.(National Health Funding Body 2018b; AIHW. 2018)

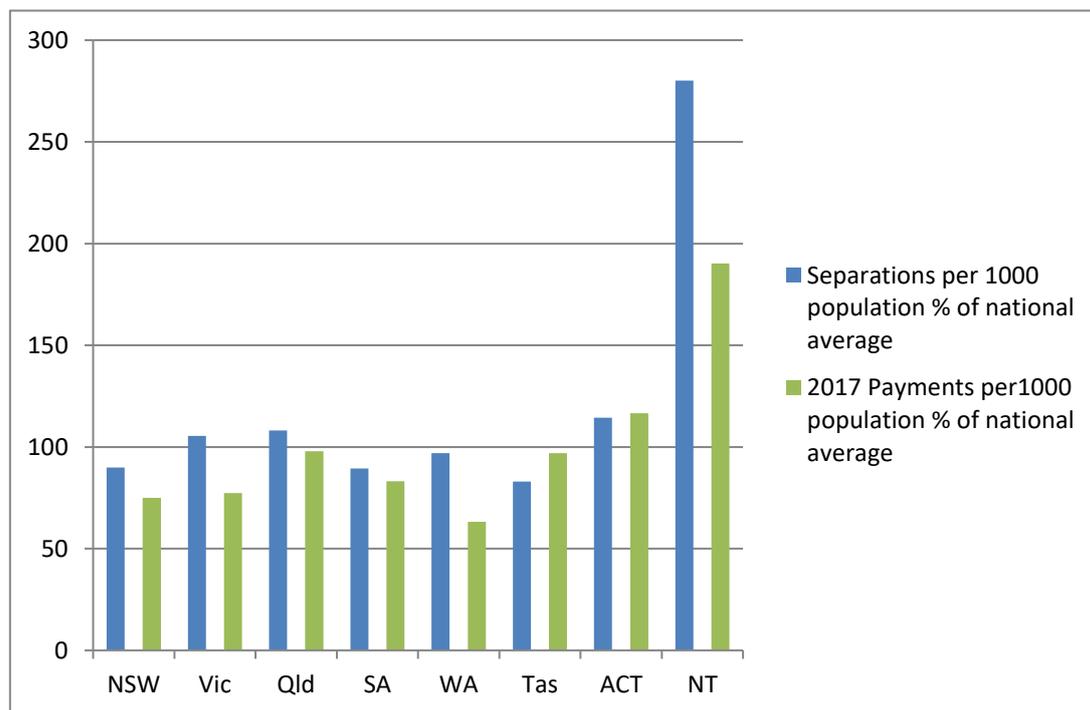


Figure 9.3 Percentage of 2016-17 Separations per 1000 population and January 2018 YTD ABF (Commonwealth) payments per 1000 population relative to the national average

Source: Admitted patient care 2016–17: Australian hospital statistics. Health services series no. 84. Cat. no. HSE 201(AIHW. 2018) National Health Funding Body. Public Hospital Funding 2016-17(National Health Funding Body 2018b)

Measuring clinical need- national

No single measure provided data on the level of clinical need to access acute care. At a population level three data sources were considered in combination to provide:

- before illness (risk factors),
- during acute care (Atlas of health service use) and
- after (death rates) as expressions of the need for acute clinical care.

Three sources were used in combination as each data source had strengths and limitations.

- Australia's Health Tracker by Area 2017 indicator has national comparators for clinical risk factors including obesity and overweight, blood pressure, smoking, alcohol consumption rates and exercise. The data is from 2014-15 scaling risks across the nation by local area and is not accessible at the state level. There are acknowledged limitations in the data (Australian Health Policy Collaboration 2017).
- The National Atlas combines national morbidity, medical benefits and pharmaceutical data on a geographic basis and is age and gender standardised. The analysis is of primary and hospital care and only five conditions were mapped. Information was provided on variation at a local hospital network basis. Data was not sufficiently detailed to allow measurement of outcomes for patients of hospital treatments. (Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017)
- Age-standardised death rates per 1000 population used detailed national 2016 data (ABS 2017) at state level and by level of remoteness from capital cities but do not directly relate to health service use.

However national clinical assessments may not address smaller patient groups with health needs greater than the general population so, reflecting PHIPF indicators, a measure for special needs has been included and access to some of the high-volume procedures modelled in Chapter 8 (SCRGSP 2018).

Special needs groups

Development of criteria for this measure involved defining what is meant by access to hospitals and special needs. 'Access' to hospitals for people who require acute care is defined as the opportunity to access to inpatient medical, surgical, obstetric, diagnostic and emergency treatments.

Data-Australians access to clinical services is influenced by a range of factors including the distribution of hospitals and of medical professionals.(Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017)Access to appropriate inpatient facilities has been identified as a health and safety risk by the Australasian College of Emergency Medicine(Australasian College for Emergency Medicine 2018). The National Health Survey of 2016 investigated access barriers to medical appointments but did not consider access issues to hospitals(ABS. 2017) Access issues associated with capital are not commonly reported.(Bain et al. 2008)

Standards-The annual report on government services includes equity of access by special needs groups as a measure of equity(SCRGSP 2018).Their definition of special needs measures “ the percentage of people who delayed going to hospital due to distance from the hospital by region”(SCRGSP 2018)page 12.8)No data was found for this measure by the steering committee.

For this research the definition of special needs is extended to include Australians with:

- greater reliance on acute health services associated with poorer health status (higher death rates and higher risk factors(Australian Health Policy Collaboration 2017; ABS 2017)),
- Indigenous people(Steering Committee for the Review of Government Service Provision 2016)
- low socio-economic status (SES) and
- remote residence (Moorin 2006a; Hall 2005; Ho K M 2008; Brennan 2014).

Measures- Access to acute care for special needs Australians was assessed as having two main dimensions;

- those who achieve access to hospital (morbidity data) and
- those who don't (mortality data, some potentially preventable presentations and waiting times).

Access of Special Needs patients to hospital is measured by utilization (total and surgical) per 1000 population by region of residence with waiting times for surgical treatment and for specific procedures by (i) indigenous status, (ii) socioeconomic status and (iii) remoteness of residence. These measures of access also include non-vaccine potentially preventable hospitalisations (PPH) to create a broader view of access to hospitals.

Criteria- used for access for special needs patients *is that access should be equal allowing for clinical need.* As clinical need for special needs groups is greater than for the general population but different for each of the special needs groups no absolute standard of appropriate service delivery has been determined from the standards and literature. So, the criteria are deemed satisfied if there is greater access to acute care for each of the special needs groups than the general population.

National Clinical needs results

- Risk factors include high and low risks in each state with:
 - Outer metropolitan and rural areas in Queensland, NSW, Victoria having the highest age standardised rates for the risk factors (Australian Health Policy Collaboration 2017)
- The Atlas found patients experienced considerable variation in the timeliness and access of patients to appropriate investigations and interventions. The worst access to preventative and curative services was for:
 - Rural Victorians for hysterectomies
 - Rural Tasmanians for endometrial ablation
 - Rural NT for Chronic obstructive pulmonary disease
 - Outback Queenslanders for diabetes complications, acute myocardial infarction, Atrial fibrillation
 - Rural western Australians for knee replacements, heart failure, cellulitis, kidney and urinary tract infections.
- Age standardised death rates for 2016 by state (Figure 9.4) had:
 - The highest death rates for people from the NT with very remote population deaths at more than double the national rate
 - Very remote residents had higher death rates in each state
 - Country people had higher death rates than each state average and
 - Age standardised rates were also higher for Tasmanians.

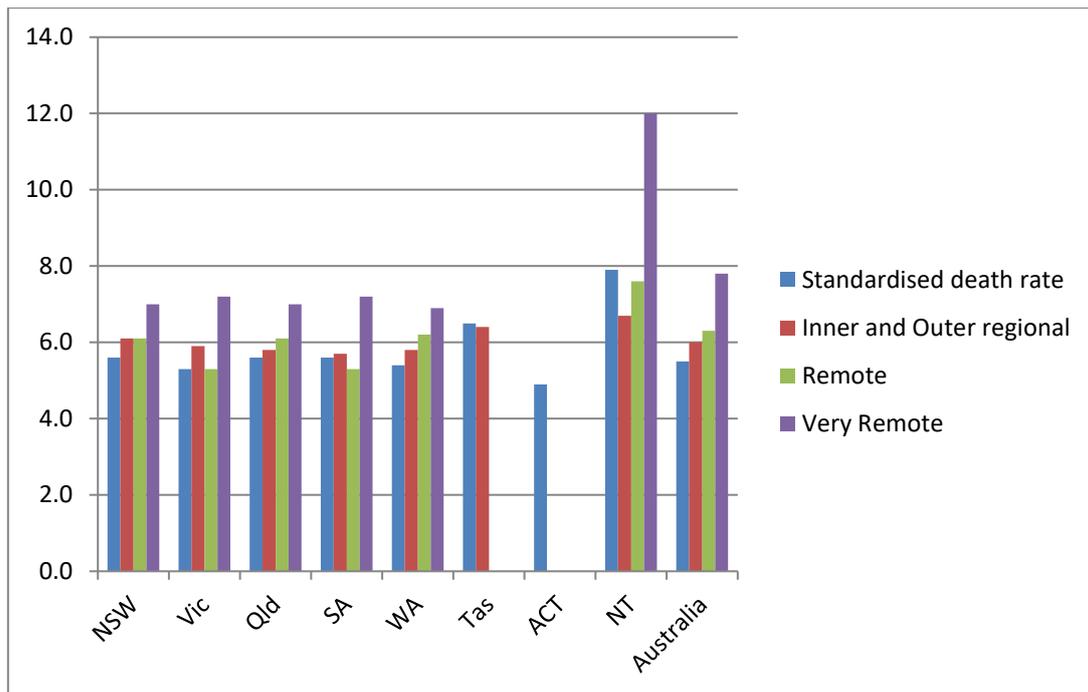


Figure 9.4 Age standardised rates of death by state, inner and outer regional, remote and very remote residence, 2016

Source:(ABS 2017)

In combination the utilization and clinical indicators identify that:

- the NT has higher clinical need and higher separation rates than other states
- remote and very remote residents of most states have death rates higher than the state averages particularly the NT, WA and NSW and
- NT and Tasmanian deathrates are higher than other states
- Clinical risk factors for outer metropolitan and rural areas in Queensland, NSW, and Victoria are high.

In conclusion, clinical need was determined to be strong in every state but particularly in the NT, Tasmania and remote and very remote areas of states. Increasing demand for acute care is identified to come from outer metropolitan areas and rural areas.

Access for special needs patients' standard

A national rate of 423 separations per 1,000 population (age-standardised) (reported on (AIHW. 2018)page 54) is used as the standard as the general rate of 255 separations per 1000 is qualified as incomplete in AIHW 2016-17 inpatient data table 3.13.(AIHW 2018a).

Additional capacity is required to support the clinical requirements of special needs groups.

9.4 The model approach to capital allocation

The aim of this section is to assess the model proposed in Chapters 7 and 8 and the method for funding (Ch.8.8) by the standards, their measures and criteria (Tables 9.1, 9.2, Figure 9.2). These are Equity(Ch.9.4.1), Appropriateness(Ch.9.4.2), Effectiveness(Ch.9.4.3) Quality (Ch.9.4.4), Responsiveness(Ch.9.4.5), Innovation(Ch.9.4.6) and Sustainability(Ch.9.4.7)..As patient access is determined by human and physical capital it is assumed that under ABF appropriate recurrent funds are provided to ensure clinical standards are delivered(SCRGSP 2018, 2019; Biggs 2018).

9.4.1 Equity

The criteria for equitable access for capital funding are set as equal for all populations and patients allowing for variations caused by clinical differences. This aims to allow for adjustments that permit additional funds for areas with the highest clinical need.

Capital to population

Capital funding per 1000 population-The model approach would be similar to ABF funding with comparable amounts for capital funding per patient episode of care. The amounts paid per state would pay for the patient's requirements for each DRG. Payment per 1000 population would be similar allowing for the following factors.

Variations- Between states the payments would vary by small amounts due to:

- Construction cost variations between states (Ch.7.8.2)(Rider Levett Bucknall 2017)(e.g. construction costs in NT are higher than Victoria). However, funding for equivalent facilities and equipment would be provided for each state.
- Variations in clinical need would be captured through DRG coding so appropriate funds followed patient needs. If a jurisdiction has more or less patients than other states, funding per 1,000 population may be different.
- If there are higher numbers of patients in DRG's with greater capital requirements larger funds would be paid to that state per capita (e.g. a hospital receiving transfers)
- States with higher numbers of rural and remote and indigenous patients would have weightings applied in line with ABF weightings in these areas.

Variations of total funds for capital per 1000 population would be primarily for clinical reasons and due to different costs schedules.

Capital per inpatient episode

The model aims to provide equal capital funding per DRG per inpatient episode. Funding would be centred on guideline-based clinical pathways common to all Australians in the same DRG. Under the arrangements specified in Ch.8.8 capital funding per patient would be paid to hospitals. Variations in per patient payment amount for capital funding would be for clinical and cost reasons as discussed above.

Major medical equipment is explicitly included in the formula for calculating capital required per patient per diagnosis group. The funding mechanism would pay a capital amount per patient for facilities and specified major medical equipment to the hospital fund. It is expected that funds would be used for those purposes and reporting mechanisms, outlined in Ch.8.8 for hospitals and health authorities, will provide information on the use of funds provided for major medical equipment.

*Variations- Economies of scale-*As small amounts are allocated per person under the model it will take many patient episodes to fund a piece of major medical equipment. If there is insufficient volume of patients, equipment may not be funded at each hospital but may be consolidated to an appropriate district facility. If major medical equipment has high use from the emergency department and outpatients clinics capital funding of their use would need to be identified.

Equity of access to major medical equipment per patient and per region would result from the application of capital allocation under the proposed model, allowing for variations.

Access for special needs

Criterion:

Access should be equal allowing for clinical need

Per patient capital funding should permit appropriate access through universal funding for special needs patients. The model formula makes allowances for special needs patients through the use of governmental standards and clinical guidelines. Also it anticipates that there will be additional weightings (for Aboriginality and remoteness) applied for special needs patients in line with ABF funding (IHPA 2017c).

Access for special needs patients will depend on the use of funds and the implementation of policies for improved access but could be monitored through the reporting mechanisms outlined in Ch.8.8.

The model approach is designed to give equal access to hospitals for special needs patients.

Equality of access for births

As Chapter 8 detailed the model funds the capital required to provide facilities and equipment for different options for births. Mothers across Australia would have equal access based on this funding model, allowing for clinical and cost differences already mentioned.

Equality of access for knee replacement

Similarly, the model would fund access for knee replacement for patients across Australia. Access would be equally enabled where a constant number of patients sought treatment. If there were modest increases in the number of patients the calculations within the formula, for the clinically recommended levels of 75%-85% occupancy, would allow some flexibility to treat patients in anticipation of capital funding to facilitate expansion. Timely funding for capital equipment and facilities would facilitate investment to manage growth.

Significant increases in the number of patients may require facilities and equipment to be prospectively provided with repayment from patient-aligned activity-based capital funds.

Patient access for knee replacement would be equal under the model approach.

Equality of access for caesarians

In combinations with the range of maternity services, mothers across Australia would have equal access to facilities and equipment based on this funding model, allowing for clinical and cost differences already mentioned.

Equality of access for hospital ICT

Systematic funding of ICT across all states according to clinical requirements should permit equal funding for access to ICT in acute care for all Australians. However, access is difficult to determine as the implementation process for ICT in hospitals is difficult to predict in the absence of a national policy. Reporting mechanisms, already mentioned, will determine if equal access is achieved.

9.4.2 Appropriateness

First two criteria for appropriateness:

- 1. Evidence based*
- 2. Patient based.*

Estimated capital cost per state

Model funding is evidence-based through the mechanism for facility and clinical guidelines and the use of expert clinical opinion. It is also allocated on a patient basis. The cost of capital per state is designed to be appropriate for the facilities required using model funding.

Access to specialized facilities

Similarly, the clinical pathway approach using expert clinical advice on length of time specialist facilities are required for the patients of a DRG is evidence and patient based. Imaging, operating theatres and ICU areas within the model are derived from the available evidence and are allocated on a patient basis.

Funding for ICT strategies

Criteria:

- 1. Clinical standards*
- 2. Efficiency*

ICT is factored into the funding model based on system standards and clinical requirements for the patient pathway. The implementation of ICT in hospitals will resolve questions in relations to the impact on efficiency. Productivity Commission expectations are that a system of ICT in hospitals will deliver improved efficiency(Productivity Commission 2017b).

9.4.3 Effectiveness

Capital to recurrent expenditure

Criteria:

- 1. Evidence based*
- 2. Patient based.*

Model testing identified that there is no ‘golden ratio’ for the relationship between capital and recurrent expenditure (Ch.8.6.1) but that it varies according to the facilities and equipment required for admissions for each diagnosis group. The model approach is steeped in clinical standards and paid on a patient basis.

9.4.4 Quality

Three quality measures and criteria are examined.

Funding for safety standards

Criterion:

Integral to funding

Safety standards contained within governmental building standards would be automatically included in capital funding for hospitals.

Building standards not met in hospitals

Criterion:

Low (less than 5%)

While funding would be at contemporary building standards and align with prevailing costs, the funding mechanism cannot guarantee the achievement of building standards in practice. Accreditation processes are not robust in measuring or reporting (Duckett 2018c) on building standards. No mechanism operates to vouchsafe this measure, but it could be included in the reporting measures.

Reports of access below clinical standards

Criterion:

Within clinical and governmental standards

Similarly funding under the model can be provided to achieve similar levels of access but the construction of acute care facilities near patients is a process managed by local authorities. Access will be determined by prevailing policies of local authorities. Reporting on geographic access could assist with this measure. The model cannot guarantee the measure.

9.4.5 Continuity

Percentage of hospitals receiving capital per annum and Percentage of hospitals receiving capital over four years

Criteria:

- 1. The percentage of hospitals receiving capital funding over four years reflects support for contemporary clinical standards*
- 2. Access equity*

Capital funding for hospitals under the model will be for all Australian public hospitals by direct funding aligned with ABF or through block grant funding in the same manner as recurrent funding. So 100% of Australian public hospitals should receive capital funding under the model.

9.4.6 Responsiveness

Criteria for the waiting list measures:

- 1. Waiting times are within government standards*
- 2. Waiting times are within clinical standards.*

Waiting lists national variation

As the formula for capital funding is founded on government and clinical standards it is likely that the national variation in waiting lists would be within government and clinical standards. With equal funding for both capital and recurrent costs waiting lists across Australia should be appropriate within systems where patient demand is steady. Where demand increases modestly there is some flexibility within the capital funding formula for increased numbers of surgical patients, assuming efficiency is achieved. However, if there are large increases in the number of patients requiring specific treatment over the short-term other strategies cannot resolve, waiting lists may increase temporarily.

Waiting lists for hip replacement

As above. Where recurrent and capital funding fund the patients for hip replacements, waiting lists would be expected to remain within clinical and governmental standards.

Waiting lists for knee replacement

As above

Waiting lists by socio-economic status

As above.

9.4.7 Innovation

Criteria:

- 1. Innovation is identified within the system*
- 2. Innovation has a mechanism for capital funding.*

Innovation is defined as evidence-based improvements in acute clinical practice.

Identification of systematic funding for improvement

Within the model, funding for relevant types of facilities and medical equipment would be identified within the DRG. New models of care, procedures or technologies would be assessed by expert professional groups for their utility to clinical care and submissions made to the IHPA in the same manner variations to the efficient price are now assessed (IHPA 2016a, 2017a). The proposed model for capital cost, to include acknowledged evidence-based guidelines in capital funding by diagnosis group, can provide funding for updating and upgrading where there are sufficient volumes of patients to fund the improvement. Clinical guidelines would link patient volumes to clinical thresholds and service role delineation (NSW Health 2016c; Queensland Health 2015c). (Health Department of WA 2010)

Identification of systematic technology adoption

As above. The IHPA may establish a relationship with the technology assessment arm of the Therapeutic Goods Administration in making determinations.

Identification of planning for advanced technologies

The provision of funds for advanced technologies would enable states to deliver a consistent platform of approved technologies to all patients requiring them. Planning for advanced technological adoption would remain with state and commonwealth governments. This criterion cannot be determined.

9.4.8 Sustainability

Sustainability has been determined to include environmental sustainability and economic sustainability of the hospitals sector (Ch.1,6 and 7, Appendices 1 and 4).

Criterion for the first four measures:

Compliance with government standards.

9.4.8.1 Environmental sustainability

Percent of hospitals with Greenstar ratings

While there are not national government standards for environmental sustainability for hospitals, state health facilities are expected to achieve Greenstar 4 rating (Australasian Health Infrastructure Alliance 2011; Green Building Council of Australia 2018) and under nationally recognised hospital engineering guidelines (NSW Health 2016b). National

Construction Code standards are for lower energy use, improved water efficiency and material selection and efficiency of material use for low embodied energy content, and recyclable content.(Australasian Health Infrastructure Alliance 2016b; Australian Building Codes Board 2017) Costing mechanisms within the model can include green building requirements in line with the Green Building Council of Australia processes to fund environmentally-sustainable buildings. The policies of government will determine if new hospitals comply with Greenstar standards.

As local hospital authorities are responsible for decisions about sustainability in hospitals it cannot be determined if funding through the model will result in more Greenstar hospitals.

Funding systems for sustainable hospitals

The model could provide a continuous funding system for environmentally sustainable hospitals when green costing indices are used.

9.4.8.2 Efficiency

Three concepts sit within efficiency:

- allocative efficiency
- productive or technical efficiency and
- dynamic efficiency discussed as innovation (Ch.9.4.7).

Allocative efficiency qualities evident

Governments require funding for health to promote efficiency(Council of Australian Governments(COAG) 2018a). The characteristics of allocative efficiency for hospital capital have been identified as:

- Timely access to capital
- Flexibility of funding for hospitals
- Capital that is affordable to the hospital and
- Displays fairness of distribution(Hellowell 2012b; Murray 2001)

The model approach is aligned to and would achieve allocative efficiency characteristics:

- Timeliness –the proposed model would provide capital funding to hospitals based on Ch.8.8 with the monthly payment schedule similar to recurrent payments(National Health Funding Body 2018a)
- Flexibility of funding for hospitals- Model funding per DRG would identify medical equipment, ICT and facilities using the cost bucket approach(IHPA 2015b) with COAG arrangements determining hospital level flexibility
- Capital that is affordable to the hospital- there would be negligible costs to the hospital
- Fairness of distribution- under the model all hospitals treating the same patients would receive the same funding (Ch.9.4.1).

Productive Efficiency

The model offers capital costs taken from clinical requirements for measuring the cost per admitted patient separation. It contends that a combination of resources made at the diagnosis level through clinical guidelines, expert advice and standards lead to appropriate resourcing for each diagnosis group, to optimise output at an appropriate cost. Model costs afford the opportunity to more accurately assess efficiency at the patient , the state and the national level.

Efficiency improvements

Criterion:

Capital supports efficiency improvements resulting in lower recurrent costs

Capital costs for national patient care are estimated to be equivalent to almost 20% percent of recurrent costs ((SCRGSP 2018) and have been estimated to be 18.2% in the model of sampled DRG's(Ch.8.6). Model funding for appropriate capital for every patient episode, determined by clinical pathways, can facilitate effective care at contemporary standards aligned to the efficient price at a lower capital cost.

Model funding can support efficiency improvements lowering recurrent costs through the:

- substitution of equipment for labour when clinically appropriate (e.g. monitoring equipment reducing the requirement for the physical presence of high cost clinical staff, telehealth, automated vehicles delivering linen, food, equipment, medicines,

automated pharmacy and pathology, artificial intelligence-aided (AI) diagnostics(Dewey 2018) and AI assisted treatment monitoring(Faux de 2018))

- improved delivery of care in response to technological and clinical changes (e.g. reductions in physiotherapy time on the wards while increasing the quality of care by the creation of an inpatient gym for hip and knee replacement patients outlined in Ch.8.4.5 and Ch.8.5.5)
- provision of patient acute care in other lower recurrent cost, clinically appropriate settings such as lower acuity hospitals, outpatient clinics, community clinics with telehealth and in the home,
- facilitating newer models of care with shorter lengths of stay, and
- in some cases reduced recurrent costs through better defined clinical pathways (e.g. decreased use of ICU and inpatient rehabilitation in newer models of care for hip and knee replacement patients with recurrent cost reductions per patient).

Identification of changes required to achieve sustainability

Criteria:

- 1. Measures for system identified*
- 2. Processes funded for the identification of changes required to achieve sustainability*

The model approach includes mechanisms to:

- Report (Ch.8.8), review and evaluate clinical services for quality, outcomes and efficiency (through the annual Report on Government Services)
- Benchmark performance and full costs between hospitals by DRG (through IHPA)
- Analyse and research bottlenecks and new systems for delivering quality care using clinical pathways, and
- For the first time, link capital to the patient, the procedure and the outcome.

It provides greater clarity permitting evidence-based change.

Funding for improvements

Criteria:

- 1. Measures for system identified*
- 2. Processes funding for improvements that are greater than replacement levels*

Buildings and equipment will be funded on a per patient basis at contemporary standards. Where improvements are evidence-based and approved through the IHPA processes

capital funding will be either higher or lower as required. The capital amount paid per patient episode will be cover the cost for replacement of assets at contemporary standards, where there are sufficient patients.

Distribution of improvements

Criteria:

1. *Evidence based*
2. *Patient based*

Where improvements in process, outcomes and efficiency are achieved the funding model distributes the improvements to all patients of the DRG. Improvements may flow across several DRGs where models of care, technology or clinical practice change. There would be no impediments to improvement being realised in all states.

Funding of capital consumed

Criteria:

1. *Evidence based*
2. *Patient based*

The model is designed to fund the capital consumed in an inpatient episode.

A summary of the results of the evaluation of the model system of capital allocation and the prevailing system assessments in terms of the measures and criteria is at Table 9.9

9.5 The prevailing system of capital allocation

The aim of this section is to assess the prevailing method of capital allocation against the standards, measures and criteria outlined in Figure 9.1, Figure 9.2, Table 9.1, Table 9.2. Each of the standards is reviewed with detailed information provided in the shaded boxes within sections.

9.5.1 Equity

Capital to population

Capital funding per 1000 population -The criteria for equitable access for capital funding are set as equal for all populations and patients allowing for variations caused by clinical differences (Ch.9.3.6).

Table 9.3 identifies capital allocated for public hospitals in the three years to 2017-18 by state, showing that:

- Capital allocated for hospitals varies significantly between states
- Nationally the average annual allocation per person was \$89 but amongst the mainland states an average of \$79 was allocated annually for hospital capital per person over three years.
- Victoria and South Australia allocations were consistently below either average and South Australia, at \$41 per person in 2017-18, had less than half the per person allocation of Queensland and WA.

Differences in capital allocation between states are substantial for each of the three years.

Table 9.3 Capital expenditure for hospitals by state and territory per person, 2015-16, 2016-17 and 2017-18

Sources: State and Territory Budget Papers 2015-16, 2016-17, 2017-18, AIHW, *Hospital resources 2015–16: Australian hospital statistics. Health services series no. 78. Cat. no. HSE 190.*, 2017(AIHW 2018a; ABS 2017a)

State	Capital expenditure per person		
	2015-16 \$	2016-17 \$	2017-18 \$
NSW	89	91	78
Victoria	39	41	71
Queensland	153	141	88
South Australia	54	99	41
WA	60	52	85
Tasmania	163	218	356
ACT	29	340	217
NT	418	493	174
Total	87	96	85

These variations do not align with hospital utilisation recorded in per capita ABF funding (Ch.9.3.5 & Figure 9.4)(Administrator of the National Health Funding Pool 2018) or the measures of clinical need identified in:

- risk factors(estimates)-Age standardised rate per 100 population(Australian Health Policy Collaboration 2017),
- national health assessments(Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017) or
- standardised death rates per 1,000 population(ABS 2017).

Clinical need was determined to be strong in every state but particularly in the NT, Tasmania and remote and very remote areas of states.

Consistently low per capital funding for Victorians and South Australians does not appear to be related to clinical variations or morbidity.

Capital per inpatient episode

Criterion:

Capital per inpatient episode is equal across Australia (allowing for clinical differences).

Table 9.4 shows significant inequality in capital allocations per inpatient by state. Over the three-year period Victoria in particular and also South Australia and WA allocated funds per patient well below the national and mainland averages.

Table 9.4 Capital expenditure per inpatient separations by state, 2015-16, 2016-17 and 2017-18

Sources: State and Territory Budget Papers 2015-16, 2016-17, 2017-18, AIHW, *Hospital resources 2015–16: Australian hospital statistics. Health services series no. 78. Cat. no. HSE 190.*, 2017(AIHW 2018a; ABS 2017a)

State	Capital expenditure per patient		
	2015-16 \$	2016-17 \$	2017-18 \$
NSW	368	386	330
Victoria	148	157	268
Queensland	582	537	334
South Australia	211	387	164
WA	246	212	351
Tasmania	692	924	1525
ACT	108	1290	824
NT	692	818	288
National average	381	589	510
Mainland state average	311	336	289

* 2017-18 inpatients have been held at 2016-17 levels

Major Medical Equipment access

Criterion:

Major medical equipment is equally distributed between populations allowing for differences in the incidence of disease.

Access to major medical equipment (MME) by state is difficult to determine as:

- Access is not reported for inpatients (although activity for some medical equipment for non-admitted patients is reported).
- There are no Australian or international standards for the appropriate distribution of MME (Chapter 6) (Queensland Audit Office 2017)page 40)

- There are no standards for waiting time, access or efficient service delivery in MME.
- There is insufficient planning for the replacement of MME(WA Auditor General 2017) No prioritised list for equipment replacement was found and concerns regarding “transparency and rigour in how high value medical equipment replacement decisions are made “(Queensland Audit Office 2017)page 6).
- There is an absence of an effective funding model for MME (Audit Office of NSW 2017; Garling 2008b).

Auditor-General reviews found inadequacies with access to MME:

- Waiting times to access MRI scans can vary from two to 98 days(Victorian Auditor-General 2015) depending on geographic location (Victorian Auditor-General 2015).
- Procurement processes for major medical equipment (MME) have been found to be ineffective (Queensland Audit Office 2017)page 6).
- Processes for the replacement of MME were poorly understood and underutilised.(WA Auditor General 2017)

The concept of access necessitates access to equipment that is fit for purpose. However audits found:

- 50% of NSW equipment did not achieve compliance with standards for maintenance of medical equipment (Audit Office of NSW 2017; Garling 2008b).
- 36% of WA equipment was older than recommended and
- Servicing of equipment was overdue for 16% of equipment(WA Auditor General 2017).

Access to major medical equipment may not be equal for all Australians based on the failure to measure access nationally, variable access by geographic area in Victoria and questions about the fitness of half of NSW equipment and one third of WA equipment. Therefore it is not possible to conclude that medical equipment that is fit-for-purpose is equally distributed or accessible for all populations.

Access for people with special needs

Criterion:

Access should be equal allowing for clinical need

While the annual report on government services (ROGS) defines access for people with special needs as an important evaluation parameter, no data is reported(SCRGSP 2018). This study identifies special needs as Australians with documented poorer health status

identified by (i) Indigenous status, (ii) remoteness of residence and (iii) socioeconomic status (AIHW 2018a).

Special needs patient access to hospital in this study has been measured using a composite of indicators (i) by separation rates and (ii) surgical utilization per 1000 population with (iii) waiting times measures for surgical treatment and for (iv) specific procedures. Data on (v) non-vaccine potentially preventable hospitalisations (PPH) have been added to create a broader view of access to hospitals.

The greater clinical requirement for access to hospitals for special needs patients means the criteria has been set as rates greater than the general population.

For these groups the available data provides a mixed picture with:

- Separation rates per 1000 population higher than the general population except for people in the lowest socio-economic groups.
- Surgical data identified that for most of the 15 selected procedures there were similar procedures per 1000 population for the three special needs groups than for other Australians.
- Surgical waiting list data for the 25 most common procedures is mixed showing longer waiting times for Indigenous and low SES people and shorter waiting times for remote and very remote residents (within some data limitations).
- PPH were high for the three special needs groups.

Separation rates

Public hospital separation rates (423 per 1000 population (age-standardised) in 2016-17) for special needs groups per 1000 population:

- Indigenous patients had separation rates of 1,047 separations equivalent to 2.6 times the rate for other Australians (AIHW 2018a)
- Patients in remote areas had separation rates of 521 and 824 for very remote residents.
- Patients in the lowest socioeconomic groups had separation rates (338) below the national rate (AIHW 2018a).

Surgical procedures

For 15 selected surgical procedures¹ rates of surgery per 1000 population identified:

¹ Cataract extraction, Cholecystectomy, Coronary angioplasty, Coronary artery bypass graft, Cystoscopy, Haemorrhoidectomy, Hip replacement, Hysterectomy Inguinal herniorrhaphy, Knee replacement, Myringotomy, Prostatectomy, Septoplasty, Tonsillectomy and Varicose veins, stripping and ligation.

- Indigenous people had fewer surgeries than other Australians for 10 procedures, higher rates for four procedures and the same rate for one procedure. (AIHW 2018a)Table 6.14)
- Very remote residents had fewer surgeries for 10 procedures than other Australians, higher rates for three procedures and average rates for two procedures. (AIHW. 2018)Table 6.14)
- Low SES people had fewer surgeries for six procedures, similar rates for five procedures and fewer surgeries for four procedures.

A national review of cardiac treatment found proportions of indigenous patients with STEMI (ST-segment-elevation myocardial infarction) treated with the clinically recommended treatment of percutaneous coronary intervention was consistently below the proportions of treatments for non-indigenous patients in every state. (AIHW 2018c)Table A3)

Similarly, the proportion of hospitalised events for acute coronary syndrome among people that included diagnostic angiography and/or a definitive revascularisation procedure (percutaneous coronary intervention and coronary artery bypass graft) was consistently lower for indigenous compared to non-indigenous people.

Surgical Waiting times

- Indigenous Australians waited almost 20% longer for procedures than other Australians (AIHW 2017e)
- AIHW reports people in remote areas have better access to surgery with shorter median waiting times than people in inner regional areas (AIHW. 2018)page 159). Waiting times for remote patients for the 25 most common procedures were better than average for 11 procedures, the same for two procedures and longer for two procedures with no date for 9 procedures (AIHW 2018a)Table 6.44)
- Similarly for very remote patients waiting times for the most common 25 procedures were better than average for six procedures and longer for three procedures with no data for 16 procedures. (AIHW 2018a)Table 6.44)
- Procedures by socioeconomic status. Access to surgical care favours the socially advantaged. Waiting times in NSW public hospitals for ED, surgery and outpatient appointments were found to be strongly influenced by patient socioeconomic status with disadvantage compounded in waiting times four months longer than the most advantaged (Johar 2013).
- Waiting times for surgery vary by socioeconomic status with low SES patients median waiting times 16% longer than high SES patients. (AIHW 2017b)

Potentially preventable hospitalisations (PPH):

- Indigenous Australians, had a rate of PPHs per 1,000 population was three times the rate for other Australians (Table 4.24)(AIHW. 2018).
- residents of *Remote* and *Very remote* areas (43 and 67 per 1,000 population, respectively) had the highest rates of PPH and the lowest were residents of *Major cities* (26 per 1,000)(AIHW. 2018) (Table 4.24).
- The most disadvantaged socio-economic groups had 33 PPH separations per 1000, appreciably higher than the most advantaged groups(22 per 1000 residents) (AIHW. 2018)

The mixed results of the available information determines that it cannot be concluded that there is greater provision for special needs people to gain access to acute services.

Equality of access for births

Criterion:

Access should be equal allowing for clinical need

Access to facilities for birth across Australia, were found not to be consistent with disparities of health between rural and urban areas. In a study of the distribution of maternity services across rural and remote Australia planning and maintenance of maternity services was found not to be equitable across hospitals.(Rolfe 2017) The provision of maternity services for rural women was found not to be dependent on the number of births or maternal risk levels, but to be “influenced by jurisdictions”(Rolfe 2017).

Similarly, in a national study of neonatal outcomes of premature birth, insufficient maternity options for low-risk deliveries for rural mothers and particularly Aboriginal mothers was found. Rural mothers have higher risk of still-birth and neonatal death of babies (Abdel-Latif 2006) but access to an inferior range of maternity care. Rural mothers also have higher risks of stillbirth and neonatal deaths for babies (Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017; Rolfe 2017). Based on these studies it could not be concluded that all pregnant Australian women have equal access to appropriate birthing facilities and clinical services.

Equality of access for knee replacement

Criterion:

Access should be equal allowing for clinical need

A national study found most candidates for knee replacement did not receive care in accordance with clinical guidelines.

Excessive waiting times were found for:

- Indigenous patients (263 days for indigenous and 190 days for other Australians)
- Rural residents (202 days for remote, 262 days for outer regional, 234 days for regional and 173 days for urban areas)and
- Socially disadvantaged patients (218 days compared to socially advantaged of 148 days) (Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017).

AIHW reports knee replacement rates per 1000 population were lower for indigenous and very remote patients.(AIHW 2018a)

National waiting time and procedures per 1000 population data identifies inequality of access for knee replacements. It is not possible to differentiate between the issues of clinical and physical access for this measure.

Equality of access for caesareans

Criterion:

Access should be equal allowing for clinical need

Inequality of access was identified.

A national maternity study found Caesarean sections for women varied significantly from a rate of 147 per 1000 population for urban women to 438 per 1000 for rural women. Caesarean rates in outer regional and remote areas were found to be above average. Inadequate access to appropriate maternity care was identified as one potential reason for excessive rates of Caesareans in rural women(Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017).

Inequality of access to Caesareans was not found to be a direct function of clinical need. It is not possible to distinguish between the issues of physical and clinical access for this measure.

Equality of access for hospital ICT

Criterion:

Access should be equal allowing for clinical need

Access to major medical equipment or ICT is not reported for hospitals. But investment in ICT, digital medical records, diagnostic information systems has been partially

identified by state from Budget papers. Nationally there are no funds to provide for capital equipment for hospitals to access equipment, patient data management, medical records infrastructure, telehealth equipment or ehealth environments(Australian Digital Health Agency 2018). As ICT investment needs to be contemporary, a partial measure of three years investment by state is used (Table 9.5).

Over the three-year period significant inequalities were evident in the allocations between states with no allocations for Tasmania and the N.T and high allocations in Queensland. As ICT investment is closely linked to specific hospital redevelopments (Ch5.4), there are significant variations year to year and some ICT costs are contained in some hospital redevelopment allocations. However, from this analysis it cannot be concluded that all Australian patients have equal access to ICT enabled acute healthcare.

Consideration of equitable distribution of services for access by patients has raised questions of the appropriateness of capital funding for the delivery of hospital services.

Table 9.5 ICT Allocation for hospitals per patient by jurisdiction, 2016-17 and 2017-18

Sources: State and Territory Budget Papers, Australian Bureau of Statistics, 3101.0 - Australian Demographic Statistics, Jun 2017 and AIHW (2017) Admitted Patient Care 2015-16 Table 2.6 Separations by state and territory, public hospitals

State	ICT expenditure per patient			
	2015-16 \$	2016-17 \$	2017-18 \$	Average \$
NSW	44	11	5	20
Victoria	0	0	3	1
Queensland	145	86	40	90
South Australia	40	20	3	21
WA	32	72	17	40
Tasmania	0	0	0	0
ACT	0	0	81	27
NT	0	0	0	0
National Average	49	30	19	32

9.5.2 Appropriateness

The appropriateness of hospital services is at the core of the standard to determine the effectiveness of funds spent across Australia on hospitals for the annual report on government services. (Figure 9.2)(SCRGSP 2018) Appropriateness is assessed for capital, in this study, by identifying and quantifying prevailing capital allocations and assessing the appropriateness of those capital allocations. Measures used to assess appropriateness are capital costs per state, access to specialised facilities and funding for ICT strategies

(Table 9.3). Waiting list data examined previously is also considered for appropriateness. The criteria for assessment relate to evidence, patients, clinical and government standards.

Criteria for the first two measures:

1. Evidence based
2. Patient based

Interviews with officials identified that:

- Capital allocation processes did not incorporate clinical advice or acknowledge NH&MRC or other clinical guidelines after the initial business case, (Appendix D Table D.10)
- Capital allocation processes were found not to be patient based in most states (Appendix D Table D.9)
- Allocated funding for ICT is ‘sometimes’ or ‘usually’ aligned with the redevelopment of a hospital rather than as a system wide program of funding (Appendix D Table D.6).

Estimated capital cost per state

The capital cost of providing care per patient is determined by depreciation plus the user cost of capital (8%) for the total value of statewide hospital assets, excluding land. To apportion costs to the patient level depreciation costs are divided by weightings drawn from recurrent costs (SCRGSP 2018). So, the estimated capital cost per patient references state depreciation, recurrent costs and the UCC cost of money but not contemporary clinical standards.

There are further limitations on prevailing estimates for the cost of capital per patient as:

- Data is not comparable between jurisdictions due to methods of estimation and valuation variations or for periods prior to 2013-14 (SCRGSP 2017).
- There is a three year lag for estimated cost of capital information to be published (SCRGSP 2016; SCRGSP 2017; SCRGSP 2018).
- The weightings used to calculate the capital cost are based on recurrent costs per diagnosis group dominated by salary costs. Chapter 8 found recurrent costs and capital costs varied between diagnosis groups and recurrent cost weightings were not a predictor of capital costs.
- Capital costing has total patients as a denominator but is not based on clinically-defined patient capital requirements.

The cost of capital estimated to be required per patient is not consistent across Australia in any year (Table 9.6). It is questionable that the value of capital assets required per patient should vary significantly over time when there are modest annual variations in the National Efficient Price paid per patient each year (Table 9.6). Capital cost per patient lacks transparency and relevance required to permit costing of clinical services that is appropriate for patient care.

Table 9.6 Cost of Capital per state per patient, national average and national efficient price 2013-14, 2014-15 and 2015-16

Sources: Sources: Report on Government Services (SCRGSP 2016; SCRGSP 2017; SCRGSP 2018; IHPA 2012a, 2013, 2014b, 2015a)

State	Capital cost per patient		
	2013-14 \$	2014-15 \$	2015-16 \$
NSW	728	901	947
Victoria	819	867	1,041
Queensland	614	548	742
South Australia	554	1,120	1,036
WA	710	763	860
Tasmania	668	1,075	1,018
ACT	907	608	1,105
NT	548	818	927
National average	709	838	960
National efficient price	4,993	5,077	4,971

It cannot be concluded that the estimated cost of capital per patient nationally or by state is clinical evidence or patient based.

Access to specialized facilities

Criteria:

1. Evidence based
2. Patient based

Existing arrangements for funding specialist facilities and equipment are reviewed through imaging, ICU, operating theatres and ICT.

Imaging

Diagnostic imaging covers ultrasound, computed tomography (CT) diagnostic radiology (such as x-ray and mammography) magnetic resonance imaging (MRI) and nuclear

medicine imaging, such as positron emission tomography (PET). The National Health Reform Agreement requires states to “provide eligible patients with diagnostic imaging services through the public hospital system free of charge, on the basis of clinical need and within a clinically appropriate period”(Council of Australian Governments(COAG) 2011b). Inquiries found quality, access, distribution and safety problems with medical imaging equipment in public hospitals.

The Senate inquiry into the availability and accessibility of diagnostic imaging across Australia found:

- There is a reasonably even distribution of machines between states but not within states with machines clustered in metropolitan areas causing geographic disparities of access. Public hospitals provided the only imaging services “in most parts of the Northern Territory, Western Australia, far western Queensland and far western New South Wales. “ (Australian Senate Community Affairs and References Committee 2018)page 12)
- Access to appropriate imaging for trauma and stroke patients in rural Queensland was described as ‘diabolical’ by health managers. (Australian Senate Community Affairs and References Committee 2018)page 14).
- Precision in clinical practice is reducing the effective lifespans for some medical equipment (from 10-15 years) as resolution of images fails to meet contemporary standards. Australian Society of Medical Imaging and Radiation Therapy identified older machines are sent to rural locations where the Department of Health Western Australia reports “quality of the images may be lower, the dose of the radiation required may be higher and the dose of the contrast agent that's required, which can have risks in terms of renal failure, may be higher.”(Australian Senate Community Affairs and References Committee 2018)page 69)
- The difficulty of capital funding for rural imaging by states within a prioritised capital allocation system has led to COAG arrangements under Section 19 (2) of the *Health Insurance Act 1973* to permit some rural hospitals to accumulate funds from privately referred patients. Darling Downs Hospital and Health Service advised that small hospitals fundraising to replace equipment was difficult. (Australian Senate Community Affairs and References Committee 2018) para. 5.58)

Access to imaging was found to be absent for two Victorian regions where no free public imaging service existed, difficult for some rural patients and poor for the northern and western suburbs of Melbourne.(Victorian Auditor-General 2015) Data is absent for the distribution of imaging for inpatients in Australia. (Victorian Auditor-General 2015; AIHW 2017f, 2018b)

Based on the findings of the Senate Inquiry and the Auditor General it is concluded that the access to imaging equipment is not evidence and patient based. The prevailing system of capital allocation is not providing universal access to contemporary equipment standards for all Australians.

ICU

Criteria: Access is:

- 1. Evidence based*
- 2. Patient based*

Access to ICU beds is measured in two ways by:

- The state median declined admissions to ICU due to a lack of resources and
- By exit block preventing patients leaving ICU for a bed on a ward, by state.

Median declined admissions across Australia have decreased in 2014-16 from 1% in the three years to 2013-14. (Australian and New Zealand Intensive Care Society 2017). However access to beds after ICU care is a significant issue for some hospitals.

Exit block medians of over 20% of patients unable to be moved to a ward (within 6 hours) for each of the last 3 years (2013-14 to 2015-16). A national median of 13% of patients had exit block from ICU (Anstey 2017). Exit block has been most pronounced in NSW with between 30% and 60% of patients prevented from discharge to wards with some hospitals experiencing up to 80% of patients unable to be moved to a ward within 6 hours. Victorian patients have a median rate of more than 20% of patients who cannot be readily discharged to a ward rising to 75% for some hospitals. (Australian and New Zealand Intensive Care Society 2017)

The evidence suggests there is sufficient access to ICU with low rates of declined admissions but that access to beds on wards for ICU patients ready for transfer is not optimal. Capital for ICU access is within government and clinical standards.

Operating theatres

Criteria: Access is:

- 1. Evidence based*
- 2. Patient based*

Access has been assessed as appropriate in three state studies(NSW Auditor General's Report 2013; Queensland Audit Office 2015; Travis 2015). An influential efficiency analysis of NSW operating theatres identified a need for guidelines to “address fair, logical and standardised efficiency measures that promote accuracy in data collection.”(MacLellan 2014)

The allocation of capital for operating theatres has been found to comply with clinical requirements in three large state studies but cannot be determined that capital for operating theatres is evidence or patient based from official interviews (Chapter 5.4.2).

ICT

Criteria: Funding for ICT strategies sustains:

- 1. Clinical standards*
- 2. Efficiency.*

Funding for ICT is unequal between states and for Australian patients (5) Reporting on hospital ICT has a range of quality, service, cost and comparability issues(Auditor-General 2017)(Chapter 7)

When state budget allocations for ICT (5) were reviewed for the period 2015-16 to 2017-18 it was evident that:

- Funding for ICT for patient care is not equally distributed in Australia
- The smaller states are not investing in ICT in hospitals
- Per patient investments vary significantly from \$0 to over \$144 per patient
- ICT rollout for hospitals remains individual hospital project-based rather than systemic, and
- There is no evidence of continuity of funding.

All ICT funding for hospitals may not be included in these figures as private-public partnership allocations may not be listed in Budget papers and some ICT funds are listed under the total hospital redevelopment. However, allowing for those factors, it cannot be concluded that funding for ICT in hospitals corresponds with strategies to sustain clinical standards and efficiency across Australia.

Table 9.7 Funding for ICT per patient by state, 2015-16, 2016-17 and 2017-18

Sources: State government budget papers 2015-16, 2016-17, 2017-18

State	2015-16 \$ per patient	2016-17 \$ per patient	2017-18 \$ per patient	Average \$ per patient
NSW	44	11	5	20
Victoria	0	0	3	1
Queensland	145	86	40	90
South Australia	40	20	3	21
WA	32	72	17	40
Tasmania	0	0	0	0
ACT	0	0	81	27
NT	0	0	0	0
National Average	49	30	19	32

9.5.3 Effectiveness

The effectiveness of capital allocation for acute clinical services has been discussed in previous chapters for Australia (Chapters 4 and 5) and other nations (Chapter 6). The annual report on government services (Figure 9.2) defines effectiveness in terms of access (Ch.9.6.1), appropriateness (Ch.9.6.2), quality (Ch.9.6.5) and sustainability (Ch.9.6.7). This section considers how government objectives for evidence-based and patient-aligned services are represented in the relationship of capital and recurrent expenditure on hospitals.

Criteria: Capital allocations in relation to recurrent allocations are:

1. Evidence based
2. Patient aligned

Evidence-based. Appendix D, Table D.8 clarified that five of the 10 officials interviewed said evidence was included in the initial process for hospital capital allocation. No clear relationship could be identified between capital and recurrent allocations on a national basis (Table 4.2).

Patient-based. Table 9.4 showed significant inequality in capital allocations per inpatient by state with Victoria, South Australia and WA allocating funds below national and mainland averages over three years. A nationally consistent relationship between capital allocations and patients could not be determined.

It cannot be determined that capital allocations relate to recurrent allocations based on evidence or patients.

9.5.4 Quality

To determine the achievement of quality standards the in current capital funding system four aspects are assessed, namely building standards (Figure 9.1), safety standards and clinical standards (Ch.9.6.2) and continuity of funding.

Building standards

Criterion:

Building standards not met is at a low level (less than 5% of projects)

Interviews with officials (Chapter 5) identified hospitals are raised to contemporary standards when new or reconfigured hospital developments endeavour to embed contemporary clinical standards in planning. In a small number of cases, clinical and building standards are not upheld. (Perriam 2008; Bullock 2017; Rose 2008; WA Building Commission 2017) Some mandatory up-grades (fire standards) are identified as specific hospital allocations in Budgets (Mansion 2017, 2018; Trad 2018).

The quality of hospital buildings and their fitness for purpose forms a very minor component of hospital accreditation(Australian Commission on Safety and Quality in Health Care 2017a). Infrequent news reports of individual facility difficulties suggest a functioning system although the number of hospitals not meeting building standards is not reported.

In the absence of data it is not possible to assess if more than 95% of hospitals comply with contemporary building standards.

Safety

Criterion:

Funding for safety standards is integral to the system of funding

The ability of facilities and systems to provide for patient and staff safety has been challenged in recent years. Aggression against ED and other hospital staff has focussed health services on modifying facilities, improving systems and increasing security to ensure a safe working environment for staff(Egerton-Warburton 2016; Hills 2014; Barry 2018; ABC 2017).

Safety though appropriate facilities and equipment is not measured or reported (Australian Commission on Safety and Quality in Health Care 2017a).

Funds for facility changes and security upgrades to increase staff safety are found within existing allocations.

Clinical standards- reports and interviews

Criterion:

Reports on patient access show levels of access that are within clinical and government standards

Nationally, the Australian Medical Association (AMA) argued that investment increases are clinically required to reduce waiting lists and match demand for access to beds (Australian Medical Association 2018). Similarly the Australasian College Emergency Medicine called for systematic action to increased capacity for Australian hospitals (Australasian College for Emergency Medicine 2018).

A national clinical review found wide (up to 12 fold) variation in clinical outcomes and practice for two of the areas examined in Chapter 7, uncomplicated births and knee replacement (Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017). It is not possible to estimate if capital investment contributed to some level of variation.

Clinicians interviewed for clinical pathways (Chapter 8) advised facilities were generally in line with clinical requirements. The interviews were with clinical professors where National Health and Hospital Fund redevelopments had taken place, with one exception. Clinicians from the hospital which had not applied for NHHF redevelopment noted inferior facilities impeded clinical practice.

Obstetrics interviews and research identified changes in the clinical characteristics of patients (Cheney 2018b) with implications for direct and indirect capital investment. The percentage of bariatric first-time mothers and prevalence of obesity increased across the study increasing the risks of adverse events for mothers and babies and the use of complex clinical facilities (including operating theatre, neonatal intensive care and intensive care).

In Victoria planning for major medical equipment was found to be inadequate and unconnected to clinical requirements. (Victorian Auditor-General 2015) Systems for planning imaging services in Victoria were found to be unconnected to major clinical streams including cancer, cardiology and neurology and the Medical Equipment Replacement Program processes for assessing competing bids for funds were undocumented and unclear (Victorian Auditor-General 2015).

Building standards and safety funding are assumed to comply with requirements as there is no evidence to the contrary. Capital allocations for hospital beds, changing patient

needs, imaging and medical equipment have been found not to support contemporary standards by clinical bodies and government auditors.

Continuity

Criteria:

- 1. Percentage of hospitals receiving capital per annum reflects clinical standards and access equity.*
- 2. Percentage of hospitals receiving capital over four years reflects clinical standards and access equity.*

Continuity is a component of capital distributional effectiveness for hospitals (Figure 9.1). Reliable, regular capital funding of hospitals was identified during interviews (Ch.5) (Appendix D). The number of hospitals funded annually and over the most recent four-year period averages between 12% and 15% of all hospitals. Most hospitals in Australia had no capital funding over four years.

For the period 2015-16 to 2018-19 the number of hospital projects funded represented 12-15% of hospitals in Australia (Table 9.8). Queensland and South Australia averaged 9% of hospitals receiving capital funds. Over the four years reviewed funding most commonly was allocated to the same hospitals due to construction projects requiring funding over multiple years. The ACT funded an additional hospital in 2018-19. Most Australian hospitals did not receive capital funds in one year or over four years:

- In NSW and Victoria 87% of hospitals did not receive funding,
- In Queensland and South Australia 93% of hospitals did not receive funding,
- In WA 79% of hospitals did not receive funding and
- In Tasmania 80% of hospitals did not receive funding.

Clinical need was identified as strong for every state (Ch.9.3.1) and particularly for the NT and Tasmania. These states had higher levels of funding than most other states with an average of 60% of hospitals funded in NT and 19% of hospitals funded in Tasmania. However, it remains true that most hospitals outside the territories remained unfunded over four years (Table 9.8).

Table 9.8 Capital expenditure by number and percentage of hospitals by state, 2015-16, 2016-17 and 2017-18

Sources: State and Territory Budget Papers 2015-16, 2016-17, 2017-18, 2018-19 AIHW, Hospital resources 2015–16: Australian hospital statistics. Health services series no. 78. Cat. no. HSE 190., 2017(AIHW 2018a)

State	Total Hospitals \$'000m	2015-16 % funded	2016-17 % funded	2017-18 % funded	2018-19 % funded
NSW	218	15	13	9	14
Victoria	148	17	12	11	11
Queensland	118	8	8	7	15
South Australia	75	8	8	12	<i>n.a.</i>
WA	90	23	20	20	22
Tasmania	22	18	14	18	27
ACT	3	100	100	100	133
NT	5	80	60	40	60
Total	679	15	13	12	14

It cannot be concluded that clinical standards and access equity is achieved with most hospitals not receiving capital funding annually or over a four- year period.

9.5.5 Responsiveness

This measure is assessed for the responsiveness of acute care facilities to patient demand through patient access to surgery, emergency departments, hip and knee replacement and for the socio-economic equity of waiting lists.

Waiting lists

Criteria:

1. *Within Clinical standards*
2. *Within Government standards*

As there are no government standards for waiting lists (AIHW 2017e) this analysis reverts to the national standard for equitable access to high quality care for comparison. There is considerable national variation for patients seeking to access orthopaedic services (Appendix D Table D.5) across Australia. Over 3% of Australians were waiting for surgery and the waiting list grows by 3.2% annually (2012-13 to 2016-17)(Table 2.7(AIHW 2017e).

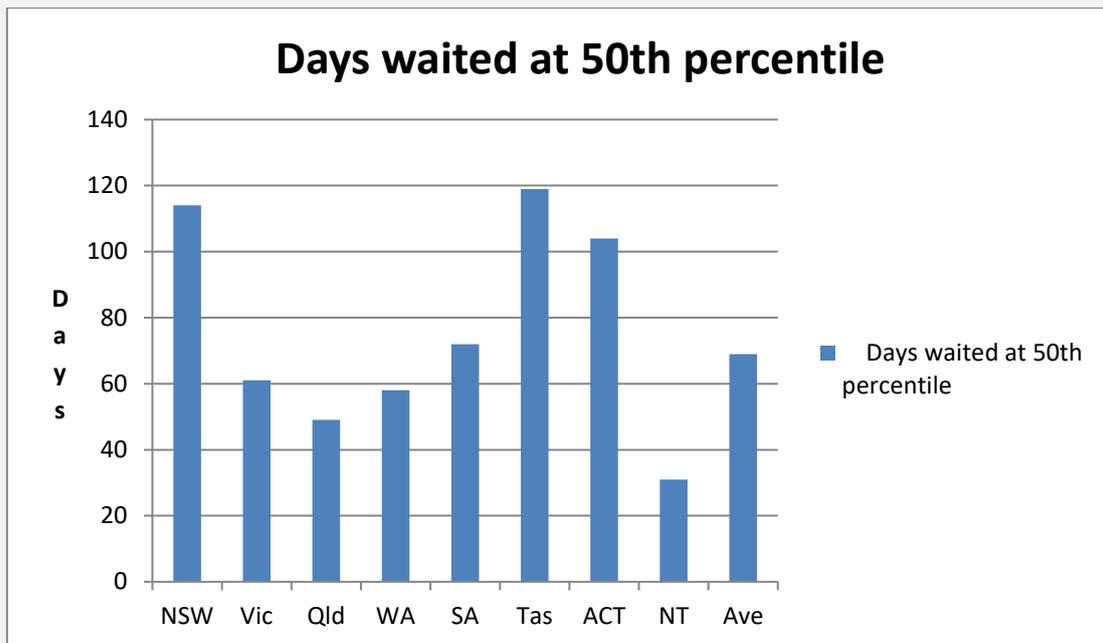


Figure 9.5 Orthopaedic Surgery Waiting times at the 50th percentile, States and territories and Australian average, 2016-17

Source: AIHW, Elective Surgery Waiting Times 2016-17 Australian Hospital Statistics. No 82. Cat. No. 197. Canberra Table 2.7(AIHW 2017e).

Waiting list growth occurs despite waiting lists being carefully managed with 16% of patients removed from the list every year(AIHW 2017e).

Equity of access is not consistent across the states with significantly longer surgical waiting times in NSW (54 day median) (Table 4.5 (AIHW 2017e)) and in orthopaedics for:

- NSW where 50% of patients wait more than 114 days and 10% of patients wait for almost a year (Table 4.5 (AIHW 2017e)).
- Tasmania where 50% of patients wait more than 119 days and 17% of orthopaedic patients waiting 1.3 years. (Figure 9.4) (Table 4.5 (AIHW 2017e))

Emergency Departments

The Australasian College for Emergency Medicine (ACEM) noted access to Emergency Departments was deteriorating with some waiting times defined as clinically dangerous (Whitson 2018). Access to additional beds was required for patients particularly in NT, SA and Tasmania where clinical need was identified as greater than average (9.3.5).

Access block (where patients wait more than eight hours for treatment) represented 22% of patients in emergency departments across Australia surveyed in one 24 hour period. It was found that 35% of patients in hospitals surveyed could not gain clinically-timely access to hospital beds (Australasian College for Emergency Medicine 2018). National targets for treatment are admission within 4 hours of arrival (Sullivan 2016b) however 20 hospitals had patients waiting more than 24 hours. Calling for additional beds ACEM noted that “it is increasingly common for hospitals to operate at 100% capacity every day.” (Australasian College for Emergency Medicine 2018) page 4). Recognising bed access issues officials identified that access to more beds in the NT, South Australia and Tasmania were expected to reduce waiting times (Whitson 2018).

Hip and knee replacement waiting lists

Over four years to 2016-17, hip and knee replacement patient waiting lists increased by 4.3% and 4.4% respectively despite higher volumes of treatment. NSW has large numbers of patients (3,906 and 6,748 respectively) waiting for hip and knee replacement respectively (Table 3.5) (AIHW 2017e). Indigenous patients waiting for hip replacement waited longer at the 50th and 90th percentile (compared to 3.9% of other Australians) and nearly 6% waited more than a year (AIHW 2017e)

Socio-economic equity of waiting lists

Access to surgical care favours the socially advantaged for knee replacement (Brennan 2014). Waiting times in NSW public hospitals for ED, surgery and outpatient appointments were found to be strongly influenced by patient socioeconomic status with disadvantage compounded in waiting times four months longer than the most advantaged (Johar 2013).

Indigenous Australians waited almost 20% longer for procedures than non-Indigenous people(AIHW 2017e)

The annual Report on Government Services draws attention to access for disadvantaged population groups(SCRGSP 2018). Access to haemodialysis is rarely reported despite high Indigenous incidence and death rates from end stage renal disease.(Davidson 2018b; AIHW 2017d; Davidson 2018a) Data on access to haemodialysis and waiting times for dialysis could not be identified(AIHW 2017c)

Significant variations in waiting times between states and specialities do not align with government standards for patient-based service delivery(AIHW 2017e).Standards for clinical care are not supported by waiting times in excess of clinical recommendations. Lengthening waiting lists involving 3.1% of the population with 10% of patients waiting over 12 months for required surgery suggests restrictions on access to surgical care. Hospitals are operating at 100% capacity(Australasian College for Emergency Medicine 2018). National elective surgery waiting times reflect resource limitations of staff and capital.(Australian Medical Association 2018) Lower socio-economic patients and particularly Indigenous Australians are on waiting lists for longer than other Australians.

National equity standards are not sustained by differences in access to hospital treatment based on geography, indigenous status or socio-economic status(Douglas 2018).Therefore it is considered that access measures do not comply with clinical and governmental standards for responsiveness to patients.

9.5.6 Innovation

Innovation is supported by strategies for achieving and funding evidence-based improvements in clinical practice. This section examines how contemporary systems facilitate capital funding for innovation.

Criteria: Measures for system identified and processes funded for:

- 1. Identification of systematic funding for improvement*
- 2. Identification of systematic technology adoption*
- 3. Identification of planning for advanced technologies.*

Clinical advances offer opportunities for improved treatment and outcomes(Williamson 2018; Mattick 2018a) yet inertia characterises the incorporation of evidence-based innovation in healthcare (Productivity Commission 2017b). There is no national system of capital funding to facilitate clinical innovation. Chapter 5 identified that the capital elements of innovation had limited access to funds on a project basis. Officials recognised evidence-based

improvements and clinical guidelines but did not incorporate them in capital allocation cases (Chapter 5). Clinicians recognise that limitations in the roll-out of clinical innovation limits the quality and efficiency of hospitals (Tan 2018). Clinical trials can sometimes obtain one-off funds for capital improvements to support clinical projects but there is no process to roll-out improvements across all hospitals. Innovation programs in Australia fund clinical changes.

National assessment of medical technologies for hospitals is managed for Australasian governments through the COAG health technology reference group (formerly HealthPACT) (Council of Australian Governments (COAG) 2018b). But there is no funding mechanism to implement these technologies nationally.

States have been challenged to include advanced technologies, such as imaging (Australian Senate Community Affairs and References Committee 2018), as health service planning and management of equipment was described as poor by Auditors General (Victorian Auditor-General 2015; Queensland Audit Office 2017; WA Auditor General 2017; Audit Office of NSW 2017). Robotics in surgery, interventional modalities combining imaging and surgery, increased use of laparoscopic or endovascular techniques and non-invasive procedures using multimodality hybrid imaging technologies are emerging in clinical practice. Adoption of these and similar technologies have capital costs and implications for efficacy (Jackson 2007).

No evidence has been found of systematic capital funding of innovation in Australia. Systematic technology adoption is also not funded through the hospitals. Funding for future technology adoption has not been identified through government processes or systems.

9.5.7 Sustainability

This research posits capital is to support patient access to efficient hospitals so sustainability for capital is the appropriate amount to provide for the clinical and governmental standards of care equitably in the present and without diminishing the future. Environmental sustainability and efficiency are assessed against government policies and standards.

9.5.7.1 Environmental sustainability

Criterion:

Percent of hospitals aligning with Greenstar ratings

Climate change has been identified as a factor in changing demand for healthcare and in service delivery. (Hanna 2018; Watts N 2017; Zhang 2018b; FitzGerald 2019) At the time of interview four states aspired to achieving Green star standards for new hospital buildings

(Chapter 5 & Appendix E). There is no Australian system to measure or improve the environmental sustainability of health facilities. At the state level, Chapter 5 identified that actions for environmental sustainability for Australian hospitals were primarily aligned with new hospital developments and major redevelopments. State officials and publications identify greener buildings as their objective however there is no evidence that this objective is consistently pursued (Chapter 5).

Of 701 public hospitals in Australia (AIHW 2017f) there are 10 Greenstar-rated public hospitals. A small number of new hospital projects in Queensland, NSW and S.A. complied with Greenstar process standards. New hospitals in WA did not comply with Green Building Council of Australia (GBCA).

Around 1% of Australian public hospitals meet Greenstar standards.

9.5.7.2 Efficiency

Criteria:

1. Alignment with government standards is evident for:

- *efficiency*
- *allocative efficiency.*

2. Capital supports efficiency in the hospitals system resulting in lower recurrent costs.

3. Capital funding for improvements is greater than replacement level.

4. Evidence-based patient aligned standards govern:

- *The distribution of improvements in efficiency and*
- *The funding of capital consumed.*

Three concepts sit within efficiency:

1. allocative efficiency
2. productive or technical efficiency and
3. dynamic efficiency also discussed in innovation (Ch.9.5.6).

1. Allocative efficiency

Criterion:

Alignment with government standards is evident.

National agreements endorsed timely access to quality health services based on patient needs throughout Australia(Council of Australian Governments(COAG) 2012). Characteristics of allocative efficiency for hospital capital (Ch.2.8.3) have been identified as:

- Timely access to capital
- Flexibility of funding
- Capital that is affordable to the hospital and
- Displays fairness of distribution(Hellowell 2012b; Murray 2001).

Prevailing capital distribution procedures do not display allocative efficiency for three of four qualities:

- Timely access to capital for all hospitals cannot be identified (from Chapter 5 or 9.8) as more than 80% of hospitals received no capital funding over four years.
- Flexible use of capital is not a characteristic of the Australian capital distribution system as prioritised business cases are for specific investment decisions (interviews with officials).
- Capital is affordable to Australian hospitals as there is no capital charging.
- Fairness of distribution has not been identified in Ch.9.5.1 (Tables 9.3 and 9.4), in access to imaging, ICU, operating theatres (Ch. 9.5. or in access to medical equipment) or through access to birthing(Rolfe 2017), hospital beds(Australian Medical Association 2018; Australasian College for Emergency Medicine 2018; ANZICS 2016) and surgical services (AIHW 2017e) Table 2.7).

2. Productive or technical efficiency

Criteria:

1. *Alignment with government standards for efficiency is evident*
2. *Efficiency in the hospitals system results in lower recurrent costs.*
3. *Capital funding for improvements is greater than replacement level.*
4. *Evidence-based patient-aligned standards govern:*
 - *The distribution of improvements in efficiency and*
 - *The funding for replacement of capital consumed.*

The National Efficient Price for diagnosis based clinical service is the mechanism delivering Australian government standards for hospital efficiency. Application of the Efficient Price has reduced growth in hospital recurrent costs(Biggs 2018). However, measurement of productive efficiency is problematic in Australia due to the absence of accurate capital data(Productivity Commission 2009e, 2010, 2017b). Appropriate capital

investment has been demonstrated to support improved efficiency and reduce recurrent costs (Ch.8.6, (Ulrich 2008b, 2008a; Sadler 2011; Sadler 2009; Berry 2004; Dodswell 2009; Ulrich 2007) (Karmann 2017).

Analysis of productive efficiency in Australian public hospitals has been thwarted by the absence of accurate figures for capital cost per patient (Productivity Commission 2009e; SCRGSP 2018; Productivity Commission 2010). Reviewing half of Australian public hospitals the Productivity Commission estimated median public hospital technical efficiency score of 0.816 (Productivity Commission 2009e). Using Stochastic Frontier Analysis, with some data limitations including capital costs, the Commission found potential hospital efficiency improvements of around 20% for individual hospitals (Productivity Commission 2010) Finding 8.2) Data limitations, including reliable data on capital mean it has not been possible to analyse productive efficiency at the hospital, specialty or DRG level with certainty. Productive efficiency in operating theatres in NSW, Queensland and WA has been criticised (NSW Auditor General's Report 2013; Queensland Audit Office 2015; WA Auditor General 2015) for limiting access but the reports do not reference capital distribution.

Potential productive efficiency gains have been identified by increasing transparency, coordinating health technology and reducing waste through the use of up-to-date clinical guidelines (Productivity Commission 2015) and investment in ITC for improved efficiency (Kruk 2018). Under existing capital allocation policies there is no evident mechanism to achieve these system objectives for improved efficiency. At interview clinicians recognised decreasing lengths of stay, improved patient outcomes and safety within the efficient price as an indication of productive efficiency.

Detailed curated data on the cost of providing care in a hospital by diagnosis group is available at hospital level, state level and nationally (IHPA 2018b, 2018a). Despite careful review by the Productivity Commission there is no evidence of a way forward for improved efficiency under the prevailing capital distribution or capital cost estimation method (Productivity Commission 2009e, 2010, 2017b). Efficiency improvements achieved by prevailing capital distribution are unlikely to be evidence or patient-based (Ch5.4.3-4) or equally distributed based on prevailing processes.

2.1 Replacement of assets

Criterion:

Evidence-based patient-aligned standards govern the replacement funding for capital consumed

The cost of replacing existing capital consumed each year is rising by an average of 14% per annum although records for the estimated cost of capital are incomplete.(SCRGSP 2018; SCRGSP 2016; SCRGSP 2017; SCRGSP 2015) Financing the replacement of existing capital is not taking place (8) and if the cost of capital consumed continues to rise by 14% per annum or more, additional investment will be required to maintain safe service delivery.

Efficiency requires maintenance of assets at an appropriate standard supporting the pursuit of efficiency by hospital management(Duckett 1995)

The most recent estimates of the cost of capital (2015-16)(SCRGSP 2018) have been compared to estimated capital expenditure from state government budget allocations for three years. Comparing the cost of capital to the total expenditure on hospitals nationally around 40% of capital costs are met with under 16% of capital costs met in Victoria and South Australia. For the latter two years these percentage estimates are likely to overestimate the value of expenditure as a percentage of replacement costs. The capital cost figure is held constant from 2015-16 and so overestimates 2016-17 and 2017-18 percentages.

Table 9.9 Capital expenditure for hospitals as a percentage of capital costs consumed, 2015-16, 2016-17 and 2017-18

Source: Annual Report on Government Services 2018 (SCRGSP 2018) State Budget Papers, (AIHW. 2018)

State	Total Estimated Cost of Capital \$'000	Hospital Capital Expenditure			Total investment as a percentage of capital cost		
		2015-16 \$'000	2016-17 \$'000	2017-18 \$'000	2015-16 %	2016-17 %	2017-18 %
NSW	1,762,521	699,172	718,406	611,845	40	41	35
Victoria	1,738,014	247,106	261,598	446,470	14	15	26
Queensland	959,499	752,928	694,196	431,716	78	72	45
South Australia	454,629	92,569	169,997	71,489	20	37	16
WA	542,436	155,113	133,664	219,897	29	25	41
Tasmania	88,634	84,826	113,297	185,410	96	128	209
ACT	124,811	11,704	139,416	88,976	9	112	71
NT	164,000	102,750	121,427	42,701	63	74	26
Australia	5,834,552	2,146,168	2,352,001	2,098,504	44	40	36

Based on the capital cost and investment data and interviews with officials funding for asset replacement is not patient or evidence-based and is not financing asset replacement or renewal.

3. *Dynamic efficiency*

Criterion:

Alignment with government standards for efficiency is evident

Dynamic Efficiency examines how well systems (for the distribution of capital) respond to emerging risks for public hospitals. (Duckett 2008a). Evident risks include adaption to technological change and responsiveness to emerging issues such as climate change(Hanna 2018), patient data management and a range of emerging health problems including funding “new technologies to combat the emergence and spread of antimicrobial resistance” (OECD Health Ministerial Meeting 2017)page 3). Public hospital infrastructure is also expected to be fit for unexpected emergencies(National Advisory Committee on SARS and Public Health (Canada) 2004; Singh 2017)

Addressing the capacity to respond effectively to both evident and unexpected risks the Australian hospitals system has a standard for meeting unexpected risks (Australian Standard AS 4083-2010 Planning for emergencies-Healthcare facilities). However, there are no identified mechanisms for funding to meet known risks.

Examination of the processes for capital allocation for expected risks have identified:

- There is no national mechanism funding technological improvements in public hospitals and state funding does not provide nationally consistent investment (Table 9.6, Table 9.7) or meet replacement costs.
- There is no national policy or funding for addressing climate change risks for public hospitals.
- There is insufficient capacity within many hospitals to manage existing admission requirements (Australasian College for Emergency Medicine 2018)(Ch.9.5.5)
- Responsiveness to evidence-based innovation in healthcare was found to be poor (Productivity Commission 2017b)(Table 5.11) (Ch.9.5.6)
- Flexibility of funding has been identified as poor based on interviews with officials (Ch.5.7).

- Learning from infectious disease outbreaks (Cossart 2014) may be implicit rather than explicit in the system. Australian antibiotic (vancomycin) resistance is at the highest rate of resistance (45% of the population) of 29 EU countries(Productivity Commission 2017b)
- Patients with antimicrobial resistance may require facilities and equipment different to those of other patients(Australian Commission on Safety and Quality in Health Care 2018a). However capital funding for appropriate facilities is not evident.

Examples of emerging risks include unpredictable access to tools of emerging clinical practice e.g. patient-centred intelligent data management, artificial intelligence assisted diagnostics and monitoring, ICT, hybrid operating theatres with 3D imaging and robotics in surgery(Williamson 2018; Dewey 2018; Faux de 2018). The experiences of the implementation of electronic medical records, the time taken, the cost and the varied approaches and outcomes concern clinicians. Clinically appropriate adoption of emerging technologies in a timely and cost-effective manner was identified as a risk in interviews.

Additionally the risk of falling behind contemporary clinical care through restricted access to information, communications and technology was identified(Tan 2018). Clinicians interviewed linked technological improvements to patient safety, improved effectiveness and procedural accuracy. Where new facilities and technologies have been adopted clinicians were able to identify decreasing lengths of stay, patient satisfaction, improved clinical outcomes, lower use of ICU, and higher efficiency for theatres and wards.

The timely adoption of evidence-based new technologies was identified as part of providing professionally competent, safe, clinical care. Alignment of capital allocation with government objectives for efficiency of public hospitals could not be identified.

9.6 Summary

Capital has been considered in terms of its purpose to fund patient access to appropriate and efficient acute care at Australian standards. Government standards have been identified as equity, appropriateness, effectiveness, quality, responsiveness, innovation and sustainability (Figure 3.3, Figure 9.1, Figure 9.2). Using Table 9.2 measures and criteria, Table 9.10 details the results for both capital funding systems support against the standards, measures and criteria.

Summarizing the review (Table 9.10) there were 33 measures and criteria established in Table 9.2.

- The prevailing capital allocation system was found to meet, or there was no data for, 3 of the 33 criteria. These were building standards, access for special needs and access for specialized facilities. The prevailing system failed to meet 30 of the 33 criteria.
- The model system was found to have a mechanism to deliver the requisite measures for 30 of 33 criteria. Items which did not meet the criteria were dependent on implementation by local health authorities (compliance with building standards, clinical standards and Greenstar standards).

Table 9.10 lists the standards, measures and criteria with the results for the model system and the prevailing system.

Table 9.10 Evaluating prevailing capital allocation and the model approach for healthcare standards, measures and criteria

Measures	Criteria	Existing system	Model system
Equity			
Capital to population	Similar (2015-2018)	No-different per state	Yes systemic
Capital per inpatient episode	Equal allowing for clinical need	No-different per state	Yes systemic
Equity of access to major medical equipment	Equal allowing for clinical need	No-different per state	Yes systemic
Access for special needs	Equal allowing for clinical need	No data (SCRGS 2018)	Yes systemic [#]
Equality of access for births	Equal allowing for clinical need	No (Rolfe 2017)	Yes systemic
Equality of access for knee replacement	Equal allowing for clinical need	No (Brennan 2014)	Yes systemic
Equality of access for caesarians	Equal allowing for clinical need	No (ASQHC 2017)	Yes systemic
Equality of access for hospital ICT	Equal allowing for clinical need	No (State Budgets)	Yes systemic
Appropriateness			
Estimated Capital cost per state	Evidence & Patient-based	No (SCRGSP 2016-18)	Yes systemic
Access to specialized facilities	Evidence & Patient-based	Unclear	Yes systemic
Funding for ICT strategies	Clinical standards & efficiency	No (Table 9.6)	Yes systemic
Waiting lists national variation	Clinical & Government standards	No (AIHW 2017)	Yes systemic
Waiting lists for hip replacement	Within Clinical & Government standards	No AIHW surgical wait	Yes systemic [^]
Waiting lists for knee replacement	Within Clinical & Government standards	No (AIHW 2017)	Yes systemic [^]
Waiting lists by socio-economic status	Within Clinical & Government standards	No (SCRGS 2018)	Yes systemic
Effectiveness			
Capital to recurrent expenditure	Evidence & Patient-based	No (Tables 9.7-8)	Yes systemic
<i>Continuity</i>			
% of hospitals receiving capital per annum	Clinical standards & access equality	No (9.7)	Yes systemic
% of hospitals receiving capital over 4 years	Clinical standards & access equality	No (9.7)	Yes systemic

Measures	Criteria	Existing system	Model system
Quality			
Funding for safety standards	Integral	No (Ch.9.5.4)	Yes systemic
Building standards not met	Low (<5%)	No (Ch.9.5.4)	No
Reports of access below clinical standards	Within Clin. & Gov't standards	Yes (Ch.9.5.4)	No
Innovation			
Systematic funding for improvement	System identified & funded	No (Ch.9.5.6)	Yes systemic
Systematic technology adoption	System identified & funded	No (Ch.9.5.6)	Yes systemic
Planning for advanced technologies	System identified & funded	No (Ch.9.5.6)	Yes systemic
Sustainability			
Allocative efficiency qualities evidence	Aligning government standards	No (Ch.9.5.7)	Yes systemic
Percent of hospitals with Greenstar ratings	Aligning government standards	No (Ch.9.5.7)	n.a.
Funding systems for sustainable hospitals	Aligning government standards	No (Table 9.8)	Yes systemic
Efficiency	Aligning government standards	No (Ch.9.5.7)	Yes systemic
Efficiency improvements	Greater than 90% **	No (Ch.9.5.7)	Yes systemic
Identification of changes required	System identified & funded	No (Ch.9.5.6)	Yes systemic
Funding for improvements	Greater than replacement	No (Ch.9.5.6)	Yes systemic
Distribution of improvements	Evidence & Patient-based	No (Ch.9.5.7)	Yes systemic
Funding of capital consumed	Evidence & Patient-based	No Table 9.8)	Yes systemic

* Allowing for clinical need as detailed in Ch.9.5.3

Dependent on the DRG coding and weightings for special needs patients

^ Demand dependent. For each patient in the DRG an investment is made but if demand increases rapidly waiting lists would increase.

** Efficiency improvements are distributed evenly.

The purpose of capital allocations necessitates two additional functional measures are evident:

- *Measure 34-Standards of service delivery should be able to absorb short-term fluctuations due to reasonably foreseeable factors* (Victorian Auditor-General 2017). This ability was not identified in the prevailing capital allocation system based on waiting list data and access to hospitals (Ch.9.5.3). A national clinician survey identified that hospitals commonly run at 100% capacity (Australasian College for Emergency Medicine 2018). Similarly, the capital allocations system and methods for accounting for capital were found not to provide scope to absorb demand fluctuations due to reasonably foreseeable factors. However, the model system calculations are based on 75% occupancy, as stipulated within guidelines, for wards, birthing suites, theatres and diagnostic areas allowing for reasonable unforeseen events.
- *Measure 35- A trust-worthy base for future investment.* Capital investment in facilities will have costs for future services and influence the clinical options for future patients. Projecting service delivery models forward from the present necessitates strong confidence that the existing funding policies are delivering flawlessly at contemporary standards. Contemporary standards have not been delivered for all Australians under the prevailing funding system (9). Allocations for capital failed to cover half of the cost of capital consumed each year (8) or provide funding for most hospitals (9.8). Current services are the basis for future acute services to larger patient groups so flaws identified in access to appropriate facilities and equipment will become amplified over time, if policies remain unchanged.

Therefore, it is concluded that the prevailing system has not been funded to (i) support foreseeable fluctuations and (ii) does not provide a trust-worthy base for future investment. The model approach based on clinical guidelines and prevailing standards with consistent funding, review mechanisms and transparency can provide a trust-worthy basis for future investment. Evidence-based occupancy standards and allocation factors allow for short-term flexibility for reasonably foreseeable factors.

It is concluded that present policies for funding capital for acute care are not sustainable.

9.7 Discussion

Essentially, the DRG-based model presents a change of scale for costing, evaluating and investing in acute care. In contrast to the traditional state system of institutional capital allocation, the model approach assesses detailed patient-centred valuation to achieve national hospital standards. Scaling to national funding for acute care capital addresses clinical, technological, efficiency and equity issues evident in Australian healthcare.

This chapter has adopted the performance framework widely used by Australian governments to report on a range of government services, to evaluate the model and prevailing capital allocation systems (SCRGSP 2018). These core standards of Australian healthcare were used to determine if the prevailing capital allocation system or the model system could facilitate appropriate, sustainable and innovative health care facilities. An effective capital allocation system was expected to:

- facilitate contemporary standards of clinical care
- be responsive to changes in patient requirements
- be responsive to evidence-based improvements in clinical practice
- support hospital efficiency
- provide equitable access to healthcare and
- be sustainable.

9.7.1 Effective facilitation of contemporary standards of care

The model system was designed to fund health facilities with embedded systems for delivering Australian healthcare standards. The model was found to have meet 32 of the 35 standards. In contrast prevailing capital allocations were found not to align with contemporary Australian governmental standards for care in appropriateness, effectiveness, quality, responsiveness, innovation, and sustainability. Over 35 measures for health capital, the prevailing system was found not to meet 32 contemporary standards (8 (Ch.9.5.7)).

While all Australians are entitled to access safe, high quality healthcare, peak clinician groups consistently reported insufficient inpatient capacity (Australasian College for Emergency Medicine 2018; Australian Medical Association 2018; Australian and New Zealand Intensive Care Society 2017) particularly for Australians with greater health needs (AIHW 2017e; Australian Commission on Safety and Quality in Health Care and

the Australian Institute of Health and Welfare. 2017)Ch.9.5.6). In Australia's system of institutional capital funding with priorities determined by political, health and State budgetary objectives, funding contemporary standards of care for all patients has not been central (Ch.5.4.4). The results of the prioritised system are a failure to fund all patients access to appropriate acute care.

Hospital capacity limitations have been identified in a substantial range of hospital activity (for medical, surgical and obstetric patients across Australia) and most enabling technologies. While capacity constraints involve a range of resources, including access to clinical staff, the studies presented addressed clinical issues separately. ABF provides funding at the efficient price for inpatient services for all Australians including weighting for Australians with special health needs to achieve contemporary quality care and outcomes. The missing element for funding capacity to facilitate clinically appropriate care is a system of capital funding resourcing contemporary standards of clinical practice.

9.7.2 Responsiveness to changes in patient requirements

The model system for capital allocation contains mechanisms to respond to changes in patient demand over the short, medium and long term. It can also manage changes in acuity associated with more complex cases through the DRG coding system. Similarly, patients with greater clinical requirements linked to remote residence or indigenous status would attract funding weights aligned to the DRG weightings for recurrent funding. These are designed to allow additional resources for patients with greater clinical needs and in rural and remote locations. The model system allows for facilities and technology to be where patients require them. Technological advances offer options for clinical support, diagnosis and monitoring valuable for at risk groups. However, rural and lower socio-economic patients have the poorest access to appropriate technologies under the prevailing system of capital allocation.

Competitive prioritised capital allocation systems have no direct mechanisms to respond to changing acuity in a timely manner for Australian patients (Chapter 5, Ch.9.9.5). Inequality of access for key activity-funded procedures including births, cardiac and surgical procedures reflects a distribution of capital that is unresponsive to patient requirements. (Rolfe 2017; Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017) (Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017; Brennan 2014) Australian hospitals endeavour to be patient-centred but the

prevailing institution-focussed system of capital allocation impedes their responsiveness to patient needs. While Australia aims for patient-centred care, Australia does not have a patient-centred system of capital allocation (Ch.5.4.4). Therefore, the prevailing system is not calibrated to short and medium term changes in patient requirements for access and technologically-appropriate services.

9.7.3 Responsiveness to evidence-based improvements in clinical practice

Capital allocations for Australian hospitals have been found not to facilitate contemporary standards of care and not to be responsive to evidence-based improvement in clinical practice. However, the model approach has a mechanism for transparent determination of the evidence for funding improvements in clinical care in Australian hospitals for capital and recurrent costs simultaneously.

“Science and medicine are advancing at a rate that demands agile regulatory conditions that do not inhibit implementation” (Williamson 2018)page 4) when infrastructure questions can be answered (Williamson 2018)pages 6,31, 49 & 105). Within the model approach there is provision for accepted evidence-based improvements to be included in the capital allocation per patient. There is also a mechanism for improvements to be advanced to the IHPA, public submissions received, and a research-based determination made for the inclusion of new technologies or facilities. As part of this arrangement reviews can decrease capital amounts in response to savings (e.g. decreased need for rehabilitation beds for hip and knee replacement patients) or identify savings on the efficient price for a DRG when a capital item substitutes for clinical professional time (e.g. AI diagnosis for eye disease(Faux de 2018; Cuthbert 2018)). The model approach also contains mechanisms that align with ABF for the introduction of new types of medicine and new diagnosis and delivery systems(Williamson 2018)from point-of-care testing, genome sequencing, gene editing, microbiomics and epigenetics to hybrid robotic surgery and imaging(Williamson 2018).A key element of this approach is transparency and the alignment of a comprehensive investment of clinical and capital resources directly linked to the patient, the procedure and the outcome.

In contrast the Australian asset-focussed system is fragmented and unresponsive to technological change. The prevailing system of capital allocation does not have transparent national mechanisms to fund capital for improvements in clinical practice nor are there systems for the diffusion of innovation (Productivity Commission 2017b)page 69). Officials confirmed that evidence is not included in capital allocation and capital for the adoption of innovation is piecemeal(Ch.5.4.3).

Auditor General reports and special inquiries challenge the effectiveness of national capital distribution for clinically-important technologies (Australian Senate Community Affairs and References Committee 2018)(Victorian Auditor-General 2015; NSW Auditor General's Report 2013; Queensland Audit Office 2015; Travis 2015; Egerton-Warburton 2016). Low levels of investment, poor data, inadequate distribution of technology, the absence of funds for ICT (Ch.9.5) indicate a system that cannot fund technology or facilitate technological change for the nation. Adoption of clinical improvements under the prevailing system rely on individual hospital redevelopments (Chapter 5) so the benefits of improvements for patients and efficiency cannot be delivered to most hospitals (Table 9.7). No national mechanisms to fund capital for evidence-based improvements in clinical practice exists.

Emblematically, under the prevailing capital allocation system, Australian hospitals significantly lag OECD countries for accessible electronic medical records (EMR) (Productivity Commission 2017; Minion 2017). This is an obstruction to clinical effectiveness and health system efficiency and is inconsistent with Australian government objectives for patient information (Australian Digital Health Agency 2018). State capital funding for EMR is not consistent across or within states as it depends on major rebuilding projects for improvements for a small percentage of hospitals (Chapter 5, Ch.5.4.3).Effective clinical data management for Australian hospitals is not addressed in prevailing capital allocation systems but is factored into the model for capital funding.

9.7.4 Support hospital efficiency

It cannot be concluded that the prevailing system of capital allocation is effective in capital allocation, supports technical efficiency in Australian hospitals or invests for future dynamic efficiency. Governments expect hospitals to promote efficiency improvement (Council of Australian Governments(COAG) 2018a). The model system of capital allocation can support efficiency by aligning capital with recurrent costs for improved:

- Allocative efficiency (timely, flexible, equally distributed, affordable capital)
- Measurement of efficiency at the DRG level to continuously improve technical efficiency and
- Dynamic efficiency through a mechanism for risk-management and the adoption of evidence-based improvements (Ch.9.6.4).

For the model allocative efficiency would be enabled full resourcing of clinical care at a national efficient price. However, COAG directions would determine the degree of flexibility of capital at the hospital level and the cost of reporting requirements. DRG-

based capital allocation would permit facilities management (maintenance, repair, replacement and disposal) to be managed at the hospital from DRG based utilization. Benchmarked information on costs between hospitals can reduce variations in facilities management and address persistent corruption(Lennarts 2010; WA Corruption and Crime Commission 2018)(Independent Commission Against Corruption 2011; Independent Broad-based Anti-corruption Commission 2017)

Allocative efficiency could not be identified in the prevailing method of capital allocation in Australia (Tables 9.3-9.5). Capital is affordable for those hospitals which receive funding but over 80% of Australian hospitals have not received any capital funding for over four years.

The efficiency effect of not providing capital in a timely, flexible and fairly-distributed manner on recurrent costs is difficult to assess on the available evidence in Australia. Blockages caused by insufficient access to beds, imaging and operating theatres within hospitals have effects on the efficient operation of hospital wards including longer lengths of stay and, potentially, quality and patient outcome issues(Milligan 2019). Salary and wage costs, at over 60% of recurrent costs, are likely to be effected by blockages in the clinical pathway from insufficient beds,, insufficient storage for equipment on wards (identified in clinical interviews) and difficulties accessing appropriate medical equipment (identified in clinical interviews) when required(IHPA 2018b).

Technical efficiency is restricted when proven technological aids to diagnosis and monitoring of patients, delivery and management systems are not employed to improve the efficiency and effectiveness of high cost staff. The potential of technological substitution to improve productivity in acute care in Australia has not yet been examined(Solow 1956) Under the prevailing system of capital valuation it is not possible to estimate technical efficiency with any accuracy(Productivity Commission 2009e, 2010). Similarly, when a dynamic efficiency improvement is made in response to model of care enhancement, prioritised capital allocations reduce the adoption rate to those hospitals able to secure funding in the periodic funding tranche (Ch.9.5.6, 9.6.3). As William Gibson recognised *“The future is already here- it’s just not evenly distributed.”* (Aedy 2018)

9.7.5 Provide equitable access to healthcare

Access is the most important standard in assessing Australian public hospitals (Figure 9.2, Figure 9.2). Equity of access has been assessed by state for all Australians, all Australian

inpatients and special needs patients through equality of funding and waiting times to access hospital services (Ch.9.4.5, 9.5.5 and 9.6.13). In the absence of a national funding system for capital, equity of access was not identified as an important factor in determining capital funding priorities by the states (Ch.5.4.1)

Capital funding mechanisms are deemed to have failed when in response to progressive clinical and technological change they:

- do not provide equal access for all Australian patients to contemporary facilities, diagnostic and treatment equipment (Ch.9.5.1)
- do not provide clinicians with equipment and facilities required for current standards of practice (Ch.9.5.2)
- do not align with contemporary models of care (Ch.9.5.3) and
- adversely affect efficiency (Ch.9.5.4).

As an activity-based funding system, the model system is designed to fund access for patients according to the requirements of their diagnosis and in relation to the volume of patients receiving care. A system that funded equitable access according to patient need would provide effective capital distribution and allocative efficiency.

Under the prevailing capital allocation system capital funding per person and per inpatient by state was inequitable to a significant degree (Table 9.3, Table 9.4). Clinical needs (Ch.9.3.6) did not explain the wide variations. Neither did capital allocated under the prevailing system meet the replacement cost of capital consumed providing care (Table 9.9).

Equality of access was considered for special needs groups with higher clinical need than other patients (Ch.9.3.6). Despite their higher clinical need access to appropriate clinical services was consistently and significantly poorer for Indigenous people and people of low socioeconomic status measured in waiting times and preventable hospitalisations(Ch.9.5.5)(Table 4.24)(AIHW. 2018). Myocardial infarction in indigenous Australians were consistently less likely to have diagnostic angiography and/or a definitive revascularisation procedure than non-indigenous Australians(AIHW 2018c).

Access to surgical care favours the socially advantaged. Australians of lower socioeconomic status median waiting times were longer for ED, outpatients appointments(Johar

2013)and for surgery in public hospitals. (AIHW 2017b) Separation rates were also considerably below the national rate (AIHW 2018a).

Chapter 8 detailed the capital requirements for births, dialysis and hip and knee replacement surgery. Funding for births would correspond to the clinical requirements for the mother and child under the model system. Under the prevailing system it was found that there was not equal access for maternity care as Indigenous and rural mothers, with higher risks of stillbirth and neonatal deaths, were found to have access to an inferior range of maternity services(Abdel-Latif 2006; Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017; Rolfe 2017).

Interviews identified that clinicians are concerned about access to contemporary diagnostic and clinical technologies (Chapter 7) and so access to specific funding for two significant tools of clinical care, (i) major medical equipment and (ii) ICT were assessed.

As Chapters 7 and 8 have detailed major medical equipment (MME) and ICT funding is an integral part of estimating and costing the clinical pathway per patient. Funds for each of these would be included in the capital price paid per patient episode through the model funding system.

Major medical equipment

However in the prevailing system audits found an absence of systems, transparency, rigour with insufficient planning for the replacement of major medical equipment(MME)(WA Auditor General 2017) (Queensland Audit Office 2017) Poor funding for the replacement of imaging machines meant higher clinical risks for rural patients(Australian Senate Community Affairs and References Committee 2018) , variable access by geographic area in Victoria and questionable fitness-for-purpose of half of NSW equipment and one third of WA equipment. Poorly served areas had the highest population clinical requirements (Ch.9.3.5). While other states have not published audits of their processes the common approach identified in official and clinical interviews and the Senate committee findings suggest the results are likely to be mirrored across Australia.

ICT

The model approach includes a transparent factor for ICT costs for each patient by DRG. Under the prevailing system nationally there are no funds for capital equipment for hospitals to access equipment, patient data management, medical records infrastructure, telehealth equipment or ehealth environments(Australian Digital Health Agency 2018).This is unlike

Europe and the USA where national funding underwrote the adoption of electronic medical records, prescribing and communications systems in hospitals (Ch.6 and Appendix D)(Wernz 2014; Maresso 2015; Thomson S 2014). State systems for prioritised capital funding often provided no funding for ICT over multiple consecutive years (Ch.9.5.2). In the absence of investment strategies and consistent investment, the clinical relevance and functionality of technology across the Australian hospital system is questioned.

9.7.6 Sustainable

The model approach has been assessed as potentially suitable to deliver socially, environmentally and economically sustainable capital funding for hospitals unlike the prevailing system

Sustainability is of particular significance for investment in capital for future acute health service delivery. Funding “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”(Brundtland 1987) describes the challenges of capital allocation

Social equity, as the first of the three themes within the definition, was found not to be met by the current system (Ch.9.6., 9.5.7, 9.5.1). Climate change has been identified as a major threat to population health with implications for health services(Watts N 2017; Zhang 2018a).National standards ignore the impact of climate change however health and construction management codes align themselves with environmentally-sustainable building codes embodied by Greenstar.(Australasian Health Infrastructure Alliance 2016b; Australian Building Codes Board 2017; Green Building Council of Australia 2018, May 2013).

State governments aspire to improve environmental sustainability for hospitals but the primary mechanism for improving environmental sustainability is through individual hospital projects (Ch.5). However fewer than 15% of hospitals receiving funding for hospital renewal (Table 9.6) which is characteristically project specific without an allowance for environmental modifications (Appendix D Table D.11). Consequently 1% of Australian hospitals have a Greenstar rating. Despite the advice of officials (Ch.5.4.4) most hospitals built in the post-2009 HHF building wave did not gain Greenstar ratings. Environmental sustainability of hospitals could be improved by adopting European schemes for DRG and Building Information Management (BIM) based facilities

management, waste reduction and reuse, lower carbon footprints, energy management modelling and asset recycling.

The third theme of the Brundtland definition of sustainability is economic sustainability. Productivity Commission estimates of hospital technical efficiency had median efficiency rates of 0.816 for public hospitals and found productivity increases of up to 20% were required to achieve best-practice (Productivity Commission 2009e) Table 8.5 and Finding 8.2). Potential hospital productive efficiency gains have been identified by increasing transparency, coordinating health technology and reducing waste through the use of up-to-date clinical guidelines (Productivity Commission 2015) However capital allocation processes do not acknowledge NH&MRC or clinical guidelines (Table 5.9). Systemic problems of access to clinical information through EMR are recognised as impediments to efficiency (Productivity Commission 2017b; Kruk 2018; AMA 2016) Prioritising investment for 15% of hospitals (over four years) does not provide systemic funding for hospitals to update, expand or improve efficiency through the substitution of capital for more expensive labour inputs (De la Grandville 2016). The nature of the prevailing system fosters old models of care and inequality of access (Chapter 4, Ch.9.5.1, 9.6.1). The model system is able to incorporate the recommended improvements for efficiency whereas the prevailing system has been unable to.

Sustainable capital allocation for hospitals should include expenditure covering the replacement costs of capital consumed, population growth and technology change (Garling 2008) (Deeble 2002a) Australia's system of capital allocation is not meeting replacement costs or allowing for population growth (Deeble 2002a), increased acuity or technological change (Ch.9.5.7).

Efficiency improvements where it is cost effective to substitute capital for labour or to reduce labour costs through the inclusion of systems and equipment can be identified and costs and benefits calculated at the patient level in the model approach (Solow 1956). The model approach contains a mechanism to incorporate improvements and distribute their application and benefits across the sector.

9.8 Valuing capital for acute care

As hospitals are highly valued it is surprising that capital allocation systems for hospitals in Australia have not previously been evaluated for their relevance to patient care or to standards of government service delivery. Capital allocation systems and their outcomes

have been reviewed in two Australian studies (Deeble 2002a; Bridges 2001) and some international studies for relationship to assets or funding solutions (Rechel 2009c; Samset 2009; Shaoul J 1998; Thompson 2011a; Vogl M 2014). However, no systematic evaluation of the capital allocation system has been attempted in relation to the mix and sequencing of treatments and services for patient care.

The Productivity Commission and the Annual Report on Government Services analysis of capital for hospitals, values assets but lacks relevance to contemporary hospital patients and their treatments (Ch.2.6.1-2.6.3). Deeble evaluated hospital capital allocations in terms of asset replacement finding flawed systems where heritage and political power influenced decisions (Deeble 2002). Bridges and Sperling acknowledged technological and patient demand change with the requirement for increased capital expenditure advocating for private funding for public hospitals (Bridges 2001)). A variety of strategies have been deployed by state governments to source the capital required for hospitals managing population growth and technological change including outsourcing capital fundraising to Public Private Partnership arrangements.

Yet these approaches were unable to answer the essential question of how to effectively invest to provide patient access to efficient hospitals. The model approach can answer that question at the patient level. Asset-based models can estimate the total value of assets but not infer their relationship to patients or determine if they contribute to (or detract from) the delivery of Australian standards for hospital services.

9.8.1 Standards

Central to this comparison has been values of the Australian system expressed through the performance framework (Figure 3.1) for Australian government services. While performance frameworks can be controversial the SCRGSP framework is applied to most government services, has a degree of transparency, is aligned with Australian standards (Meteor) and accesses a wide range of experts, published and unpublished data. This study copied the PHPIF as the appropriate measurement system for service delivery to ensure integrity of the standards and framework have been maintained.

This study has found that the risks associated with failure to meet the standards of access, efficiency, and clinical appropriateness are not explicitly managed within the prevailing capital allocation system. Instead the risks and costs are externalised to manifest in recurrent costs for hospitals, waiting times and patient costs and costs to the economy. To

minimise these externalities and adverse effects on hospital costs and efficiency this analysis aimed to connect capital to the patient, the procedure and the outcome.

Deebles' approach fixed capital allocations at replacement levels and at a point-in-time for medical equipment that may or may not have been efficient or effective in delivery(Deeble 2002a). However, a guidelines-based model does not perpetuate any maldistribution or inefficiencies and reflects common clinical and government standards.

9.8.2 Valuation

This thesis has considered how capital for hospitals can effectively be valued (Ch.2.6.2-3,2.7, 2.10, 3.1, 4.5.4.1, 5.4.4, 6.5, 7.1-2, 9.5). Asset valuation issues have made European capital allocation systems vulnerable. European systems for capital allocation have identified limitations arising from reimbursing hospitals for the cost of capital based on individual hospital assets(Lennarts 2010; Vogl 2014) .Imbalances of asset distribution, periods of underinvestment or sub-optimal asset accounting systems, mean depreciation payments may not meet capital consumed for individual hospitals providing contemporary standards of clinical care.(Vogl 2014) While reimbursements for short-lived medical equipment will not be heavily disadvantaged by technological transitions in service delivery, long-lived assets such as hospital buildings may be depreciated at rates lower than their value or replacement cost. This has resulted in building investment backlogs in Germany, Austria, Spain and the USA.(Vogl 2014) Capital investment for hospitals was identified as critical to reducing costs and improving efficiencies after the Global Financial Crisis(McKee, Basu and Stuckler 2012)

Continuity of funding is also a consideration. Steady funding associated with DRG based capital systems meant that that Austria, Finland, France, Germany, Norway, the Netherlands and the USA¹ (Table 6.1) did not have reductions in capital funding for hospitals in the GFC after 2008(Appendix D)(Maresso 2015). Australian capital allocation systems have been characterised by peaks and troughs of capital funding for hospitals. Duckett cautioned that this could lead to opportunistic and potentially inefficient bids for facilities.(Duckett S 1994a) It has also meant here is no incentive to value assets by function or to dispose of redundant assets. Continuity and regularity of capital funding enables

¹ It has been argued that the uncertainties of the GFC led to increased investment in hospital investment in the USA due to the reliability of the sector and the rate of return on investment.

planned asset acquisition and replacement with potential for better cost management than the boom-bust cycle of capital funding (Ch.4.4, official and expert interview).

Based on the unresolved difficulties of asset valuation, and the European experience of depreciation-based asset reimbursement, this research has preferred contemporary standards for clinical service delivery and costing.

Deeble's model drawing on Duckett's recommendations (Duckett S 1994a), advocated for capital equipment expenditure at the hospital level. This thesis has embraced that concept and annexed it to contemporary ABF funding structures for synergies and simplicity (Ch.8.8). This aligns with the NHHRC recommendation for capital to be included in ABF (NHHRC 2009).

9.8.3 The basis for future healthcare

Australians are adopting technological advances in banking, communications, transport, health and education (Australian Bureau of Statistics 2018). However, for public hospitals a mechanism to fund the adoption of technologies, including electronic medical records, and clinically-appropriate technological innovation is absent. Nor was a robust system identified, in prevailing capital allocation, for adoption of evidence-based innovation and adaptation to changing models of care. The delayed, sporadic and often ineffective roll-out of electronic medical records has failed to deliver anticipated efficiency improvements (Ross 2016; Tan 2018). Clinicians are concerned that there are impediments to the adoption of technological innovations in the health sector (Tan 2018; Stark 2019). A platform for common national clinical access to primary care medical records is funded by the Commonwealth (My Health Record) but capital funding is not provided to hospitals to enable digital medical records (Australian Digital Health Agency 2018) and a national system of patient records.

Community expectations are of a highly connected technologically sophisticated hospital system however the actual rates of connectedness are very poor by national and international standards (Minion 2017; Productivity Commission 2017a). It was found that 70% of Australian healthcare workers surveyed for the Philips 2017 Future Health Index believed "Current funding mechanisms will prevent Australia from moving to a patient centric healthcare system" (Minion 2017).

Nationally COAG has identified a 2018 objective driving best practice and performance using data and research. (Council of Australian Governments (COAG) 2018a) It is

concluded that existing capital allocation methods do not represent best practice, effectively measure capital data or actively incorporate research.

Hospital funding in general has evolved to focus on the efficient delivery of services combined to achieve a specific patient outcome (e.g. a birth, a dialysis episode or a hip replacement). A sustainable episode of care provides the appropriate resources for the optimal outcome. The proposed model can provide a mechanism to incorporate continuous improvement in health facilities linked to guidelines, evidence and patient care as a system that learns. Aligning funding processed for acute care, the Model includes clinical and government standards through guidelines-based clinical pathways, an extension of legislated processes for COAG, the IHPA and the National Health Funding Pool minimising the risk of inappropriate allocation.

The prevailing capital allocation system has developed for institutional preservation (Chapters 4 and 5, Appendix C). A fit-for-purpose capital allocation system based on healthcare standards is required as the prevailing system failed 33 of 35 healthcare measures. Failing the four measures which form the basis for future health investment (dynamic efficiency, responsiveness to innovation, able to manage reasonable but unforeseen changes and providing a sound basis for future investment) is not optimal for an investment system.

Capital costs are not well measured or understood in Australia under the prevailing system and there is not equitable distribution of capital resources between all states, hospitals or patients. So continuing to rely on altruistic capital funding (Asheim 1994) from an unknowable budgetary base (Ch.5.4.1)(Deeble 2002a) is unlikely to meet the definitions of sustainable investment or achieve the distributional change required to be a sustainable or efficient hospital system (Brundtland 1987). Identification and measurement of health capital can be used to strengthen the mechanisms for sustainable development for health services (Asheim 1994) using technology to enhance efficiency (Solow 1956, 2005) so future patients are not denied access to efficient, effective and appropriate hospital care (Brundtland 1987).

9.9 Conclusion

This chapter has presented an evaluation of two models of capital funding to determine if they met the standards set for Australian hospitals. The proposed model addresses many of the shortcomings of the existing model. The evaluation contains limitations including issues of access to data for the prevailing system in turn influencing the comprehensiveness of the indicators used. Additionally, the comparison is with a theoretical model for which limited data (Chapter 8) is available. Allowing for the limitations, it is concluded that a diagnosis-based system of capital allocation is likely to be able to fund capital to enable more appropriate, sustainable and innovative acute care than the prevailing system.

The final chapter addresses the research context, methods, conclusions and implications of the research.

Chapter 10 Conclusion

10.1 Aim

The central question of this research asked:

“Can diagnosis-related capital facilitate more appropriate, sustainable and innovative acute care?”

Answering the research question required:

- i. review of the prevailing capital allocation systems,
- ii. development of a diagnosis-based model for capital allocation for acute care in Australia, and
- iii. a comparison of the prevailing and the model systems against Australian standards.

10.2 Research context

Over the last 25 years Australia has progressively implemented patient-based Activity Based Funding (ABF) for most inpatient hospital services, but not for capital funding. Patient-centred care has been enshrined with a national entitlement to universal access to quality care (Council of Australian Governments (COAG) 2011b; Australian Commission on Safety and Quality in Health Care 2009). This research has considered capital for public hospitals in the context of the patient services it is intended to facilitate.

Little is known about capital allocated for hospitals. The literature on capital investment for Australian hospitals is limited (Deeble 2002a; Bridges 2001) with Deeble the first to estimate capital investment relative to hospital services. Comparing the growth in recurrent expenditure to capital expenditure he found investment levels were not aligned to population growth or technological development (Deeble 2002a). Subsequent reviews of health and hospital services in most states found, along with clinical considerations, the capital allocation system did not permit universal patient access to high-quality services when required (Garling 2008b; Forster 2005; Menadue 2003; Bansemer 2014; Travis 2015; Australian Senate Community Affairs and References Committee 2018; Tasmania Legislative Council Government Administration Committee 2017; Reid 2004). A national review recommended capital be included in Activity Based Funding (NHHRC 2009) but the mechanism and value of capital were not addressed. Subsequently the Productivity

Commission was directed by the Commonwealth Treasurer to address capital costs for hospitals as part of a comparative hospital study(Productivity Commission 2009e). Data on the cost of capital used in patient care was acknowledged to be unreliable and could not be valued from depreciation information(Productivity Commission 2009a, 2010). The value of hospital capital used in patient care was not accurately measured (Kerr 2015) and is no longer published(AIHW 2016c). Within the annual Report on Government Services quality issues for the valuation of capital prevents inclusion in the hospital efficiency indicator(SCRGSP 2019)

10.3 Research methods, key findings and advantages

Data challenges were managed by using an Exploratory Sequential Mixed Methods approach, incorporating quantitative and qualitative methods (Ch.3.4). Interviews with officials responsible for capital allocation from each jurisdiction provided data on decision-making for capital allocation systems. Systematically conducted literature reviews identified additional information which was supplemented by state-by-state searches of the grey literature. This strategy was adopted as capital allocation is rarely examined independently as an issue but can be found as a subsidiary aspect of health services reviews. Across Australia 13 health service reviews found capital allocation issues adversely affected health service delivery.(Tasmania Legislative Council Government Administration Committee 2017; Productivity Commission 2009a, 2009e, 2015, 2017b; Garling 2008b; Forster 2005; Reid 2004; NHHRC 2009; Travis 2015; Australian Senate Community Affairs and References Committee 2018; Menadue 2003; Barsemer 2014)

Although managed on a state basis, the process for capital allocation was found to be consistent across Australia. Capital allocation was initiated by regional health authorities, ranked by officials as part of a regular funding program (or planned asset replacement process) within the priorities of the State Budget. Patient-centred care is the objective of each health system but only one state (of eight) had patient-centred planning for hospitals. Rather than being patient-based and supportive of clinical standards, the process was found to be an asset-focussed system for institutionally-based capital planning where priorities were usually based on budgetary and political considerations (Ch.5.4.1).

Instrumental to assessing the effectiveness of capital allocation was defining the role of capital for acute care. The definition for effective capital allocation workshopped and adopted for Australia was *'funding patient access to appropriate care in efficient hospitals'*.

Looking at other models, verifiable information on capital allocation systems was found for 17 comparable OECD nations in the WHO Health in Transition (HiT). From the definition three measures-effective funding, patient access and efficiency- were scored to determine national scores for 'funding patient access to efficient hospitals'. The national scores were aggregated by the system of capital funding into five funding types. DRG-aligned capital funding gained the highest scores followed by government subsidy. The lowest scores were predominantly private funding of public hospitals and public-private partnerships(Ch.6.3.6, 6.4.2)(Kerr and Hendrie 2018). Similar results were found when eight types of major medical equipment (MME) machines per million population¹ were assessed by system of capital funding (Table 6.8) from OECD data. As an indicative measure the nations with DRG-based allocations for MME were closest to the average for the 24 OECD nations reviewed. Medical equipment funded through block grants and PPP or regional funding had predominantly below average funding while national funding provided above average funding.

Building a DRG-based capital funding model for Australia drew on the international experience but due to issues with accuracy, appropriateness, accountability and equity, the method for valuing capital was new. As noted by Australian reviews, the AIHW and the annual report on government services, Australian depreciation-based capital valuation has issues of accuracy, appropriateness, accountability and equity (Tasmania Legislative Council Government Administration Committee 2017; Productivity Commission 2009a, 2009e, 2015, 2017b; Garling 2008b; Forster 2005; Reid 2004; NHHRC 2009; Travis 2015; Australian Senate Community Affairs and References Committee 2018; Menadue 2003; Bansemer 2014; SCRGSP 2001a, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012; AIHW 2016c; SCRGSP 2013, 2014, 2015, 2016; SCRGSP 2017; SCRGSP 2018; AIHW 2017f, 2018d) Deeble's costing method for hospital capital was the first 'bottom-up' costing for different types of hospitals. However, rather than costing hospital inventory (Deeble 2002a) this research has used 'bottom-up' costing at the patient level focussed on specific patient care using evidence-based clinical guidelines and patient clinical pathways. It was determined that due to the complexity of modern hospital services (Day 2018) the model required a higher level of specificity to cost the different requirements of clinical care for different patient groups.

¹ *Computerised Tomography Scanning, Magnetic Resonance Imaging, Positron Emission Tomography, Gamma Cameras, Digital Subtraction Angiography, Mammographs, Radiation Therapy and Lithotripters*

10.4 The model

Creation of an Australian model in which the capital amount required for each patient care episode could be estimated to fund appropriate patient-based clinical care in efficient hospitals required:

- Design of a model to estimate contemporary patient clinical capital requirements (Chapters 3 and 7)
- Alignment of the model design with prevailing government standards for patient care in public hospitals (Chapters 7 and 9)
- Creation of a formula to identify the elements and relationships to calculate capital costs (Ch.7.3.1)
- Developing a proof-of-concept model relevant to more than one third of public hospital patients in seven diagnosis groups together requiring access to a wide range of facilities and equipment (Chapter 8)
- Charting the patient clinical pathway for each of seven diagnosis related groups according to established standards of care in practice guidelines
- Gaining expert clinical opinion through interviews with professorial-level clinicians across Australia (n=27), metropolitan and regional, actively involved in providing care within the specific DRGs (Ch. 7.6), and,
- Determination from these sources of the capital elements required for a patient episode in Australia for the seven DRGs in terms of:
 - Capital directly involved in patient care and
 - Capital indirectly required for patient care but required to be accessible or as part of the common facilities which constitute the hospital.
 - Specifically identifying within the modelling, the capital elements required per DRG for key activity areas including theatres, ICU/HDU/CCU, procedure rooms, and
 - Identifying the different forms of patient spaces required for contemporary clinical care including accommodation with bathrooms, bariatric rooms, isolation spaces, waiting areas, short-stay beds and chairs (Chapters 7 and 8).

Evidence was applied to the formula for detailed ‘bottom-up’ costing and apportionment to the patient level for each of the DRGs modelled for proof-of-concept (Chapter 8). Sensitivity analysis was conducted for the key variables for each model including costing methods and alternative models of care (Chapter 8).

Representing 36% of admitted public patients, seven DRGs (dialysis, obstetric and surgical) with recognised clinical guidelines were selected and costed using the model (Chapters 7 & 8).

10.5 Results

The results of the model are summarised in the areas of cost, appropriateness, sustainability and innovation.

Cost: Costs were established for each DRG from a formula addressing facilities, medical equipment and ICT costs. The average capital cost estimated by ‘bottom-up’ costing per patient for the selected group of DRGs was equivalent to 18% of the recurrent cost of the DRGs. This was slightly lower than the ‘top-down’ cost estimate from government sources of 19% (Table 8.20)(SCRGSP 2018; IHPA 2017b) for all DRGs. However the percentage relationship of capital to recurrent costs varied significantly between DRGs (from 6% to 36%)(Table 8.19). While the capital cost per patient per DRG can be applied across Australia, the average figure of 18%, as the relationship between capital costs and recurrent costs, was specific to this group of DRGs and cannot be extrapolated across other DRGs.

Technological improvements in hospitals have been linked to higher capital and recurrent costs (Sorenson 2013; Thomson 2009; OECD Health Ministerial Meeting 2017). However, in this study three of the seven DRGs had evidence of lower capital and recurrent costs associated with capital invested in contemporary models of care (hip and knee replacement and planned caesarean) compared to traditional models. Consequently, hospital staff and facilities were freed for an average 6.5 hours per patient in the new models compared to the more inert traditional approach.

Appropriateness: The model provides a mechanism to deliver appropriate capital for patient care linked to contemporary standards of clinical care for all patients within a diagnosis group, equally. Capital investment can be connected directly to the patient, the treatment and the outcome. The model aligns with the contemporary system of recurrent funding by linking the tools for delivering clinical services with professional guidelines and government standards. Predictable regular capital funding based on patient numbers will permit patient demand to align with supply for facilities, equipment and systems in a timely manner. Capital allocated by DRG can be transparently assessed and accurately reported for patients, hospitals and states (Ch.9.4 and 9.6).

Sustainable: Economic sustainability focussed on allocative, productive and dynamic efficiency. The qualities of allocative efficiency for capital allocation for clinical care (timely access to capital, flexible use of capital, capital that is affordable to hospitals and capital that is fairly distributed) are found in the model approach (Ch.9.4.7).

Funding for the model is proposed to be aligned with ABF (Ch. 8.8) for allocative efficiency and to resolve the fragmentation of funding for hospital services (Productivity Commission 2017b) permitting common pursuit of quality and productive efficiency within diagnosis groups. Examples of improved productive efficiency were identified for the DRGs costed. The cost of capital consumed in patient care would be reimbursed in the model system enabling renewal and reinvestment in facilities and equipment where the prevailing system has averaged 40% of annual replacement costs over the past three years (Table 9.8) Anchoring the cost model in clinical standards and clinical pathways based on patient utilization and using ‘bottom-up costing’, provides costing more likely to be appropriate than existing historic asset-based capital cost estimates(Productivity Commission 2009e; SCRGSP 2018; Deeble 2002a)(Ch.9.8)

The model approach contains mechanisms to pursue dynamic efficiency for evidence-based improvements in services including managing change in patient numbers and requirements, technology, clinical practice and pursuing efficiency on a national basis. Environmental sustainability can be managed within the model by setting standards, carbon and waste management policies (Malik 2018), adopting Greenstar standards and by using green costing index for areas. Adaption of the costing index to life-cycle costing can also include maintenance costs and fund disposal or adaption of facilities and equipment(Kerr 2019).

Dynamic efficiency is not evident in the current model of funding but the model approach enables investment and also disinvestment of technology and facilities aligned with contemporary standards. This method will examine the efficacy of investments past and present towards achieving efficient service delivery in specific treatments for quality outcomes.

Innovation: Unlike the prevailing system the model approach has mechanisms for transparent funding of clinical improvements and technology by aligning with ABF adoption processes(IHPA 2016a, 2017c, 2019a). Predictable regular funding based on DRGs will permit patient demand to fund supply for facilities, equipment and systems. Predictable funding allows for hospital developments to have a reliable funding stream enabling both short and longer term projects.

In summary, it proved possible to create a model to value the capital required per patient for clinical care at the DRG level based on contemporary standards.

The third element of the research was to assess the performance of the model and the prevailing system of capital allocation using the standards of the Public Hospital Performance Indicator Framework appropriate to effective capital funding. Measures to assess these standards used information from interviews with clinicians and officials, literature review, budget papers and data from government sources(SCRGSP 2018; Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017).

Comparing the model and the prevailing approach to capital allocation, the current system has been found not to provide universal access to clinical care at Australian government standards (Ch.9.5.1, 9.8) and to underinvest in hospital services (Tables 4.2, 9.8). Service quality for hospitals is expected to comply with government standards but measures of appropriateness (Ch.9.5.2) and quality (Ch.9.5.4) showed the existing system failed these standards. The prevailing system of capital allocation was found to be ineffective (Ch.9.5.3). There is an absence of patient-centredness (Ch.9.5.1), responsiveness (Ch.9.5.5), allocative and dynamic efficiency (Ch.9.5.7) in the prevailing institutionally-based system of capital allocation. Innovation in clinical care or technological change was found not to be supported by capital funds (Ch.9.5.6). On most measures (33/35) the prevailing system of capital allocation was determined to be unsustainable (Ch.9.6.6).

Clinical interviews identified concerns about timely access to the tools required to provide care at contemporary clinical standards (Ch.7). Clinical access to necessary tools for appropriate patient care have been identified as piecemeal with inadequate access to key functional areas including imaging and operating theatres(Australian Senate Community Affairs and References Committee 2018; NSW Auditor General's Report 2013; Queensland Audit Office 2015; WA Auditor General 2015; Travis 2015)(Ch.9). In Australian hospitals, EMR is a 20th century innovation with poor implementation results (Productivity Commission 2017b)page 67) and the result of a system unable to fund consistent investment in clinically required equipment.

Currently the cost of capital consumed delivering a contemporary episode of care is defined by statewide estimation of asset depreciation (for facilities up to 50 years old) rather than effective treatment of the patient. But over the last 50 years Australian hospitals have changed from providing general adult clinical pathways (medical, surgical, obstetric

and mental health) with (a comparatively) limited use of technology (Sax 1974; NSW Department of Health June 1991; Butler 1983). Contemporary public hospitals are funded under ABF for numerous, diverse but specific patient clinical products differentiating between day only or overnight inpatient care with greater use of ambulatory settings, specific procedure areas, critical care, monitoring and testing, imaging and multiple technologies including EMR. ABF has focussed hospitals on the efficient delivery of specified patient outcomes. However over 50 years the system of capital allocation in Australia has remained largely unchanged.

As technology, medical equipment and information and communications systems become increasingly critical to appropriate clinical care, risks identified with capital allocation will need to be managed to support hospitals and patients. Overall the Australian capital allocation system has been found not to meet the standards set for Australian public hospitals (Figure 9.2) (Table 9.9) or to effectively fund patient access to efficient hospitals when compared to other OECD nations (Table 6.6)(Kerr and Hendrie 2018).

A new model has been developed for capital as an enabler of effective acute care delivery using a functional formula, verifiable tools, clinical pathways(Productivity Commission 2017b), transparent measurement aligned to a demonstrably effective ABF system(Biggs 2018)(Ch.7). As a patient-based system of capital costing the Model invests at the appropriate standard for each varied hospital product supporting continuous improvement. The Model has been developed to address the requirements of contemporary acute healthcare and assessed for its capacity to deliver at Australian standards for public hospitals (Table 9.9). Proof of concept testing (Ch.8) and testing by public hospital performance standards (Ch.9) determined the model system can work to improve the effectiveness of acute care.

There are several parallels between the development of this Model and the introduction of ABF to Australia.

Limitations

There are a number of recognised limitations of the study detailed in each chapter.

Data: It should be noted that interviews with health officials did not include two smaller jurisdictions that declined to be included. The international capital allocation measure is based on earlier studies which themselves contain limitations. Both the capital allocation and the MME study are restricted to those nations for which information is published.

The model has limitations. It is based on clinical guidelines established through a consensus process and detailed by clinical experts through interviews. This method mirrors the approach used for determination of the AHFG's and used for costing Dialysis (Australasian Health Infrastructure Alliance 2016a). One group of experts may have different views to another group of professorial level experts. Chapter 7.6 details the approach used in this research to manage that risk. Conflicting views were found amongst the experts within the profession and the same state but not across states and sensitivity analysis was run to model the dissenting point of view. The clinical pathway modelled was the pathway favoured by most professionals. Clinical expert conclusions on practice changes (length of stay, use of specific facilities) for hip and knee replacement patients, for example, provided practice detail that was later published by other clinical research (Naylor 2017; Schilling 2018; Salonga-Reyes and Scott 2017). Objective analysis of the quality of clinical evidence continues to improve (Alhazzani 2018).

Range: The model has been tested on dialysis, obstetric and surgical DRGs but has not been tested for medical patients potentially with multiple morbidities. Medical patients are expected to require some of the same facilities as surgical patients, but this has not been tested through the development of clinical pathways based on guidelines and expert advice. Medical patients require patient accommodation and some diagnostics but not, by definition, operating theatres and procedure rooms. So medical patients per day capital costs are expected to be lower than surgical and obstetric patients but their total costs may be higher due to longer lengths of stay. The model has not been tested for children although facilities for well babies were included in obstetrics. Although the model is patient-based it cannot be considered truly patient-centred as the views of patients have not been included in consultations. This was due to privacy and cost issues. If the system is further developed patient consultations on facilities directly and indirectly required should be included.

Sources: The number and range of published guidelines is increasing each year but not all treatments are covered. Detailed clinical guidelines suitable for capital allocation modelling have been published for stroke, colonoscopy, endoscopy and chest pain. Expanding the use of the model may be slower in DRGs without guidelines. It was difficult to get appropriate expert advice in some specialties particularly nephrology. However, NSW Health Infrastructure achieved high clinical involvement to create the Dialysis brief (Australasian Health Infrastructure Alliance 2016a). Some less frequent DRGs may cover a range of conditions that may have different clinical pathways such as cancer treatments, 'other knee procedures (I18Z)', 'other foot procedures (I20Z)' and

‘Other factors influencing health status (Z64A).’ There may be requirements for different facilities, equipment and length of stay in these DRGs, but this has not been examined in the model or testing.

Costing: Investment in ICT for hospitals under the prevailing system of capital allocation has been difficult to identify. The absence of information and transparency on the cost of ICT in public hospitals (Auditor-General 2017; NSW Health 2016a; Health Department of WA 2015; Queensland Health 2015b) limit the inclusion of ICT to a variable which could not be accurately costed. The costing data base used is a commercial product based on the accumulated data of national projects (Rider Levett Bucknall 2017). More detailed cost information on key activity areas and life-cycle costing would improve the quality of costing index to a higher costing standard (Queensland Audit Office 2017) (Audit Office of NSW 2017; Kerr 2019). Negotiations have begun with the Institute of Quantity Surveyors to categorise costs more specifically.

Scope: Hospitals host inpatient and outpatient facilities with patients using imaging, treatment areas, corridors, waiting areas and hotel facilities (cleaning, supply, catering, waste management, IT, medical records etc.) but allowance has not been made in the model for the capital required for outpatients, emergency department and non-admitted patients. As with ABF it is possible that the model can be developed for application to outpatients, emergency department, hospital-in-the-home and other acute settings (Productivity Commission 2016; Health WA 2014)

Model testing was for the most commonly used DRGs but did not include complex diagnosis groups. The method for establishing indirect costs permits future expansion of the data on hospitals. Three hospitals were used to create the model hospital and it was assessed and validated by three professorial experts and infrastructure officials. However future research offering access to a wider profile of hospitals would allow confidence costing level 5 and level 6 services (NSW Health 2016c; Tasmania Department of Health and Human Services 2015b; Queensland Health 2015c)

Gaps: Further research is required in a number of areas to advance the accuracy of the model approach. Specifically, into standards for hospital ICT systems and their cost, into a broader sample of information to identify indirect costs for buildings and ICT, into detailed national building and equipment cost indices for specific areas of hospitals such as ICU, CCU, operating theatre types and day procedure areas. Resolution of the evidence gaps in capital funding for hospitals can help improve accuracy, permit benchmarking, assist accountability and efficiency.

10.6 Previous research and international approaches

There has been little research published in the 21st century discussing the background of systems of capital allocation or reviewing past systems of capital allocation for public hospitals (Ch.6.3.1)(Bridges 2001; Deeble 2002a). While a wide range of publications address how capital can be afforded and the financing innovations that can provide funding (Bridges 2001; Thompson and McKee 2004; Barlow 2008; Fidler 2007) few link capital allocations to patient care (Gurría 2017).

This research is the first to recognize that capital allocation is a consistent theme of the problems identified in multiple health service reviews (Chapter 4) (Australian and New Zealand Intensive Care Society 2017; Australasian College for Emergency Medicine 2018; Auditor-General 2017; Audit Office of NSW 2017; Bansemer 2014; Barton 2004; Duckett 2002; Garling 2008b; Forster 2005; Langoulant 2018; Menadue 2003; NHHRC 2009; Productivity Commission 2009e, 2010, 2017b, 2015; Richardson 2004; Reid 2004; Travis 2015; Victorian Auditor-General 2015, 2017; Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017; Australian Senate Community Affairs and References Committee 2018) .

Information quality, accountability, transparency, accuracy are significant issues for hospital capital. There is an absence of understanding about the investments necessary for future patient access and clinical requirements for hospitals. Linking capital allocation specifically for the tools of clinical care to the patient, the treatment and the outcome by diagnosis group provides a common authority for investment, a source for benchmarking, reporting and purchasing. The prospective funding method allows hospitals to receive appropriate capital amounts for patient care in a timely way to facilitate patient demand-based investment for facilities, and regular funding for approved technology specific to patient care.

Greater transparency for investment and reporting on the outcomes of the investment has been called for (Boxall 2011; Deeble 2002a; Kerr 2015; Productivity Commission 2009e, 2010). Capital previously invested in hospitals supports contemporary care based on previous assumptions about service requirements with significant ‘unknowns’ about clinical practice, patient characteristics, mode of care and technology. When investment decisions are made (up to four) decades in advance of contemporary patient arrival there are two possible consequences. First efficiency is restricted by the model of care based on the original facilities, systems and equipment available. Secondly the model of care

developed for the most recent redevelopment remains the model of care that can be provided (Tables 5.7 & 5.8). As Churchill recognised "We shape our buildings, and afterwards our buildings shape us"(Churchill 1943). With fewer than 15% of Australian hospitals receiving capital funding over the most recent four years (Table 9.7) most hospital care will be restricted by previous funding and technology decisions made with little clinical involvement (Appendix D, Table D.10) a decade or more before patient arrival. Time lags between application for hospital capital developments and service opening are a recognised feature of Australian healthcare. Efficiency effects on contemporary care of facility and technology decisions taken five to 10 years before opening have not been researched.

The literature does not examine the relationship between contemporary standards of care, capital and the efficient price for services. However this research models a transparent system with information relevant to hospitals and hospital systems, as foreshadowed by Deeble(Deeble 2002a).

Capital in Australian acute care was topical twice. Concerns about patient access issues in Australia in the 1970s and 1980s(Eyles J 1985; Whitlam 1971) provoked discussion of capital funding options including resource allocation formulas (NSW)(Sax 1990) and capital charging (Mayston S 1995; Duckett 1995; Shaoul J 1998) in the 1990's. Neither developed. However, at a time of significant technological change a capital allocation system able to systematically assess options and fund appropriate change would be appropriate. This research has assessed capital allocation systems for how effectively they will support acute healthcare, systems and MME for the short- and medium-term future (Chapters 4, 6 and 9)

10.7 Inspiration

The model developed in this thesis is original but draws on a range of earlier research from clinical, historic, health service, health facility design, architectural and economic sources.

Clinical

Clinicians expect the tools required to deliver competent care to be available in public hospitals and future health services to be technology rich. The environment for acute care is both evolving and devolving. Clinical services are evolving due to advances in technological options with changes for models of care(Williamson 2018). Improving health through technological innovations and tools for better risk management encourage

clinical services to devolve to other settings, closer to the patient's home(Mattick 2018b; CSIRO 2018; Hill 2015). However the inertia of the asset-based planning system resists changes which may be in the interest of patients and costs(Minion 2017; Astley et al. 2017; Australian Senate Community Affairs and References Committee 2018; Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017; Productivity Commission 2017b). This research was inspired by clinical evolution and the need to enable evidence-based improvements in clinical services for all Australians.

Historic

Deebles' concerns regarding the influence of existing assets on capital allocation prompted research into the evolution of capital funding for hospitals in Australia(Deeble 2002a). Few studies of the history of capital allocation for Australian hospitals were identified (Kerr 2013; Quince 2009). Determining the origins of the prevailing system of capital allocation drew on individual hospital historic studies, newspaper reports and parliamentary papers to build an understanding of funding mechanisms for hospitals across Australia since 1788. Sufficient data was found for 18 hospitals ranging across four states with sufficient breadth of clinical context. This research found changes in community expectations and clinical technical capacity were the primary catalysts for change in capital funding systems (Chapter 5, Appendix C).

Health-activity based funding

Within the increasingly diverse range of clinical services for patients, DRGs provided a system of prospective funding for patients with common clinical processes. Many DRG based allocation systems include depreciation-based payments for capital.(O'Reilly et al. 2012b; Scheller Kreinsen 2011b; Vogl M 2014) Innovation in capital funding systems has not always delivered appropriate, sustainable and innovative acute care settings due to lack of transparency, patient-focus, inflexibility and poor alignment between capital and recurrent costs(Barlow 2008; Barlow 2010; Shaoul 2011).

Over 25 years DRGs have delivered benefits to the Victorian and later Australian health systems.(McNair 2002; Biggs 2018) The method of using cost buckets, direct and indirect costs, developed for Australian DRGs has inspired the formula for calculating capital(Rodrigues 1993; IHPA 2018b; PWC for the IHPA 2013).

Health facility planning and design

This research develops from a pervasive issue identified through 35 years practice in health facility planning over 40 hospital projects. The potential for this study grew from 2007 workshop involvement in the European Health Property Network (EuPHN) canvassing the changing contexts and unidentified economic aspects of investment for hospitals (Ch.2.8) (Rechel 2009b) Rechel dismissed DRGs as a basis for capital funding, however this research drew on the evidence on clinical pathways and the experience of capital allocation systems to challenge Rechel's conclusion. The diverse European experience of investment, and failure to invest, spurred the development of an economic analysis of capital allocation systems(Kerr and Hendrie 2018)(Chapter 6).This research has built on EuPHN planning and building analysis but aimed to systematise and monetise capital in acute care as a mechanism for improvement. Broad consideration of procurement and new models of care within the EuPHN remained asset focussed. The breadth and richness of thought has emboldened this research to examine sustainable and innovative capital delivery. It has also encouraged development of a model and formula that can have application in nations with a DRG-type system, drawing on local standards.

Architecture

Key questions in health architectural research of specificity versus flexibility of facilities and the relationship between design and operational costs remain contentious(Stichler 2017). Architectural research has linked access to appropriate facilities with clinical improvements (Ulrich 2006; Hamilton 2006; Bracco 2007; Maben et al. 2016). This thesis has drawn on architectural research on changing levels of specificity in hospitals (Copeland 2013; Hill 2015)and methods for health facility planning in the development of the Area Schedule of accommodation and functions in development of the model(Ch.7.3.4). American and UK architects have sought to identify a broad financial relationship between design, building and recurrent costs(Fuller 2016). This research costs that relationship at the patient level to allow for specificity of facilities, MME and funding allowing architectural configuration decisions to be based on clinical pathways, efficiency and efficacy.

This research developed from questions about the value of capital in supporting economically-efficient clinical care, and European research on approaches to investing in future health including lifecycle costing (Bjorberg 2009; Samset 2009; Ellis 2018).

Rates of reimbursement for technology relative to built capital depreciation have led to operational imbalance for hospital facilities (Vogl M 2014; Lennarts 2010; Busse 2011). The US system is based on a national prospective payment weighted by DRG with additional payments for local characteristics (costs and wages, geography and medical education)(Centers for Medicare and Medicaid Services 2018).Drawing on these approaches, this research aimed to formulate a prospective payment appropriate for Australia. Given the issues of accuracy, appropriateness, accountability and equity identified for hospital capital (Chapters 4, 5 & 9), a depreciation-based capital payment was rejected in favour of a standards-based approach.

Economic research

The micro-economic analysis in clinical service planning identified multiple efficiency issues in clinical care arising from ‘working-around’ system, equipment and facility impediments to effective and efficient care over numerous health facilities. The cost of insufficient capital allocation was evident in clinician time wasted, length of stay, patient transfer numbers and patient costs. Infrequent capital allocations were observed to disadvantage areas of clinical need(Tudor Hart J 1971) Value Theory framed the conflicting values between the prestige of public hospitals and their clinicians, high-value allocations for new or expanding hospitals, and the national inattention to capital valuation (Mazzucato 2018).

As a microeconomic costing model, this research builds on the work of Deeble, and the creators of DRG costing methods in the USA and Australia (IHPA 2012b; Palmer 1991; Duckett 2000; Duckett 1995; Deeble 2002a). In particular the research has adapted the Australian hospital cost data collection methods and standards for capital cost formulation (Commonwealth Department of Health and Ageing 2005) The research has identified micro-economic costing can sustain macroeconomic objective of efficiency, effectiveness and sustainability.

Innovation has been included in the research question based on the clinical, architectural and historic research but also to explore the potential of productive efficiency improvements from Economic Growth Theory in relation to technological change for acute healthcare(Solow 1956, 2005; Aghion 2016). Similarly concerns about the inertia of the depreciation-based value system on production were sparked by the Theory of Creative Destruction.

10.8 Appropriate time

A standards-based approach is possible at this time in Australia for three reasons. Some authoritative mechanisms exist in Australia for transfiguring clinical and governmental standards through the AHFG, clinical guidelines overseen by NHMRC and efficient funding through IHPA processes into an effective capital allocation mechanism. Secondly this is a key moment of technological transition. Impending technological change necessitates an agile system of capital allocation, responsive to evidence-based clinical developments, in a timely manner, connected to evidence-based clinical practice. At key moments of technological transition for Australian hospitals funding systems have changed (Chapter 5, Appendix C). Thirdly, the close pursuit of hospital cost efficiency is necessary in the Australian system as technological and clinical change evolve. Australian acute care requires detailed verifiable efficiency analysis at the patient level and a transparent and suitable system for investment.

10.9 Implications

Universal access for patients to high quality clinical care has been an objective of the Australian health system; this research provides a mechanism to facilitate equality of access to acute health services for all Australians through comprehensive ABF payments. Australian governments have also aspired to patient-centred care; the model can fund a comprehensive framework for patient care. The fiscal barriers between approved clinical care and the tools required to deliver acute care could be dissolved. Inequalities of access to contemporary standards of care and technologies between states and within states, could be resolved through the Model funding mechanism.

Indigenous people, rural patients, disadvantaged socio-economic groups and those in outer metropolitan areas have been identified as having poorer access to acute health care (Ch.9.3.5). This model aligns capital with the patient, the treatment and the outcome based on accepted clinical standards. Where additional weightings are applied to capital for rural and indigenous people in the same manner as for ABF, clinical planning can address the service access imbalance for high risk patients (Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017).

Patient-based funding provides an opportunity to diversify and devolve care by funding clinically appropriate services closer to the patient home. Capital amounts could be directed for appropriate technologies to support at-risk patients through IHPA-approved

DRG funding. Technological and clinical changes offer a future to include remote monitoring, hospital-in-the-home, mobile x-ray, telemetry for patients to receive treatment at home rather than hospital. Similarly, funds could be identified for telehealth and monitoring equipment in rural hospitals connected to specialists in larger centres.

Equally DRG-based capital funding for approved clinical pathways will specify and cost appropriate medical equipment. Older modalities will not be funded leading to disinvestment, and disposal, of redundant equipment(Schumpeter 1942). Technological advances have previously meant an increase in medical equipment as investment and disinvestment policies were not linked to the patient and the treatment(Haas 2012).Clinical pathways based on clinical guidelines will support effective funding of required equipment rather than depreciation covering all previous purchases.

The ICT factor in the capital formula provides a method of funding for a national electronic medical records system in hospitals to link to the MyHealth Record. Australia has not funded a viable platform for hospital medical records(Australian Digital Health Agency 2018). Hospital Electronic Medical Records have been funded on a project by project basis for a small number of public hospitals sinking Australia below OECD standards for EMR (Productivity Commission 2017b). Data from inpatient medical devices requires a secure platform for clinical access potentially supported by Artificial Intelligence programs. A national funding system could provide a fit-for-purpose national medical records platform with appropriate access, size, storage, security and functionality.

A national data set for capital payments would have reporting systems to mirror ABF. Funding would be linked to specific facilities, equipment and systems and to indirectly required assets. In addition to clinical audits there would be financial and administrative reports at the hospital, regional, state and national level on expenditure and assets. This would provide comparable data for benchmarking hospital capital expenditure across Australia. Access to the benchmarking data and reports on costs through a parallel system to the national hospital costs data collection could address levels of fraud in the system. It is a model that fosters transparency in a system that has been opaque and tainted with corruption(Kerr 2015; Independent Commission Against Corruption 2011; Independent Broad-based Anti-corruption Commission 2017; WA Corruption and Crime Commission 2018)

Adoption of the Model approach to capital funding will enable specific evaluation of efficiency of service delivery at the diagnosis group, service, hospital, state and national

levels. Allocative efficiency can be aligned with health objectives and comprehensively assessed for the first time using the Model approach. Efficiency has been improved in hospitals through ABF but analysis of the next stage of efficiency improvement is limited by the absence of accurate capital costs. Therefore productive efficiency opportunities of technological advances remain unexamined in relation to a disaggregated Elasticity of Substitution in acute care (Arrow 1961) and the effects of specific investment in technologies on the production functions for DRGs (Solow 2005). Improved access for patients at refined costs for governments may be enabled through the application of economic analysis methods upheld in other domains. Capital-labour substitution and harnessing the productive enhancement of technology have been demonstrated to deliver improved outcomes in industry(De la Grandville 2016; Aghion 2016) offering opportunities for improved health efficiency.

Hospital funding is ‘lumpy’ over time(Deeble 2002c). This was true when buildings were the primary cost, funding was politically prioritised and major hospital construction was infrequent (Ch.2.6,2.8.2-3,5.3.2,5.4.1). Modular construction methods, progressive improvements and the growing significance of medical devices and ICT have been found to change the necessity for redevelopments and up-grades(Sun 2009; Schinko 2016). DRG-aligned capital funding permits improvements to be steadily funded, planned and progressed in line with health approvals and clinical standards to maintain consistent clinical support.

Like ABF, it is projected that the model can be extended to include non-admitted patients including ED, outpatients, hospital-in-the-home, rehabilitation-in-the-home, palliative care and mental health facilities. This model has been designed for application in Australia, but the formula and methods could be applied in other countries based on their standards for clinical services.

This research has developed a model of capital funding to enable acute health care to be appropriate, sustainable and support innovation in the short term and provide a reliable basis for the future.

10.10 Commonwealth-state issues

A challenge is establishing the Commonwealth as a sustained contributor sharing the cost of capital funding for hospitals, currently a state responsibility.(Council of Australian Governments(COAG) 2011c, 2018b) Commonwealth funds for hospital capital are rare

and have been election project based since 2013. In most OECD countries, national governments fund hospital capital (Chapter 6) including as EMR or electronic prescribing (Maresso 2015). Commonwealth involvement will require COAG agreement amendments. For the states per patient payments for capital will require a regular commitment to expenditure higher than the smaller states have managed.

At the regional and hospital level organisational and managerial changes will be required to achieve allocative efficiency with a higher level of reporting, benchmarking and continuous development of each hospital and for acute services provided in the community (Drummond 1996).

10.10.1 Implementation and transition

As with ABF there will be implementation and transition issues some of which will be unanticipated. Governance structures established with ABF, including supervision of quality and safety will provide a reliable framework for implementation of capital payments.

A fund supervised by the National Health Funding Body would need to be established by COAG with matching state and national legislation (Chapter 8.8). Experts working to the IHPA would be required to determine cost per DRG in consultation with the states and the Australian Commission on Safety and Quality in Health Care and the Australian Consortium for Classification and Development annually. Further development of costings for a wider range of DRGs will be necessary to test the model. Two options for government supported testing have been considered:

- for each state to nominate one test hospital for shared DRG-based funding with the Commonwealth then
- applying the model to one state such as Tasmania.

Evaluation programs would need to be established to assess the practical operation of the model under IHPA. As with ABF full scale adoption of the model could be completed after appropriate evaluations and results have determined the costs and the benefits.

10.10.2 Political risk under the current system

The risks posed by prevailing capital allocation are increasing. For politicians the continuation of the inappropriate distribution of capital, geographically and across asset types, is becoming more concerning as inequality of access to diagnostic equipment,

required hospital beds, key activity areas and technology manifest at the political level(Australian Senate Community Affairs and References Committee 2018; Australian Medical Association 2018; Australian and New Zealand Intensive Care Society 2017; Australasian College for Emergency Medicine 2018; CSIRO 2018) Political risks are posed by surgical waiting lists increasing beyond 3% of the Australian population. Risks to clinical standards and the efficient price have been identified where access to the tools required for clinical care, such as imaging and EMR, are not available unless there has been a recent redevelopment. The prevailing system has proven unable to deliver appropriate, sustainable, innovative acute services for all Australians.

Politically-based priority setting for capital for hospitals is increasingly difficult given the growing complexity and specificity of acute health care, combined with the significance of achieving efficiency and managing health costs within state budgets. A reliable mechanism to determine effective, appropriate and sustainable capital allocations would assist politicians achieve their objectives for universal access to efficient quality healthcare.

10.11 Future challenges

Australian healthcare will face economic, demographic, technological challenges in the early 21st century that are both like and unlike previous challenges. Acute services will continue to be required to deliver appropriate care at Australian standards. The lesson of the past is that new services will develop for the delivery of specific outcomes and capital project funding will follow the most effective advocates (Chapter 4, Appendix D) rather than be universally distributed (Tudor Hart's Law of Inverse Care)(Tudor Hart J 1971).

10.11.1 Funding for access to technology is significant for future services

Unlike the past the challenge is not to restrict investment to restrain costs but to support the clinical workforce with capital to sustainably optimise access, effectiveness and efficiency. To achieve expected standards for universal access to quality services, funding for clinical and capital components should be aligned to avoid anomalies of access, effectiveness and efficiency. Disjointed funding of capital and recurrent services has been found to reduce the capacity of acute service delivery and create avoidable economic, health system and patient costs (9.6.6)(CSIRO 2018)

10.11.2 Effective technological support

Unlike the past, there are predicted to be greater technological requirements and therefore sustainable investments are necessary to optimise the relationship of capital to workflow and technological interface parity for clinical staff to achieve sustainable outcomes.(CSIRO 2018) Questions of appropriate investment in technology under ABF will be assessed from patient-level services and outcomes which tend not to be visible in top-down institutional approach to technology adoption. Integrated care for patients across sites using various technologies will require funding linked to clinical requirements and governmental standards.(CSIRO 2018) Chapter 8 has documented that the mix of clinical skills and technology will not be the same for each patient group or clinical outcome.

10.12 Conclusions

ABF and the legacy capital allocation system delivers quality care for most Australians. Hospitals benefited from significant additional funding under the Commonwealth Health and Hospitals Fund (2009-2014)(Australian Department of Finance 2013) providing major upgrades and new facilities unable to be met by the prevailing system of capital allocation. Consequently, capital allocations align with most clinical requirements in many hospitals through careful health planning, partnering with the private sector, leasing, fund-raising and the distribution of resources arranged through health departments and regions. Yet for hospital capital Australia maintains a system that does not deliver equal access for all patients to the facilities and medical equipment they require(Australian Senate Community Affairs and References Committee 2018; Australian Medical Association 2018; Australian and New Zealand Intensive Care Society 2017; Australasian College for Emergency Medicine 2018; Australian Commission on Safety and Quality in Health Care and the Australian Institute of Health and Welfare. 2017). Clinical services are funded to the efficient price in an equal manner across Australia, but not the capital required to support patient clinical care.

There is no national system for capital funding to support clinical care in hospitals. The state systems are similar in aspiration and process but afford different outcomes for patients depending where they live. Without a national system of capital allocation, the standards of Australian governments for public hospital performance cannot be assured for all patients.

Defining the purpose of capital funding for hospitals as '*funding patient access to appropriate care in efficient hospitals*' permitted the first evaluation of capital funding for patient services in Australia. The definition allowed a comparative analysis of the objectives of Australian hospitals relative to comparable OECD nations to reveal the effects of the capital funding system on patient access and efficiency. There had not previously been a viable definition of the purpose of capital allocation for hospitals.

This thesis has endeavoured to demonstrate that patient-based care necessitates a different view of capital allocation for hospitals. Prioritised allocations do not provide equal response to patient needs or provide for emerging medical technologies and equipment. The current requirements for capital allocation for acute care are not providing equitable access for all Australian patients to 20th century innovations causing Australia to fall behind in key indicators and lack a mechanism to deliver imaging and EMR. It is not a comprehensive system of funding. The prevailing system has demonstrated it is not able to deliver technology across Australian hospitals. A politically-influenced prioritised system has been found not to deliver equitable services (Ch.9.7). In this thesis a model has been developed that can establish an estimated cost for the capital required for clinical care per patient by diagnosis group that includes technological factors.

Acute care standards are defined by government and clinical expectations for the effective delivery of a complex range of hospital services. For 35 measures of equity, appropriateness, effectiveness, quality, responsiveness, innovation and sustainability the prevailing system of capital allocation failed to achieve Australian Public Hospital Performance standards over 32 measures. However, the model system of capital allocation was assessed as able to deliver capital that is equitable, appropriate, effective, quality, responsive, innovative and sustainable.

It is concluded that a diagnosis-based system of capital allocation is better designed to deliver more appropriate, sustainable and innovative acute healthcare facilities than the prevailing system.

The utility and process of microeconomic research has not often been applied to acute healthcare. The outstanding example of microeconomic costing and efficiency success is ABF using DRG-based funding.

This research has disputed the assumption that hospital capital is a static constant in acute care delivery. It also refutes the precept that a competitive rationed system of capital allocation provides an appropriate and efficient system of capital allocation for acute care.

Instead this thesis finds the changing nature of efficient acute care can be more effectively analysed in light of historic and theoretical economic frameworks. Schumpeter recognised ‘creative destruction’ as the method by which old techniques are replaced by investment in more effective production methods. The evolution of Australian hospitals and their funding methods was similarly seen as a sequence of changing techniques for clinical services (Ch.4, Appendix C) increased complexity of care and difficulties funding new technologies prompted changes in governance and funding. Community founded and funded hospitals were regulated (1920-1929) (Ch.4, Appendix E) and after WWII were funded by the states (Ch.5, Appendix E). Challenges funding technological change was the catalyst for, first, State and then the Commonwealth government to provide capital funding.

However, ‘creative destruction’ did not defund redundant capital which continue to be valued as the appropriate assets to deliver care. Capital separated from its function to support appropriate and efficient clinical care failed to link with the productive improvements and efficiency benefits of technological innovation identified in Economic Growth Theory (Solow 1956) Capital funding aiming to replace assets (Deeble 2002) failed to incubate innovation in Australian healthcare.

Analysis of Continuous Elasticity of Substitution of technology, in healthcare has been touched on by this research by examining new models of care and technological applications resulting in lower recurrent and capital costs. Continuous Elasticity of Substitution (Solow 1956, 2005; De la Grandville 2016) has not seriously been explored in healthcare in Australia as yet. Examination of the concepts of ‘creative destruction’ are also timely as equipment and technology have greater importance in acute care delivery (Schumpeter 1942; Aghion 2016). The model approach set within, and objectively supporting, Australian healthcare standards would provide an appropriate and transparent transactional framework for disinvestment of redundant technologies and adoption of innovation.

The prevailing process for capital allocation limits, constrains and prevents the system-wide adoption of innovation. Restrained capital funding for innovation, in a highly innovative sector, has worked against continuous and wide-spread progress with benefits equally distributed to patients and hospitals. The single hospital project approach to capital funding ensures technological moments in time are captured for each hospital depending on their most recent project. Old technology however is not as clinically valuable as more recent technologies. With limited funding less politically attractive or competitively successful hospitals and clinical services (e.g. mental health, rural hospitals, opposition

safe seats) can miss funding over decades, consigning them to technological and therefore clinical irrelevance. A normative, consistent, Pareto-optimal approach to capital as proposed by the model developed in this thesis would defund redundant technologies and facilities enabling transformative innovation.

Evidence-based clinical change is identifying new models of care with improved benefits for patients and the health system. The winner / loser approach to capital funding embeds the prevailing model of care in the design and functioning of hospitals. Like a boom-bust cycle in corporations this approach is likely to be antithetical to continuous improvement and adaption to new models of care. Some economic research suggests that capital restriction, as in a recession, has negative effects on productivity over several years (Piketty 2014; Caballero 2005)) The timeframe for renewal of equipment and facilities has changed. It is time for the method of funding capital to also change to align with and harness the productive benefits of innovation.

As this research has discussed significant variation in quality of service are not consistent with Australian standards and ABF funds to contemporary standards for clinical care. However, the prevailing system of capital allocation does not fund patient access to efficient and appropriate acute care in most hospitals.

10.12.1 The requirements of the future

The hospital of the future will be expected to effectively deliver high quality care to Australians. The hospital bed has been superseded as the foundation of clinical service delivery and will be only a part of the range of technologies and facilities required to deliver clinically appropriate care in the future. Technology is increasingly important to delivering appropriate acute care. Clinical advances including Genomics and Personalised Medicine will require clinical access to a wider range of technological supports, ICT and data platforms and storage systems. The prevailing capital allocation system has demonstrated it is not able to comprehensively deliver access to 20th century technologies and has been found to have no mechanisms for delivering evidence-based innovation across Australia (Ch.9.7.1). State and national reviews have called for funding changes to support access for Australian patients(Kerr, Hendrie and Moorin 2014).

Clinical care in a range of areas, particularly chronic disease management, relies on connectedness and effective communications. Australia has fragmented, unstandardized and unconnected ICT in public hospitals(CSIRO 2018)page 34). ICT investment in

Australian public hospitals is largely unreported and specifically excluded from the National Digital Health Strategy(Australian Digital Health Agency 2018). The lack of systematic investment in ICT results in poor rates of connectedness by national and international standards (Australian Bureau of Statistics 2018; Minion 2017; Productivity Commission 2017b)impeding effective communication and connectedness between clinicians. Effective communication technologies are expected in acute clinical care.

Similarly, reliable access to diagnostic and treatment tools, exemplified by MME, are necessary for efficient patient care. National data on MME is below international standards with reviews identifying poor access, planning, maintenance and replacement issues and clinical concerns(Australia Senate Community Affairs and References Committee 2018)(Chapter 5.5)(Table 6.8)(Victorian Auditor-General 2015; WA Auditor General 2017; Queensland Audit Office 2017; Audit Office of NSW 2017).A transparent system consistently delivering appropriate technologies for equitable access to quality clinical care is necessary for efficient future acute care.

The model to fund capital for acute care outlined in this thesis can deliver sustainable funding for medical equipment, ICT and the facilities required to house them aligned with ABF to provide comprehensive evidence-based funding for clinical services. Accurate transparent costing of capital for clinical services can also facilitate cost savings through enhanced efficiency at the DRG level and more effective capital management.

It is an appropriate time to invest in diagnosis-based capital allocation as the technological developments of acute care compel investment to deliver universal access to efficient quality care for patients. The existing system has not funded patients access to efficient hospitals at the standards expected by Australian governments. Advancing technological thresholds uniformly across the Australian hospitals is not a characteristic of the system, except when the Commonwealth has contributed to the capital cost of public hospitals(NHHRC 2009). Commonwealth-state sharing of capital costs for patients can, as it has in the past, advance the fairness of access to contemporary standards of care in Australian hospitals and facilitate an equitable future.

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APPENDICES

Appendix A Glossary

ABF	Activity-based funding for acute care services based on the services performed and the type of case treated.
ABFU	Activity Based Funding Unit
Access	The Australian Oxford Dictionary defines access as “ a right or opportunity to reach or use or visit; admittance. “(Moore 1996) Access is a mechanism used to describe the right or opportunity to health, to acute health services when the requirement arises(Bowen 2000) and in this thesis to the right or opportunity of hospitals to access capital. Equitable access to health services can be defined as “ <i>provision of health services in a way that provides an equal opportunity for all citizens to achieve maximum health .</i> ” (Bowen 2000)(See also Equity)
ACCD	Australian Consortium for Classification and Development comprises the National Centre for Classification in Health at Sydney University with the University of Western Sydney and KPMG to provide technical advice on DRG classification to the IHPA.
ACHS	The Australian Council on Healthcare Standards is Australia's leading health care assessment and hospital accreditation provider. It is an independent, not-for-profit organisation dedicated to improving quality in health care. The Council represents governments, consumers and peak health bodies from throughout Australia and has accredited Australian hospitals for 40 years. It is closely associated with the ACHSM.
ACHSM	Australasian College of Health Service Management is the professional association for health service managers.
ACT	The Australian Capital Territory
Activity Based Costing (ABC)	A management accounting tool which identifies costs associated with specified activity within a strategic cost management framework. (Young D W and Pearlman L K 1993)
Activity Based Funding	A method of funding for hospitals in which hospitals are paid for each episode of care they provide. The amount (price) paid for each episode of care is calculated in advance so that the risk of managing costs is born by the hospital. (Productivity Commission 2009b)
Acute	Having a short and relatively severe course. (AIHW)
Acute hospitals	Public and private hospitals which provide services mainly to admitted patients with acute or temporary ailments. The average length of stay is relatively short.(AIHW)

ACSQH	Australian Commission on Safety and Quality in Healthcare
Admission	Admission to hospital. In this report, the number of separations has been taken as the number of admissions, hence an admission rate is the same as a separation rate. (AIHW)
Administrative expenditure	All expenditure incurred by establishments (but not central administrations) of a management expense/administrative support nature, such as any rates and taxes, printing, telephone, stationery and insurance expenses (including workers compensation).
ADMISSION	The admission process has two main components - the 'administrative' process and the "clinical (medical /nursing / allied health) admission / assessment process' and may occur in a number of locations.
Admitted Patient cost proportion	The ratio of admitted patient costs to total hospital costs, also known as the inpatient fraction or IFRAC.
Adverse event	An incident in which harm resulted to a person receiving health care.
AHFG	Australasian Health Facility Guidelines . The AHFG or AusHFGs are an initiative of the Australasian Health Infrastructure Alliance (AHIA). AHIA membership is comprised of representatives from government health infrastructure planning and delivery entities in all jurisdictions in Australia and New Zealand.
AHIA	The Australasian Health Infrastructure Alliance (AHIA) is composed of senior health infrastructure officials from across Australian and New Zealand. It is a sub-committee of AHMAC which reports to health ministers and to COAG.
AHMAC	Australian Health Ministers Advisory Council
AIHW	The Australian Institute of Health and Welfare, Canberra. Australia's premier source of information on health and the operation of the health sector. A Commonwealth Government funded instrumentality responsible to the Australian Minister for Health and Ageing.
Allocative Efficiency	<p>This refers to "the optimal choice of input proportions, given their respective prices. If interventions are regarded as inputs, then this translates into choosing them according to their cost effectiveness"(Evans 2000). Technical or productive efficiency and allocative efficiencies put together provide the concept of <i>economic efficiency</i>.</p> <p>In this thesis allocative efficiency for capital aims to identify the value of capital, and the optimal process for capital distribution, required to achieve the outputs defined for acute care with the minimum waste (Ch.2.8.3).</p>

Allocative Statistics	Allocation statistics are relativities used to distribute overhead costs to the appropriate direct cost centres for costing patient services by DRG. (Australian Department of Health and Ageing 2010)
ALOS	Average Length of Stay by a patient in a public hospital. The figure is calculated by dividing total bed days by total separations for all patients or specified groups of patients. ALOS usually applies to a specified period of time.
AMA	Australian Medical Association
Amenities for Patients and visitors	<p>Amenities may include waiting areas, gardens, toilets, baby change and baby feeding facilities, kiosks, quiet rooms etc. They may extend to provision of sleeping accommodation in Palliative Care or Paediatric Units, or on-site accommodation for relatives, patients from remote locations or from poor socio-economic circumstances.</p> <p>The provision of accessible toilets for people with disabilities as a ratio of all toilets will be determined in accordance with the acuity and dependency levels of patients and the needs of visitors, and planners should refer to the Australian and New Zealand Building Codes.</p>
Amenities for staff	Occupational Health and Safety Acts and Regulations require employers to provide for the welfare of employees and to consult with employees when providing facilities for their welfare. Building code of Australia requirements are the minimum standard for provision of staff amenities. Staff Lounges and/or Cafeterias may be provided depending on the size, function and location of individual units and/or the Facility. There may be central amenities in addition to unit-based amenities. Infection control requirements may also determine the need for amenities such as showers and change rooms.
APC	Ambulatory Payment Classification
Appropriate Care	<p>Collins Dictionary appropriate is defined as “right or suitable; fitting” page 57(Collins 1989) Care is defined as “ to provide for the physical needs , help or comfort of” page 193 (Collins 1989).</p> <p>So, appropriate care is to provide for the physical needs, help and comfort (of patients) in a manner that is right or suitable and fitting. Chapter 1 details the guidelines and standards Australian governments use to define appropriate care for patients.</p>
AR-DRG	Australian refined Diagnosis Related Groups (IHPA 2019b).
Area Schedule	Area schedules list all departments (sub-departments) in a building, or set of buildings, and the physical areas they require plus internal circulation or corridor space.(Victorian Department of Health 2010b)

Assessment area	An area where initial clinical assessments are performed on patients and are different to inpatient medical assessment units following the AHFG. For obstetrics the Assessment area totals 162m ² . <ul style="list-style-type: none"> • 1 Bed Room, 12m² • Ensuite - Standard, 5m² • Interview Room • Lounge - Patient / Family, 10m² • Staff Station, 10m² • Clean Utility / Medication Room, 12m² • Dirty Utility, 10m² • Store - Equipment
ATSI	Aboriginal and Torres Strait Islanders, or services for this population.
Australian Refined Diagnosis Related Groups (AR-DRGs)	An Australian system of diagnosis related groups (DRGs). DRGs provide a clinically meaningful way of relating the number and type of patients treated in a hospital (that is, its casemix) to the resources required by the hospital. Each AR-DRG represents a class of patients with similar clinical conditions requiring similar hospital services.(AIHW)
Average length of stay	The average number of patient days for admitted patient episodes. Patients admitted and separated on the same day are allocated a length of stay of 1 day.
Bariatric Patients	Patients exceeding a BMI of 30 or more. Obese obstetric patients require additional staff, time in labour, and space. Larger beds, lifts, operating theatre tables are required for bariatric patients.
Benchmark	A standard or point of reference for measuring quality or performance.
Benchmarking	A continuous process of measuring quality or performance against the highest standards.
Billion	In this thesis one billion is one thousand million(Berejiklian 2016)
Capital	This definition is used for the purposes of this study. It is of Real Capital and excludes the value of land. "A stock of goods used in the production of goods or services which have themselves been produced."(Deeble J 1995) Capital is the stock of productive assets.(Saltman 1997)

Capital Cost per weighted separation	“‘Capital cost per separation’ is calculated as capital, labour and material costs divided by the number of weighted separations. Capital costs include depreciation and the user cost of capital for buildings and equipment. This measure allows the full cost of hospital services to be considered. Depreciation is defined as the cost of consuming an asset’s services. It is measured by the reduction in value of an asset over the financial year. The user cost of capital is the opportunity cost of the capital invested in an asset, and is equivalent to the return foregone from not using the funds to deliver other services or to retire debt. Interest payments represent a user cost of capital, so are deducted from capital costs to avoid double counting. “(SCRGSP 2017) This is the measure used by the Productivity Commission.
Capital charging	A charge on health service providers for the estimated cost of the capital used each year based on the value of assets.
Capital consumption	The amount of fixed capital used up each year—otherwise known as depreciation
Capital expenditure	Expenditure on large-scale fixed assets (for example, new buildings and equipment with a useful life extending over a number of years).(AIHW Glossary 2011) Capital: (also see definitions)
Care type	The care type defines the overall nature of a clinical service provided to an admitted patient during an episode of care (admitted care), or the type of service provided by the hospital for boarders or posthumous organ procurement (other care). <ul style="list-style-type: none"> • Acute care • Rehabilitation care • Palliative care • Geriatric evaluation and management • Psychogeriatric care • Maintenance care • Newborn care • Other care • Other admitted patient care – this is where the principal clinical intent does not meet the criteria for any of the above.
Casemix	A consistent method of classifying types of patients, their treatment and associated costs.
CCs	Co-morbidities and Complications

CHEERS	The Consolidated Health Economic Evaluation Reporting Standards for health economic evaluations were developed by the Good Research Practices Task Force established by the International Society for Pharmacoeconomics and Outcomes Research (ISPOR). The Task Force comprised specialists in the economic evaluation of health care programmes and the editors of journals publishing cost-effectiveness studies of health care interventions.(Antioch 2017)
Circulation	For this study circulation refers to the corridors within a department. Corridor widths must be sized to allow for the safe movement and passing of trolleys, beds, wheelchairs and other mobile equipment. The discounted circulation is calculated for different areas based on their function. For most areas discounted circulation is 32%-35% for operating theatres circulation is 40%.(AHFG) (Australasian Health Infrastructure Alliance 2016c, 2016e)
Clinical or Care Pathways	<p>Care pathways or clinical pathways describe optimal packages for particular syndromes and, describe the patients' optimal journey through a hospital based on the patients diagnosis. Ideally, encapsulate measurable inputs and outcomes.(Rechel 2010a)</p> <p>See De Bleser L, Depreitere R, DeWaele W, Vanhaecht K, Vlayen J, Sermeus W. Defining pathways. <i>J Nurs Manag</i> 2006; 14: 553-63 doi: 10.1111/j.1365-2934.2006.00702.x pmid: 17004966.</p> <p>“Clinical pathways translate the best available evidence to local practice workflows, reflecting patients’ co-progression of disease with treatments and related interventions in a given clinical setting. They aim to reduce variations in treatments and support clinical decision making when faced with multiple or ambiguous care options, thus improving care quality and controlling costs.” (Padman 2016)</p>
Clinical Care Standards (Australian)	“Clinical care standards are developed using a process designed to optimise the uptake and reach of the care they describe. First, each topic requires the agreement of representatives of state and territory health departments. Second, before public consultation, the draft standard is considered by representatives from private and public health sectors. Third, each draft is released for broad public consultation, with feedback sought from all levels of the health system as well as from key organisations. Finally, before it is released, the standard is submitted to the Australian Health Ministers Advisory Council and then to Australian Health Ministers.

This highly collaborative and consultative method of development not only assists in ensuring the relevance of the standard to the health care system but builds engagement of both clinical and policy decision makers at multiple levels within the system. In prompting review of existing initiatives, the standard acts as a focus for integrated whole-of-system efforts to improve the quality of care.” (Chew 2016)

Clinical Care Standards are patient-centred describing the standard of care a patient can expect without bias for age, gender, income or geographic area. Secondary prevention strategies and clinical care outside hospitals are included in the Standards. (Chew 2016)

Clinical Guidelines A clinical guideline is a set of recommendations based on systematic identification and synthesis of the best available scientific evidence to make clear recommendations for the care, health professionals provide (NHMRC 2011; NSW Agency for Clinical Innovation 2014)

Clinical Pathway The term 'clinical pathway' in the health industry covers several 'processes':

- a. a specific 'clinical pathway' for a disease involving community based, hospital and institutional care. It is used in hospital during an episode of care (e.g. for AMI) and prescribes what must 'happen' on each day of stay;
- b. to describe several decision making algorithms - sometimes called 'protocols' -in the UK.
- c. the 'patient journey' in hospitals and beyond which can involve several protocols (with decision nodes) etc. It may also include hospital specific clinical pathways of the type described in (a) above.

In Australia clinical pathways can cover all these meanings and are used in coordinating care for patients, describe processes and expectations for involved health professionals while minimizing clinical practice variation and risk.(Allen 2008; Padman 2016; Müller et al. 2009; Guerrero 2009)

Clinical Service Redesign A methodology used internationally to improve the timeliness, quality and safety of patient care.

Clinical support	<p>Departmental areas for clinical work in outpatients, on wards, operating theatres, imaging and procedural areas are detailed in the AHFG. For obstetrics and orthopaedics operating room Clinical Support includes:</p> <ul style="list-style-type: none"> • Control Centre • Bay - Flash Sterilizing • Bay - Blanket / Fluid Warmer • Bay - Linen • Bay - Mobile Equipment, • Store - Non-sterile / Deboxing • Store- Sterile Stock, • Store - Equipment • Store - Equipment • Store - Loan Equipment • Anaesthetic Workroom & Biomedical Equipment • Anaesthetic Store • Perfusion Room - Set-up • Store - Perfusion • Audiovisual Workroom • Cleaner's Room, • Disposal Room • Blood Store • Bay - Pathology • Medication Room • Office - Write-up, • Office - Single Person, • Toilet - Staff
Clinician	<p>A healthcare provider, trained as a health professional. Clinicians include registered and non-registered practitioners, or a team of health professionals providing health care who spend the majority of their time providing direct clinical care</p>
CMS	<p>Centers for Medicare and Medicaid Services (United States)</p>
CT	<p>Computed tomography (CT)—a diagnostic medical imaging machine used to create detailed images of internal organs, bones, soft tissue, and blood vessels.(Queensland Audit Office 2017)</p>
COAG	<p>The Council of Australian Governments is the peak intergovernmental forum in Australia. COAG comprises the Prime Minister, State Premiers, Territory Chief Ministers and the President of the Australian Local Government Association.</p>
CTCA	<p>Computed tomography coronary angiography</p>

Communications	<p>Within a hospital communications covers:</p> <ul style="list-style-type: none"> • emergency call; • patient nurse call; • staff assistance call; • building services and equipment monitoring; • communications cabling systems; • data communications; • duress alarm systems (refer to Security section]; • emergency warning and intercom systems (EWIS); • intercom systems; • MATV signal distribution system; • microwave systems; • pocket paging and Bring your own Device (BYOD) support systems; • public address; • radio; • radio frequency screening; • voice communications; and • video systems. (Australasian Health Infrastructure Alliance 2016b)
Cost of capital	<p>The cost of capital consumed in the treatment and care of one patient. The Productivity Commission defines the Cost of Capital as the return foregone on the next best investment, estimated at a rate of 8 per cent of the depreciated replacement value of buildings, equipment and land. Also called the ‘opportunity cost’ of capital.(SCRGSP 2017)</p>
Cost weight	<p>The costliness of an AR-DRG relative to all other AR-DRGs such that the average cost weight for all separations is 1.00. A separation for an AR-DRG with a cost weight of 5.0, therefore, on average costs 10 times as much as a separation with a cost weight of 0.5. There are separate cost weights for AR-DRGs in the public and private sectors, reflecting the differences in the range of costs in the different sectors. In this report, average cost weights using public cost weights are based on AR-DRG version 5.2 2008–09 public sector estimated cost weights (DoHA 2010). These were applied by AIHW to AR-DRG version 5.1/5.2 DRGs for 2004–05 to 2009–10 reference years.</p>
Cost-effectiveness	<p>Minimising the cost of production for a given outcome. Comparing options for the same outcomes cost-effectiveness is achieved where costs are lower than the alternatives.</p>
CPOE	<p>Computerised Physician Order Entry is a process of electronic entry of physician instructions for the treatment of hospital patients.</p>

Council of Australian Governments (COAG)	COAG is the peak intergovernmental forum in Australia, comprising the Prime Minister, State Premiers, Territory Chief Ministers and the President of the Australian Local Government Association (ALGA). More information can be found at http://www.coag.gov.au
CPG	Clinical Practice Guideline
CSSD	Central Sterile Supply Department responsible for sterilizing , holding and distributing sterile instruments in the hospital.
DALE	Disability adjusted life expectancies derived from Mathers C, Sadana R, Salomon J. et al. Estimates of DALE for 191 countries: methods and results. Geneva, Switzerland. World Health Organization, 2000 (Global Programme on Evidence for Health Policy Discussion Paper No.16)
Data Envelope Analysis (DEA)	DEA is an economic technique for evaluating a set of similar entities or Decision Making Units to convert multiple inputs into outputs.(Cooper, Seiford and Zhu 2004) DEA is a tool can identify the best use of resources amongst a range of similar organizations.(Steering Committee for the Review of Commonwealth/State Service Provision 1997) In health multiple inputs such as expenditure, number of doctors, population, beds can be related to multiple population outcomes including life span, disability adjusted life years.(Evans 2000) This makes comparisons of indicators across multiple countries feasible.
Depreciation	Depreciation is the subtraction of value of an asset reflecting the decrease in value the asset experiences over time.(Saltman 1997) The Productivity commission defined depreciation in relation to public hospitals as “Depreciation is the reduction in an assets value due to usage and obsolescence. “(Productivity Commission 2009e)
Depreciated Replacement Value	The value of an asset determined by its Total Replacement Value less accumulated depreciation from the date of purchase to the current time.
Deprival Value	Equivalent to Depreciated Replacement Value for hospital assets.
Diagnosis area	Areas for diagnostic testing including medical testing, pathology and imaging.
Diagnosis related group (DRG)	A widely used casemix classification system used to classify admissions into groups with similar clinical conditions (related diagnoses) and similar resource usage. This allows the activity and performance of hospitals to be compared on a common basis. In Australian acute hospitals, Australian Refined DRGs are used.(NHHRC)
DOSA	Day of surgery area

Efficiency	<p>Efficiency is composed of Allocative efficiency, Productive efficiency and Dynamic efficiency.</p> <p>Allocative Efficiency</p> <p>Allocative efficiency seeks the optimal distribution of assets to achieve the greatest community wellbeing or outcomes for that use of the money(Productivity Commission 2009e). One of the key objectives of allocative efficiency is priority setting for the distribution of resources between elements of the health system. In the case of hospitals the priority setting is between disease groups (cardiology versus orthopaedics versus mental health) and between preventative, diagnostic and curative services but also for this study, between hospitals.(Duckett 2008a)</p> <p>Productive Efficiency</p> <p>Productive efficiency is achieved when desired outputs are maximised within the resources available, where any additional outputs require more resources.(Hurley 2009)</p> <p>Dynamic Efficiency</p> <p>Dynamic efficiency examines how well systems for the distribution of capital respond to emerging risks for public hospitals including sustainability and increased acuity. (Duckett 2008a).</p>
Effective	<p>The Productivity Commission identifies effectiveness for hospitals in terms of equity of access, appropriateness and quality. (SCRGSP 2017)Figure 12.4) An effective capital allocation system for hospitals would provide equity of access, be appropriate and would fund quality services.</p>
Elective care	<p>Care that, in the opinion of the treating clinician, is necessary and for which admission can be delayed for at least 24 hours</p>
Elective surgery	<p>Elective care in which the procedures required by patients are listed in the surgical operations section of the Medicare Benefits Schedule, with the exclusion of specific procedures frequently done by non-surgical clinicians and some procedures for which the associated waiting time is strongly influenced by factors other than the supply of services.</p>
EMR	<p>Electronic Medical Record</p>

Engineering (in a hospital)	<p>Engineering services cover all electrical, fire, heating, ventilation, air-conditioning, hydrolytic, ICT, lighting, medical gasses, security, alarm, communications, acoustic, pneumatic tube, steam sterilisation, building management and control, vertical transportation, automatic guided vehicle systems and radiation shielding services within a hospital. These are outlined in the AHFG Engineering Services Guidelines. (Australasian Health Infrastructure Alliance 2016b) Each service is required to be provided to meet acceptable standards for:</p> <ul style="list-style-type: none"> • Functional Integration • Security, Vandalism and Robustness • Infection Control and Cleaning • Disaster and Emergency Management • Sustainability, Life-Cycle and Waste Management • Maintenance and Logistical Support • Emerging Technologies and • Certification and Compliance
Enhanced Service Related Group (ESRG)	<p>A grouping of diagnosis groups with common resource uses particularly in relation to medical specialties.</p>
Entry	<p>The common entrance to the hospital and/or clinical unit entrance. Includes reception area and waiting area. For obstetrics and orthopaedics the Entry is 72.6 m² comprising:</p> <ul style="list-style-type: none"> • Reception / Clerical, • Waiting, • Interview Room • Bay - Vending Machine • Bay - Water Dispenser • Toilet - Public, • Toilet - Accessible,
Environmental sustainability	<p>Environmental sustainability seeks to improve human welfare by protecting the sources of raw materials used for human needs and ensuring that the sinks for human wastes are not exceeded, in order to prevent harm to humans “(Goodland 1995)</p>
Equity	<p>The Oxford Dictionary defines equity simply as fairness.(Moore 1996) Health equity as Bowen describes three elements of equity, sometimes referred to as the equity triangle, involves access to health services, that are affordable and acceptable.(Bowen 2000) She defines equitable access for health services as the “<i>provision of health services in a way that provides an equal opportunity for all citizens to achieve maximum health</i>”. (Bowen 2000)</p>

Equity	Equity is access to care at the right place at the right time irrespective of physical location(COAG 2018; SCRGSP (Steering Committee for the Review of Government Service Provision) 2018) Access for indigenous people to hospitals is important in considering equity. (SCRGSP (Steering Committee for the Review of Government Service Provision) 2018). Access for patients from rural and remote areas and lower socio-economic bands is an identified measure of equity. SCRGSP (Steering Committee for the Review of Government Service Provision) 2018) Access to health services for people from lower socio-economic ranking are part of equitable access. (Hall 2004)
ESSU	Emergency Department short stay unit used for observation of patients who present at the emergency Department who may or may not require admission to hospital beds. Generally a 23 hour maximum stay.
ETG	Episodic Treatment Group
Evidence based Design	“A movement that looks at to rigorous evidence such as that obtained from controlled experimentation, to improve outcomes for both patients and healthcare providers. “(Ballard G & Rybkowski Z 2007)
Ex Ante	Ex ante predictions reference expectations of an event, activity or value prior to that event happening. Using ex ante predictions permits uncertainty to be recognised. Ex ante and ex post are used to identify the differences in value between an expected outcome or value and the result when the event happened. From the Latin ‘from (what might lie) ahead’.
Ex Post	This term is similar to actual returns and is Latin for ‘after the fact’. It is used in conjunction with Ex Poste to analyse the differences between an expected value or return and the predicted value or return.
Facility	A complex of buildings, structures, roads and associated equipment, such as a Hospital or Health Facility represents a single management unit for financial, operational maintenance or other purposes.(Australasian Health Infrastructure Alliance 2016b)
FFS	Fee for service
Fittings	Hospital items attached to walls, floors or ceilings that do not require service connections such as curtain and IV tracks, hooks, mirrors, blinds, joinery, pin boards etc. (Australasian Health Infrastructure Alliance 2016b)
Fixtures	“Items that require service connection (e.g. electrical, hydraulic, mechanical) that include, but are not limited to hand basins, light fittings, medical service panels etc. but exclude fixed items of serviced equipment”.(Australasian Health Infrastructure Alliance 2016b)

Fixed Equipment	Items that are permanently fixed to the building or permanently connected to a service distribution system that is designed and installed for the specific use of the equipment e.g. theatre pendants.(Australasian Health Infrastructure Alliance 2016b)
Food Services	“The Food Services Unit provides meals, snacks and beverages for inpatients, day-only patients, occasionally for relatives, and for staff. cook chill - This system is based on cooking food until thermal kill is achieved followed by rapid controlled chilling that reduces the food temperature to below -3°C within a specified time. Storage at this temperature extends the shelf life of the product for between 5 and 45 day depending on the system used. Meals are plated cold and trayed in rethermalisation carts that are divided vertically in two sections. The carts are then connected to terminals and both sections are refrigerated. Prior to serving, the terminals are activated and the hot part of the trays will be rethermalised while the cold products remain chilled.”(page 27 (Australasian Health Infrastructure Alliance 2016e)
Green Star	An Australian system for rating buildings for environmentally sustainable outcomes, including energy use and carbon footprint of the building and its materials. The equivalent in the USA is LEED. All new Australian facilities will target a Green Star Health Care 4 star equivalency rating, this has been and will continue to be considered as aspirational within the context of project location, scope and budgetary allowances. (Australasian Health Infrastructure Alliance 2016b)
Gross Capital Stock	Gross Capital stock is the accumulated value of the past GFCE less any retirements.(AIHW)
GDA	Gross Departmental Area (GDA) refers to the sum of the floor area of a hospital department or departments. To this total figure is added the area for plant and the travel or circulation areas for corridors between departments.
GDP	Gross Domestic Product
Gross Fixed Capital Expenditure (GFCE)	The value of capital assets with a life of more than one year that are used in the production process. (AIHW)
GFA	Gross Floor area is the sum of departmental areas within a facility including discounted circulation for corridors within the department. To GFA estimates for plant and travel (the corridors that link departments and public spaces) are added to obtain total facility area for construction.
GHM	Groupes Homogenes des Malades (French DRG classification system)

Guidelines	Clinical practice guidelines are ‘systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific circumstances’.(Australian Commission on Safety and Quality in Health Care 2012)
Haemodialysis	<p>A treatment for renal failure where the function of the kidneys to remove substances from the blood is replaced by a machine. Treatment requires the patient to be attached to the machine for three to six hours per day three days a week. This process may be undertaken in a purpose-built centre or using a machine installed in a patient’s home.(Australasian Health Infrastructure Alliance 2016a)</p> <p>On-line Haemodiafiltration (HDF) is the combination of haemodialysis and haemofiltration which combines the advantages of high diffusive elimination of small ureamic toxins with high convective removal of large ureamic toxins, such as beta 2 microglobulin.(Australasian Health Infrastructure Alliance 2016a)</p> <p>Satellite haemodialysis units may be located on a hospital site, a community health centre or other standalone location. Patients are typically medically stable. Others may access satellite services as they lack a dialysis partner or suitable accommodation at home. Selected satellite services will also training for home dialysis, both haemodialysis and peritoneal dialysis.(Australasian Health Infrastructure Alliance 2016a)</p> <p>In-centre haemodialysis units will be collocated in a hospital with other acute services and provide haemodialysis treatment for acute nephrological emergencies, those with significant acute medical or surgical illness not always directly related to and other hospital inpatients. A high level of medical support is needed as patients are typically medically unstable.(Australasian Health Infrastructure Alliance 2016a)</p> <p>Peritoneal dialysis involves the exchange of fluid to and from the abdomen on several occasions each day either manually (Continuous Ambulatory Peritoneal Dialysis) or overnight with the assistance of a machine (Automated Peritoneal Dialysis). Peritoneal dialysis is performed at home but training in technique and problem solving may occur at a Renal Dialysis Unit. (Australasian Health Infrastructure Alliance 2016a)</p>
Health Planning Unit	Acute health facilities are composed of a series of functional units known as Health Planning Units (HPU). They are used for the” planning and design of a unit that will be fit for purpose in accordance with its designated service delineation / capability and defined catchment population.” (Australasian Health Infrastructure Alliance 2016b)

Hospital	<p>A health-care facility established under Commonwealth, state or territory legislation as a hospital or a free-standing day procedure unit and authorised to provide treatment and/or care to patients.</p> <p>The OECD defines a hospital as “a single separate organisational entity that provides admitted patient care. Some hospitals will have more than one campus, while some hospital campuses will have more than one hospital. The organisation of care in some countries results in the aggregation of single hospital entities into trusts, groups, chains, or networks.”(Lorenzoni 2017)</p>
Hospital Admission	<p>“<i>Hospital admission</i> is defined as the period of hospital care from the date of formal admission to a hospital to the date of formal discharge from the same hospital.”(Lorenzoni 2017)</p>
Hospital-in-the-home care	<p>Provision of care to hospital admitted patients in their place of residence as a substitute for hospital accommodation. Place of residence may be permanent or temporary</p>
HRG	<p>Healthcare Resource Groups (England)</p>
ICER	<p>An incremental cost-effectiveness ratio is used to compare options. For example identifying a threshold QALY value (or ‘cost per QALY’) for accepting or rejecting possible new interventions by comparison with each intervention’s ICER.(Birch 2015a)</p>
IHPA	<p>The Independent Health Pricing Authority is an independent government agency established by the Commonwealth as part of the <i>National Health Reform Act 2011</i>. The IHPA sets the annual Efficient Price for hospital services and is responsible for data, classification, costing and pricing hospital services in Australia.</p>
IIP	<p>The Integrated Interventional Platform (IIP) is where surgery, interventional radiology and interventional cardiology are co-located as a single operational and physical entity within the surgical suite. Typically these would include computed tomography angiography(CTA), magnetic resonance angiography MRA), nuclear medicine (NM) and ultrasound (US) in addition to advanced operating theatre imaging. Often there will be a technical control room attached for surgical IT specialists and surgical imaging technologists. (Rostenberg B 2009)</p>
In-centre Haemodialysis	<p>In-centre haemodialysis units will be collocated in a hospital with other acute services and provide haemodialysis treatment for acute nephrological emergencies, those with significant acute medical or surgical illness not always directly related to and other hospital inpatients. A high level of medical support is needed as patients are typically medically unstable.(Australasian Health Infrastructure Alliance 2016a)</p>

Indirect Residual Area (of a DRG)	<p>The area of a hospital required to support the care of a patient group (DRG) when:</p> <ul style="list-style-type: none"> • All the areas indirectly required are summed • Travel and Plant have been calculated from the Gross Floor Areas • Travel and plant have been added • The areas that will not be required by patients of that DRG have been subtracted. <p>The Indirect Residual Area is the basis for estimating the cost of capital indirectly required for patient care.</p>
Investment	<p>Investment is a flow of funds that involves additions to capital. (Saltman 1997)</p>
Inequality – health inequality	<p>WHO defines health inequalities as “differences in health status or in the distribution of health determinants between different population groups.”(WHO 2013)</p>
Innovation	<p>Innovation in this study is evidence –based improvements in clinical care included to improve patient outcomes, efficiency and costs.</p> <p>Clinical innovation- the introduction of evidence-based, effective new technology and innovations in the models of care that improve patient outcomes.(IHPA 2016a)</p> <p>Process Innovation substitutes for an already existing technique. (Cheah CW and Dossel D 1988)</p> <p>Product Innovation;An alternative way of performing a function.</p>
LDRP	<p>LDRP suite – Labour Delivery Recovery Postnatal suite for the birth of babies.</p> <p>Neonatal intensive Care Unit/Special Care Nursery for the treatment of babies who are unwell or ‘qualified babies’. That is babies recently delivered who are themselves patients.</p>
LEED	<p>The United States Green Building Council Leadership in Energy and Environmental Design (LEED) rating system, used for gauging the level of sustainability or ‘greenness’ in a building. http://www.usgbc.org.lead</p>
Lifespan	<p>Lifespan is defined as the projected viable use of the facility or equipment including major refurbishment and maintenance, so costs reflect both structure and fitout. Research on hospital lifespans identified a range of viable lifespans for layers of a hospital. Each have different degrees of functional specificity, construction and maintenance costs. They vary in the level of technology required in the building areas and the numbers of people who use the spaces.(Netherlands Board for Healthcare Institutions 2007b)</p>

Lifespans were identified as:

- Hospital structure as 40 years
- 50 years maximum for office and hotel services
- Clinical areas (hot floor and industrial areas) 20 years (Netherlands Board for Healthcare Institutions 2007b)page 31).

Maternity	“Maternity is the branch of health care which provides services for the management of pregnancy including pre-conception counselling and care; onset of labour and birth; the postnatal period and parenting; and immediate care of the newborn. It encompasses the total needs of the pregnant woman and her family, including the physical, educational and psycho-social requirements, irrespective of the care setting.”(Australasian Health Infrastructure Alliance 2016b) Maternity services include obstetrics services pertaining to the ante-natal, birth and immediate post-natal period.
MFF	Market Forces Factor (England)
MH-CASC	Mental Health Classification and Service Costs
MME (Major Medical Equipment)	Medical equipment costing \$50,000 or more. Most commonly this is imaging equipment in most hospitals. (WA Auditor General 2017; Audit Office of NSW 2017) Medical Equipment: Medical equipment refers to major medical equipment purchased from the capital budget. It does not include medical equipment that would normally be consumed within one patient episode or one year and would be funded from the recurrent or annual budget.
Microeconomics	the branch of economics concerned with particular commodities, firms or individuals and the economic relationships between them.(Hanks 1989)
Model of Care	How care is organised and delivered to the patient.(Queensland Maternity and Neonatal Clinical Guidelines Program 2012)
MCDA	Multi-Criteria Decision Analyses (MCDA) is a process that includes economic evaluation checklists, and other decision criteria (including Value measurement models, reference modeling and outranking methods) to enable health economists to impact on decision making in healthcare in alignment with clinical standards. “During the 1970s and 1980s there was debate in the economics and ethics literature about relevant criteria for making resource allocation decisions in health care. At that time the focus was on clinical and cost-effectiveness.

During the subsequent two decades, health technology assessment bodies emerged. There was growing recognition that other criteria are important, relating to equity, acceptability, burden and sustainability. More recently during the 2010s there has been growing interest in decision analytic methods for considering multiple criteria, driven primarily by NICE in the UK and shifts to Value-Based Pricing. MCDA is a methodology designed to help decision-makers when making complex choices—first developed in the 1960s and 1970s” (Antioch 2017)

MedPAC	Medicare Payments Advisory Commission (United States)
MEG	Medical Episode Grouping
MRI	Magnetic resonance imaging (MRI)—a diagnostic medical imaging machine used in radiology to create an image of parts of the anatomy. It can create detailed images of the organs and tissues within the body.(Queensland Audit Office 2017)
National health data dictionary (NHDD)	A publication that contains a core set of uniform definitions relating to the full range of health services and a range of population parameters.
National Safety and Quality Health Service Standards	Healthcare Standards established by the Australian Commission on Safety and Quality in Healthcare
NHCDC	National Hospital Cost Data Collection
NEP	National Efficient Price for hospital care
NHRA	National Health Reform Agreement
NHS	National Health Service in the UK
NSW	New South Wales
NT	The Northern Territory
NWAU	National Weighted Activity Unit used in conjunction with the National Efficient Price to determine DRG payments
Net Capital Stock (NKS)	The net Capital Stock is the Gross Capital Stock less the accumulated value of depreciation of those inputs being used in the productive process(i.e. those that have not been retired).
Occasion of service	Non-admitted patient occasion of service.
OECD	Organisation for Economic Cooperation and Development

On-line Haemodiafiltration (HDF)	HDF is the combination of haemodialysis and haemofiltration which combines the advantages of high diffusive elimination of small ureamic toxins with high convective removal of large ureamic toxins, such as beta 2 microglobulin.(Australasian Health Infrastructure Alliance 2016a)
Operating theatre – Opportunity Cost	The amount of other goods and services which could have been obtained instead of any good. If it had not been produced, the resources used in making it could have been used to produce other goods and services instead. If it had not been bought, the money spent on it could have been used to buy the other goods.
Outpatient Clinic	Facilities within or near a hospital for pre or post-acute review and treatment of patients. Collocating outpatient clinics in a single location, supported by a range of clinical support services such as pharmacy, pathology collection and medical diagnostic and treatment services
Outcome (Health Outcome)	A health-related change due to a preventive or clinical intervention or service. (The intervention may be single or multiple, and the outcome may relate to a person, group or population, or be partly or wholly due to the intervention.)
PAS	Patient administration system
Patient	A member of the public who is the subject of clinical services for the purpose of improving their condition.
Patient Accommodation	Commonly called wards these are areas for patients for 24 hours or multiday patients. For obstetrics a 30 bed ward for patient accommodation totals 1430m ² comprising: <ul style="list-style-type: none"> • 1 Bed Room -15m² • 1 Bed Room - Special, 18m² • Anteroom, negative pressure, • Ensuite - Standard, 5m² • Ensuite - Special, 6m² • Newborn Bathing / Examination / Treatment Room • General Nursery • Bay - Blanket / Fluid Warmer • Feeding Room • Interview room SW, MH • Staff room w kitchen • Meeting Room , • Formula Room • Office - Single Person, 9m² • Lounge - Patient / Family • Store - Files, 10m² • Clean Utility / Medication Room, 12m²

- Dirty Utility, 10m2
- Disposal Room, 8m2
- Bay - Mobile Equipment, 4m2
- Bay - Linen
- Bay - Blanket / Fluid Warmer
- Bay - Resuscitation Trolley
- Store – Drugs
- Store - Sterile Stock, 12m2
- Store - Equipment, 14m2
- Store – General, 9m2
- Bay – Wheelchair Park
- Bay – Beverage, Enclosed
- Cleaner's Room, 5m2
- Lounge / Beverage - Visitors
- Waiting,
- Toilet - Public, 3m2
- Meeting Room, 20m2
- Staff Station

Patient Care Area The National Construction Code of Australia defines this as 'a part of a healthcare building normally used for the treatment, care, accommodation, recreation, dining and holding of patients, including a ward and treatment area'.

Patient-centred Using the patient as the basic denominator for service delivery.

Patient centred care Clinical services focussed on the clinical needs of a patient or a grouping of patients with common requirements.

The experience (to the extent the informed, individual patient desires it) of transparency, individualization, recognition, respect, dignity, and choice in all matters, without exception, related to one's person, circumstances, and relationships in health care. (Berwick DM 2009)

PC The Productivity Commission(PC) is an independent economic research and advisory group reporting to the Commonwealth Treasurer. The Productivity Commission was created as an independent authority by an Act of Parliament in 1998, to replace the Industry Commission, Bureau of Industry Economics and the Economic Planning Advisory Commission. However its roots go deeper, to the establishment of the Industries Assistance Commission in 1974 (which itself replaced the Australian Tariff Board) and, later, the Industry Commission in 1989. <https://www.pc.gov.au>

The PC chairs and provides support for an annual report on government services by the inter-governmental Steering Committee for the Review of Government Service Provision (SCRGPS).

- Peritoneal dialysis** Involves the exchange of fluid to and from the abdomen on several occasions each day either manually (Continuous Ambulatory Peritoneal Dialysis) or overnight with the assistance of a machine (Automated Peritoneal Dialysis). Peritoneal dialysis is performed at home but training in technique and problem solving may occur at a Renal Dialysis Unit. (Australasian Health Infrastructure Alliance 2016a)
- Personalised Medicine** Personalised medicine is concerned with understanding the uniqueness of individuals, not just from assessing their DNA but their lifetime experiences, their behaviour, and their interactions with their environment, and diagnosing and treating patients by identifying causes and effects and treating the cause(Phillips 2019b).
- PET** Positron Emission Tomography (PET)—an imaging machine used to observe metabolic processes—and dual machines (PET/CT and PET/MRI) are medical imaging high value medical equipment(Queensland Audit Office 2017)
- PFI** Public Finance Initiative form of private public partnership funding for British infrastructure including hospitals
- Picture Archiving and Communications Systems (PACS)** A digital system for transmitting and storing medical imaging results.
- P4P** Pay for Performance
- PbR** Payment by Results (England)
- Plant** Calculations for the floor space required for the mechanical areas of a hospital allow 12.5% of Gross Floor Area for Plant. Plant involves the major equipment required for a hospital including air-conditioning, coolers, chillers, water supply, electrical supply and other major machinery and the areas required around them for access, maintenance and repairs.
- POE** Post-Occupancy Evaluations are formal reviews of hospital facilities and equipment conducted within the first year of operation of a new hospital. A methodology developed to support the systematic evaluation of health service buildings and facilities. Other methodologies may be used in some jurisdictions such as a building performance evaluation.(Australasian Health Infrastructure Alliance 2016b)

PPS	Prospective Payment System (United States)
Potentially preventable hospitalisation (selected)	Those conditions where hospitalisation is thought to be avoidable if timely and adequate nonhospital care is provided.
Pre-MDC (Pre-major diagnostic category)	Twelve AR-DRGs to which separations are grouped, regardless of their principal diagnoses, if they involve procedures that are particularly resource-intensive (transplants, tracheostomies or extracorporeal membrane oxygenation without cardiac surgery).
Principal diagnosis	The diagnosis established after study to be chiefly responsible for occasioning an episode of admitted patient care.
Private hospital	A privately owned and operated institution, catering for patients who are treated by a doctor of their own choice. Patients are charged fees for accommodation and other services provided by the hospital and relevant medical and paramedical practitioners. Acute care and psychiatric hospitals are included, as are private free-standing day hospital facilities.
Procedure Room	Room for performing procedures that do not require general anaesthesia but may include analgesia and/or conscious sedation (e.g. complex wound dressings, suturing, lumbar puncture)(NSW Health 2016c).
Productive Efficiency – Public hospital	A hospital controlled by a state or territory health authority. Public hospitals offer free diagnostic services, treatment, care and accommodation to all eligible patients.
Public patient	A patient admitted to a public hospital who has agreed to be treated by doctors of the hospital's choice and to accept shared ward accommodation. This means that the patient is not charged.
Recovery	Also called Post Anaesthesia Care Unit (PACU). The recovery area adjacent to operating theatres used for patients recovering from an anaesthetic. (Australian and New Zealand College of Anaesthetists 2012, 2006)
	Stage 1 Recovery accommodates:
	<ul style="list-style-type: none"> • unconscious patients who require constant observation and monitoring with, ideally one-to-one patient nurse ratio. Open planned bays will be provided that can be observed from a staff station(Australasian Health Infrastructure Alliance 2016d).
	Recovery stage 2 accommodates:
	<ul style="list-style-type: none"> • patients who have regained consciousness after anaesthesia but require further observation; and • patients who have undergone procedures with local anaesthetic who may 'bypass' recovery stage 1.

Depending on the size and complexity of the service, these spaces may also be used to hold patients prior to their procedure as the peaks in activity change across the day.

Bay will be arranged in an open-planned arrangement with direct access to Stage 1 and Stage 3 areas(Australasian Health Infrastructure Alliance 2016d).

The recovery Stage 3/ discharge lounge will accommodate comfortable chairs with adequate space between them for small tables. Centres which have a high volume of more rapid turnover patients with shorter first stage recovery (e.g. endoscopy, cystoscopy, ophthalmology, plastic surgery) may require larger discharge lounges with more chairs to avoid overcrowding.

Access is required to toilets, lockers and a beverage bay.

Access to a small interview room for confidential follow-up discussions and instructions. Depending on configuration, this room may be shared with holding(Australasian Health Infrastructure Alliance 2016d).

Recurrent expenditure

Expenditure on goods and services which are used up during the year; for example, salaries and wages expenditure and non-salary expenditure such as payments to visiting medical officers

Remoteness area

A classification of the remoteness of a location using the Australian Standard Geographical Classification Remoteness Structure, based on the Accessibility /Remoteness Index of Australia (ARIA) which measures the remoteness of a point based on the physical road distance to the nearest urban centre. The categories are:

- Major cities
- Inner regional
- Outer regional
- Remote
- Very remote
- Migratory

Repairs and maintenance expenditure

The costs incurred in maintaining, repairing, replacing and providing additional equipment, maintaining and renovating buildings and minor additional works.

Residual Area (of a DRG)

The area of a hospital required to support the care of a patient group (DRG) when:

- All the areas indirectly required are summed
- Travel and Plant have been calculated from the Gross Floor Areas
- Travel and plant have been added
- The areas that will not be required by patients of that DRG have been subtracted.

The Indirect Residual Area is the basis for estimating the cost of capital indirectly required for patient care.

Responsiveness (Health System Responsiveness)	<p>WHO defined responsiveness to be the “responsiveness of the health system to the legitimate expectations of the population. Responsiveness in this context explicitly refers to the non-health improving dimensions of the interactions of the populace with the health system, and reflects respect of persons and client orientation in the delivery of health services, among other factors.” (Tandon 2002)page 2) Responsiveness can be seen to be analogous to patient-centredness but to also systematically respond to dynamics related to the volume of patients requiring care.</p> <p>Responsiveness is how well the health system meets people’s legitimate expectations about how they should be treated, independently of any health outcomes .(<i>World Health Report 2000</i>).(Rechel 2010b)</p>
RFID	Radio Frequency Identification Device
RIS	Radiology information systems
Role Delineation	<p>Role delineation provides a framework that describes the minimum support services, workforce and other requirements for clinical services to be delivered safely(NSW Ministry of Health 2018). The functional scope of hospital services is defined as the requirements for clinical services to be delivered safely. Services connect and combine to provide a consistent level of service across a hospital. Role delineation across the service matrices helps to identify what level of each clinical specialty is available by site.(Health Department of WA 2010; NSW Health 2002) For example Level 4 Obstetric requires:</p> <ul style="list-style-type: none"> • “Level 4 Anaesthetic, operating suite, ICU, Nuclear Medicine, Radiology, Pathology and Pharmacy services • Scope as for Level 3. In addition, antenatal, intrapartum and postnatal care for women $\geq 34+0$ weeks gestation with no risk factors, or with risks identified as category A or B*, and some women with risks identified as category C* (in consultation with the specialist obstetrician or maternal foetal medicine specialist within the Tiered Maternity and Neonatal Network). • Service requirements As for Level 3. In addition, supported by Level 3 neonatal service. Should undertake intrapartum foetal blood sampling. Established links and support with surrounding Level 3 maternity services and Level 1 and 2 neonatal services, regarding consultation, referral and transfer. Established links and support with geographically appropriate Level 5 and 6 maternity services and Level 4, 5 and 6 neonatal services regarding consultation, referral and transfer.” (NSW Health 2016c)page108)
SA	South Australia

Safety	National standards affirm that all Australians are entitled to access safe, high quality health care.(Australian Commission on Safety and Quality in Health Care 2009)Safety also relates to clinician safety from assault in the workplace, particularly ED.(Australian Commission on Safety and Quality in Health Care 2012)
Salutogenic Design	The design of buildings to improve the health of the occupants or community or that focuses on the factors that keep us well, rather than those that make us unwell. (Dilani 2009)
Satellite haemodialysis units	These may be located on a hospital site, a community health centre or other standalone location. Patients are typically medically stable. Others may access satellite services as they lack a dialysis partner or suitable accommodation at home. Selected satellite services will also training for home dialysis, both haemodialysis and peritoneal dialysis.(Australasian Health Infrastructure Alliance 2016a)
SBPPCCCA	Sustainable, best-practice, patient centred, clinical care for Australians.
Separation	An episode of care for an admitted patient, which can be a total hospital stay (from admission to discharge, transfer or death), or a portion of a hospital stay beginning or ending in a change of type of care (for example, from acute to rehabilitation). Separation also means the process by which an admitted patient completes an episode of care either by being discharged, dying, transferring to another hospital or changing type of care.
Separations	The total number of episodes of care for admitted patients, which can be total hospital stays (from admission to discharge, transfer or death), or portions of hospital stays beginning or ending in a change of type of care (for example, from acute to rehabilitation) that cease during a reference period..
SFA	Stochastic Frontier Analysis characterises the minimum input bundle of resources required to produce various outputs, or the maximum output producible with various with various input bundles at a given level of technology(Kumbhakar 2000)
Specialised service	A facility or unit dedicated to the treatment or care of patients with particular conditions or characteristics, such as an intensive care unit.
Stage 1 Recovery	Stage 1 Recovery accommodates unconscious patients who require constant observation and monitoring with, ideally one-to-one patient nurse ratio. Open planned bays will be provided that can be observed from a staff station.(Australasian Health Infrastructure Alliance 2016d)
State	Australian states and territories. This abbreviation has been used throughout the document.

Sustainable	<p>Sustainable is from the Latin <i>sustineo</i> meaning to keep up and has meant “to support or to bear the weight of” and “to give strength to” and “to nourish”(Moore 1996) It has also developed meanings “to conserve an ecological balance by avoiding depletion of natural resources.”(Moore 1997) Sustainability has evolved in its meaning to be “capable of being sustained” or a method of harvesting or using a resource so that the resource is not depleted or permanently damaged” (Merriam-Webster 2018) The World Bank defined sustainability as “a requirement of our generation to manage the resource base such that the average quality of life that we ensure ourselves can potentially be shared by all future generations.”(Asheim 1994)</p> <p>Financial sustainability, Environmental sustainability</p>
Technologies used for acute care	<p>“ Health technologies include new medicines; diagnostics, devices, equipment and supplies; medical and surgical procedures; support systems; and organisational and managerial systems used in prevention, screening, diagnosis, treatment and rehabilitation. “ (IHPA 2019a)page 11)</p>
Telehealth	<p>Transmission of images and/or voice and/or data between two or more health units via telecommunication channels to provide clinical advice, consultation, education and training services. Telehealth has become an important means of networking but remains in a state of development as new uses and systems are implemented. A properly developed telehealth system within a network may enable a hospital to have a support service where there is equivalent functional access to that service and where patient care is not compromised by that service being off-site. See tooth fairy.(NSW Health 2016c)</p>
TENS	<p>Transcutaneous electrical nerve stimulation used for pain management particularly in obstetrics.</p>
Travel	<p>Area Schedules of hospitals include an area for travel of 15% of the total Gross Floor Area or sum of all the departmental and administrative space of a hospital. Travel represents the corridor spaces outside and between departments.</p>
Treatment Area	<p>The National Construction Code of Australia defines this as: 'an area within a patient care area such as an operating theatre and rooms used for recovery, minor procedures, resuscitation, intensive care and coronary care from which a patient may not be readily moved'.(Australasian Health Infrastructure Alliance 2016b)</p>
Total Replacement Value	<p>This is the current and full cost of replacing an asset. Can be used with Depreciated Replacement Value to give an approximation of asset condition.</p>

URG	Urgency Related Group
User Cost of Capital (UCC)	The opportunity cost of the capital used to deliver hospital services. That is the return that could be generated if the funds were employed in their next best use. ((Productivity Commission 2009b)
WA	Western Australia
WAU	Weighted Activity Unit
WEIS	Weighted inlier equivalent separations used in Victoria and elsewhere to allow for more resource intensive admissions
WOOS	Cost- Weighted outpatient occasions of service
Woman Centred Care	For obstetrics Queensland Health define Woman centred care as care” focused on the woman’s individual, unique needs, expectations and aspirations, rather than the needs of institutions or maternity service professionals. This type of care recognises the woman’s right to self determination in terms of choice, control and continuity of care.”(Queensland Maternity and Neonatal Clinical Guidelines Program 2012)

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Appendix B Questionnaire for Officials

Information for State, Territory and Commonwealth Government Officials

Capital Funding for Hospitals: Can diagnosis-related capital facilitate more appropriate, sustainable and innovative acute healthcare facilities?

We are collating information on the protocols for estimating and allocating funds for capital associated with acute healthcare facilities, medical equipment and information technology and communications systems. We are seeking your advice on the existing or proposed systems for allocating capital for acute health care for your health system. Most of this information will be in the public domain but there may be further information which may be required for making direct comparisons between jurisdictions, clarifying definitions or associated with new or emerging policies.

Research is also being conducted into the capital implications of sustainability and innovation in acute health facilities and on the capital required for a small range of diagnosis related groups.

Information collected during interviews for inclusion in the research will be provided to the informants for their correction prior to inclusion in any publications.

Information collected from the interview will be used only for informing the research and will be kept confidential and stored securely for 5 years after the publication of the research.

Further information on the research can be obtained from:

Rhonda Kerr

T: 0438 645982

E: rhonda.kerr@postgrad.curtin.edu.au

or

Delia Hendrie

E: D.V.Hendrie@curtin.edu.au

Any concerns on ethical grounds should be made the Secretary of the Human Research Ethics committee on (08) 9266 2748 or by email at hrec@curtin.edu.au or by mail to the Office of Research and Development, Curtin University of Technology, GPO Box U1987, PERTH WA 6845

This project has been reviewed by the Curtin University Human Research Ethics Committee and has received approval number SPH-39-2011

We appreciate your willingness to assist with our research and value your time and input. Thank you.

Consent for State, Territory and Commonwealth Government Officials

I/we
have agreed to participate in informing research on capital estimation for healthcare.

I/we know:

- What the research is about,
- That I/we do not have to be involved and may withdraw from the research at any time
- I/we may contact Rhonda Kerr or Delia Hendrie if there are any additional questions about the research
- Information provided will be securely stored and will only be used for this research.

.....
PARTICIPANTS NAME

.....
AGENCY & POSITION

.....
DATE

.....
RESEARCHERS NAME & SIGNATURE

Information for Clinical Key Informants

Capital Funding for Hospitals: Can diagnosis-related capital facilitate more appropriate, sustainable and innovative acute healthcare facilities?

Appropriate levels of capital for healthcare are of great importance for our community and our clinicians. Access to hospital beds and appropriate diagnostic and treatment facilities permits clinicians to effectively manage growing demand from populations with increasing chronic disease and an ageing demographic. Traditionally capital to facilitate increased clinical activity, improved productivity, innovation and provide technological support is calculated and allocated in budgetary processes which are facility rather than patient based.

We are collecting information on the capital requirements for contemporary Australian best practice patient care. You will be asked about which facilities, major medical equipment and IT and communications equipment are necessary to provide contemporary best practice care. We are aiming to build a profile of the capital required for a fully equipped clinical environment which facilitates contemporary best practice clinical care.

Between 35 and 45 minutes of your time is required to comment on the patient care pathway for 2 Diagnosis groups. You will be asked to confirm or reject the need for a range of facilities and equipment required by clinicians for direct patient care and a wider range of facilities and equipment required to be present within the facility. Your opinions on any other items which need to be present for patient care will be welcomed for inclusion. You will also be asked to contribute to the discussion on innovation in healthcare and sustainable practice.

Information collected from the interview will be used only for informing the research and will be kept confidential and stored securely for 5 years after the publication of the research. In the publication of the research you may wish to be anonymous, to be acknowledged by position or to be an acknowledged participant or collaborator in any paper. Please record your preference in the attached consent form.

It should be noted that participation in this study is completely voluntary. Participants are able to withdraw at any time without prejudice or negative consequences. Information collected during interviews for inclusion in the research will be provided to the informants for their correction prior to inclusion in any publications.

Further information on the research can be obtained from:

Rhonda Kerr

T: 0438 645982

E: rhonda.kerr@postgrad.curtin.edu.au

or

Delia Hendrie

E: D.V.Hendrie@curtin.edu.au

Any concerns on ethical grounds should be made the Secretary of the Human Research Ethics committee on (08) 9266 2748 or by email at hrec@curtin.edu.au or by mail to the Office of Research and Development, Curtin University of Technology, GPO Box U1987, PERTH WA 6845

This project has been reviewed by the Curtin University Human Research Ethics Committee and has received approval number SPH-39-2011. We appreciate your willingness to assist with our research and greatly value your time and input. Thank you.

Consent of Clinical Key Informants

I/we
have agreed to participate in informing research on capital estimation for healthcare.

I/we know:

- What the research is about,
- That I/we do not have to be involved and may withdraw from the research at any time
- I/we may contact Rhonda Kerr or Delia Hendrie if there are any additional questions about the research
- Information provided will be securely stored and will only be used for this research.

I/we would like: To be anonymous
To be acknowledged by position
To be acknowledged by name
To participate further in publishing

.....
PARTICIPANTS SIGNATURE

.....
AREA OF CLINICAL EXPERTISE

.....
DATE

Information for International Participants

Capital Funding for Hospitals: Can diagnosis-related capital facilitate more appropriate, sustainable and innovative acute healthcare facilities?

We are collating information on the protocols for estimating and allocating funds for capital associated with acute healthcare facilities, medical equipment and information technology and communications systems. The primary focus of our research is Australia and we are examining key international healthcare systems as comparators.

We are seeking your advice on the existing or proposed systems for allocating capital for acute health care for your health system. Most of this information will be in the public domain but there may be further information which may be required for making direct comparisons between jurisdictions, clarifying definitions or associated with new or emerging policies.

Research is also being conducted into the capital implications of sustainability and innovation in acute health facilities and on the capital required for a small range of diagnosis related groups.

Information collected during interviews for inclusion in the research will be provided to the informants for their correction prior to inclusion in any publications.

Information collected from the interview will be used only for informing the research and will be kept confidential and stored securely for 5 years after the publication of the research.

Further information on the research can be obtained from:

Rhonda Kerr

T: 0438 645982

E: rhonda.kerr@postgrad.curtin.edu.au

or

Delia Hendrie

E: D.V.Hendrie@curtin.edu.au

Any concerns on ethical grounds should be made the Secretary of the Human Research Ethics committee on (08) 9266 2748 or by email at hrec@curtin.edu.au or by mail to the Office of Research and Development, Curtin University of Technology, GPO Box U1987, PERTH WA 6845

This project has been reviewed by the Curtin University Human Research Ethics Committee and has received approval number SPH-39-2011

We appreciate your willingness to support our research and value your time and input. Thank you.

Consent of International Participants

I/we
have agreed to participate in informing research on capital estimation for healthcare.

I/we know:

- What the research is about,
- That I/we do not have to be involved and may withdraw from the research at any time
- I/we may contact Rhonda Kerr or Delia Hendrie if there are any additional questions about the research
- Information provided will be securely stored and will only be used for this research.

I/we would like: To be anonymous
To be acknowledged by position
To be acknowledged by name

.....
PARTICIPANTS SIGNATURE

.....
AREA OF EXPERTISE/ POSITION

.....
NATIONALITY

.....
DATE

Questionnaire for Officials

What is the current process for allocating capital for acute healthcare buildings?

1. Where does the process begin?
2. Is it when hospitals prioritise a list of capital options for that financial year or is there a planned and monitored system of replacement and improvement?
3. When are lists are combined and prioritized at an area level or at a regional or State level?
4. How are these decisions weighted and by whom?
5. Is there a State plan which sets the priorities?
6. Where does the final decision about the priorities lie- in the Department -for advice to the Minister or with the Minister or with Cabinet?
7. How is the political view included in the process? For example if a small rural hospital or a smaller city hospital perceives a need outside the published plan and the matter is taken up by their local member, where would that input be considered?

The money amounts for health capital

8. Who sets the size of the annual and 3 yearly projected allocation and how?
9. If it is the Department of Treasury are they privy to the estimated requirement for capital from the Department before the amount is finalised?
10. Are there people from Treasury and Health in a formal or informal mechanism who confirm priorities and discuss estimated forward requirements?
11. Or is the amount for hospital capital largely a function of the Budget situation?
 - a. That is do they have an amount which can be afforded that year for hospital capital?
 - i. If so is that amount a similar percentage or figure year to year?
 - b. Or is the amount largely independent of the Departments priority list
 - i. or closely tied to major projects?
12. What time spans are considered?
 - a. The timing set in the Plan
 - b. Building lifespans of 20, 30 or 50 years?
 - c. Are there different lifespan calculations for different elements of the buildings (EDs versus wards versus office or OPD spaces?)

Questionnaire for Officials

13. What is the current process for allocating capital for acute healthcare medical equipment? Is it closely or completely aligned to built capital on a scale of:

- a. unaligned or an independent process
- b. sometimes aligned,
- c. occasionally aligned,
- d. usually connected or
- e. a fully integrated process?

14. What is the current process for allocating capital for acute healthcare information technology and communications?

Overall allocation of Capital for acute care

15. Appropriateness

- a. What processes are used to determine if the capital allocation is appropriate for clinical need?
- b. In the design-build-commissioning process are there regular clinical inputs? E.g. sketch design, commissioning involvement of clinicians and clinical involvement in building budget decisions?
- c. When clinical processes change (e.g. Clinical redesign) what mechanisms are there for capital investment in revised facilities or new equipment or
 - ii. is this done on a project by project basis or
 - iii. included in the usual annual mechanism?

16. Sustainability

- a. How is environmental sustainability factored into capital investment for hospitals?
- b. Is there consideration of how older facilities can be retrofitted to be more sustainable
 - i. On a facility by facility basis or
 - ii. On a regional or system wide basis?
 - iii. Or is sustainable building a redevelopment stage consideration
 - iv. Or a combination of all the above?

Questionnaire for Officials

17. Innovation

- a. How is innovation in clinical service delivery supported in the capital investment system?
 - i. In a systematic way or
 - ii. On a project by project basis.
- b. Is it generally accepted that service delivery innovation is well supported in the existing process of prioritising capital projects?

18. Clinical service planning and capital allocation are:

- a. Service based
- b. Institution based
- c. Regional
- d. Patient centred or
- e. Diagnosis-based?

19. Are clinical pathways used in capital estimation and planning?

- a. Throughout the hospital
- b. On a service by service basis
- c. On a departmental basis
- d. On a system wide basis
- e. Not yet formally incorporated?

20. Evidence based design

- a. How is evidence based-design incorporated into the funding of capital for new and refurbished facilities?
- b. How would a change to facilities to improve patient safety, outcomes and staff retention be incorporated into the capital investment schedules?

21. Which method is preferred to estimate the demand for critical care or hot areas such as ICU/CCU/ theatres/ procedure rooms

- a. Benchmark ratios (beds per 1000 population)
- b. % of beds
- c. Trend estimates from historic data using functional benchmarks (hours per patient)
- d. Other.

22. Are there any matters you think need to be clarified amongst the questions or answers?

23. Are there plans to change or modify the existing process?

- a. What benefits do you think they will achieve?

Questionnaire for Officials

Many thanks for your time and thoughtful consideration of these important, but not generally well understood, matters and your kind willingness to assist in this research. If there are any matters you consider should be revised or other information which should be recognised it can be included over the next few weeks. A copy of the notes of the interview will be forwarded to you within 10 working days. Please alert me to any errors or misunderstandings or corrections you would like made.

Appendix C Capital Formation

C.1 Aim

Deeble argued that “no hospital administrator would take seriously any formula-based standards [for capital allocation] which ignored inheritance.”(Deeble 2002a)page 55) He found that “all hospitals are not equally well endowed “(Deeble 2002a)page 54) in the distribution of capital through the 141 hospitals surveyed across Australia. He suggested evidence of higher investment in metropolitan hospitals treating similar patients to country hospitals; finding the difference inexplicable. (Deeble 2002a)

In this Appendix the value of that statement in understanding contemporary capital allocation systems for public hospitals is assessed.

C.2 Methodology

The theme of legacy was explored through data base searches for material on the foundation of pre-21st century Australian hospitals using key words ‘hospital’ ‘foundation’ and ‘opening’ combined with the name of the state. The searches of Proquest, Emerald and Medline were not successful. So data was sought on the foundations of hospitals in Victoria, WA, Queensland and NSW through hospital and government websites, hospital libraries and Parliamentary libraries. National Library of Australia Trove collection provided useful access to detailed newspaper and indexed parliamentary information on the founding of hospitals. Data on 30 hospitals was sought and sufficient information was found for 18 hospitals. Information was sought on a range of hospitals using the search terms above. The aim was to assess a range of hospital covering specialist and university affiliated hospitals, larger metropolitan hospitals and hospitals in regional and country areas in NSW, Queensland, Victoria, SA and WA regarding funding arrangements.

Material from the NLA sources was transposed to a table showing the date of funding, original funding and source of funding for 18 hospitals. Analysis involved examining the context for funding, responsibility for funding and the balance between community and government in capital fundraising. Recorded information was verified from at least 2 sources. Detail of the information abbreviated into Table C.1 is at Appendix A. To verify the conclusions made about fundraising the first Hospitals Acts for each State were reviewed for capital funding arrangements and ownership conditions.

The origins and responsibility for capital funding for three major NSW hospitals, four university hospitals in Victoria, three significant regional hospitals in WA and the specialist childrens hospital, a major women's hospital in Queensland and three regional hospitals is examined. Limited data on initial hospital funding does not permit a statistically significant sample of the 735 public hospitals in Australia in 2016.

C.3 Results

Table C.1 identifies the original funding sources for prominent hospitals with further information on each of the hospitals later in this Appendix. Much information on the initial funding for public hospitals is a difficult to obtain as many hospitals had community, rather than government origins, and community records are often no longer accessible. So the hospitals presented are those for which the National Library of Australia had verifiable information.

These hospitals display the origins of capital for the range of public hospital types:

- specialist and university affiliated hospitals,
- metropolitan general hospitals,
- regional and smaller country hospitals across 4 states.

Cultural norms in the 19th century had illness as a domestic matter unless there were risks to public safety through infectious diseases such as leprosy, tuberculosis or mental illness. When many of Australia's significant hospitals were established capital funding for hospitals was not considered to be an issue for Government but was regarded as a local issue.(Carment 1949; Department of Prime Minister and Cabinet 2014; Hansard Parliament of Queensland 1923; Cummins 1979). It can be seen from Table C.1 that community fundraising has provided the initial funding for building and equipping 83% hospital facilities examined in the 4 state sample over the later 19th and early 20th centuries. In most cases land was allocated by state or local governments as the primary contribution of government supplemented by Government donations in 9 of the 18 hospitals reviewed. Cummins, a former Director General of Health in NSW, identified this as the dominant system for funding for general hospitals to World War II.

Table C.1 Original sources of capital funding for selected hospitals in four states, 1811-1953

Source: National Library of Australia, Trove records, detailed in Appendix C

State	Hospital	Funding Date	Original Funding	Source of Funding
NSW	Sydney	1811	Monopoly 3 shillings per Gallon of Rum to the hospital	Sale of Rum
NSW	Royal Hospital for Women.	1820	Womens Committee The Benevolent Society	Contributions Land donated by Governor
NSW	Crown St Womens.	1893	Dr James Graham	Public Subscription
Victoria	Royal Melbourne	1841	Committee	Public donation House donated by John Pasco Fawkner, Government grant
Victoria	Royal Womens (Queen Victoria Memorial Hospital)	1856	Women doctors Mrs Frances Perry & Ladies Committee Dr Constance Stone	Public Donations & Fund-raising The Shilling Fund
Victoria	The Alfred	1871	Citizens Committee After the wounding of Prince Alfred by Fenian rebels	Public Subscription Council- donated swamp land
Victoria	Geelong & District Kitchener Memorial Hospital	1852	Local Committee	Individual and Corporate Donations
Victoria	Preston & Northcote Community Hospital	1941- 1953	City of Preston	Community fundraising matched by State funds
WA	Fremantle	1897	Government using Convict labour	House of Captain Henderson
WA	Fremantle Doig Wing	1932	Memorial Committee	Public fundraising including a 'Pass the hat' at the WAFL Grand Final

State	Hospital	Funding Date	Original Funding	Source of Funding
WA	Katanning	1926	Katanning Roads Board	War Memorial Local Donations
WA	Childrens (Princess Margaret)	1909	A small girl then a Committee	Community fundraising & Government Land grant
WA	Armadale-Kelmscott District War Memorial Hospital	1929	Committee	Local Donations War Memorial Government donation
Queensland	Moreton Bay	1849	Committee	Convict built Donations & Government funds
Queensland	Lying-in	1866	Committee led by Lady Bowen	Government, donations & loans
Queensland	Toowoomba	1859	Committee	Public donations with Government land grant
Queensland	Rockhampton	1858	Committee	Donations Fundraising
Queensland	Yeppoon	1915	Committee	Donations Fundraising

C.4 Responsibility

Table C.1 reveals that communities bore the responsibility for capital fundraising for hospital buildings and equipment with State governments ranking amongst contributors in the 19th century. However Kerr states that from the time of Federation in 1901 that each state was responsible for the provision of health care facilities and, in 1911, after the creation of the Australian Capital Territory, the Commonwealth government also funded hospitals. (Kerr 2013) But earlier legislation had sanctioned capital fundraising practices by hospitals. These identified that Ladies Benevolent Societies and committees were responsible for the funding and operation of most hospitals.(Hansard Parliament of Victoria 1928b)

Capital funding for public hospitals operated entirely under the management of local hospital boards until legislative change provided public supervision of hospitals through:

- Section 17 5(b) of the *NSW Public Hospitals Act 1929*
- Sections 24c , 30b, particularly section 42 (4) (b) and section 51 (1)of the *Hospitals and Charities Act Victoria 1928*
- The *Queensland Hospitals Act of 1923*- an Act to make better provision for the maintenance management and regulation of hospitals and for other purposes. Sections 17 and 18, 24(1) (ii)
- In South Australia the *Hospitals Act 1934* Section 15 and the *Hospitals Act Amendment Act* (No 1497 of 1921)
- The *Hospitals Act 1927* Western Australia Section 21 (a) (b) and (c)
- The *Hospitals Act 1918* Tasmania Sections 28 and 29 and 45 to 49.

These Acts brought hospitals founded, funded and operated by Ladies Benevolent Societies and other charitable groups under the authority of the State government hospital boards and proscribed their expenditure on the operation of hospitals and in particular hospitals buildings, equipment and maintenance. However hospital developments were funded primarily by community fund raising led by local committees, ladies benevolent societies, loans, a contribution from the Budget and through lotteries such as the Golden Casket in Queensland. So while Kerr was correct in identifying that from the time of Federation the responsibility for health was at the State Government level, the funding of hospitals remained a local government matter, as Queensland's' Mr. Chute confirmed.(Hansard Parliament of Queensland 1923)(Appendix C)

While capital for hospitals founded for prisoners, soldiers, the mentally ill and people with infectious diseases were entirely funded by government, subsidies paid to hospitals for the care of the poor did not include capital funding. Quasi-legal status was afforded certain public hospital committees in the colonies now covered by NSW, Queensland and Victoria to hold property, sue and be sued under the *NSW Hospitals Act* of 17 June 1847.(NLA 2015) In addition religious orders and philanthropic organizations established hospitals in each state which later became public hospitals. (Sax 1974)

The end of WWII expanded funding for the repair of former servicemen and women through the Repatriation Hospitals system administered by the Department of Veterans Affairs. As these hospitals were not available to the general public, they have been excluded from this study. However, after WWII changes in medical practice, increasing

medical specialisation, significant population growth and expansion of the scale of public hospitals created demand for changed funding arrangements.

Transitions in funding arrangements occurred throughout Australia based, in part, on the improved ability of Governments to fund hospital developments through grants due to improved income tax systems after 1942. (Reinhardt 2006; Department of Prime Minister and Cabinet 2014) Then the Commonwealth passed the *Hospitals Benefits Act 1945* which funded a per diem rate for public patients across Australia. The amending Act (*Hospital Benefits Act 1948*) in section 5 confirms the States responsibility to provide capital for hospitals.

It is worth noting that in the period before hospital care was made free under Medibank in 1975 (Biggs A 2003; Anthony D 1973) public hospitals were organised by ward according to payment methods. So an adult ward for full-fee paying private patients would have one level of service and amenity, an intermediate ward for people paying part of the fees would have less amenity and a public ward for patients deemed indigent would have a lower level of amenity.(Glencross 1928; Anthony D 1973) (Department of Prime Minister and Cabinet 2014) Many hospitals were funded by a voluntary annual public subscription through benevolent societies until the introduction of Medibank in 1975. From the 1920's when legislation brought hospitals under the supervision of state governments to WWII, state governments progressively took greater responsibility for funding hospital buildings and equipment often through loans authorised by the Commonwealth Government. Primarily, hospital boards retained responsibility for capital fundraising over the 19th and 20th centuries. (Quince 2009)

From when the first hospital was built from rum barrels through to the 1950's hospital capital formation was a community responsibility overseen by government and reflected what could be raised in that community. Generally, government could be recognised through the 18 cases outlined, the parliamentary debates, and the conditions of the legislation, as a reluctant contributor to hospital capital formation. Capital for hospitals would therefore not be expected to be equally distributed between high socio-economic and low socio-economic areas or distributed based on need. This came to be termed Tudor Hart's Inverse Care Law stating that: "The availability of good medical care tends to vary inversely with the need for it in the population served".(Tudor Hart J 1971)

C.4.1 Discussion and analysis

Setting aside significant issues of the distribution of investment in health care (Eyles J 1985) this study concludes that Australian public hospital funding systems of the 19th and 20th centuries were funded to align with the expectations of the communities funding the hospital. Hallmarks of success for hospital development were a good cause to raise money for the hospital (for example a war or celebrity memorial¹) and political influence to secure land and additional funding from the government. Connecting the access to political influence and strength of private fundraising resulted in public hospitals being built in more affluent areas of capital cities causing access challenges for lower socio-economic people.(Eyles 1985) (Sax 1974) (Deeble 2002a) (Moorin 2006b)

C.4.2 Conclusions

Consequently a public hospital system was created that reflects the political preferences and fundraising capacity of the time. So capital allocation patterns were more closely aligned with financial capacity than clinical requirements. Progressively over the 20th century state governments increased their support for capital fundraising in line with the complexity of care provided in the hospitals, their level of responsibility, population change and improved income arrangements after World War II.

C.5 Background Information

while the subject examined is contemporary methods of capital acquisition, the history of capital investment in hospitals has relevance to understanding the current endowment. But rather than comprehensively examine the origins and funding streams of the 735 public acute hospitals in Australia, a sample of hospitals from 4 States is discussed. They represent 4 modes of establishment which have influenced public hospital development. The aim of the analysis is to identify how their foundation was funded and how capital was raised for medical equipment.

The 18 hospitals selected are:

¹ Examples include the Geelong and District Kitchener Memorial Hospital of the late 19th century, the Katanning War Memorial Hospital post World War I, the Queen Victoria Memorial Hospital, and the Ron Doig Wing of Fremantle Hospital.

C.6 NSW

The Sydney Hospital was originally known as the Rum Hospital and was the first hospital established in Australia. Poor health in the early colony meant that the tent hospital of the First Fleet and the portable hospital of the Second Fleet required replacement with a permanent building. Governor Macquarie was unable to fund a substantial hospital building required and so sold a monopoly on the sale of rum to Garnham, Blaxcell and Alexander Riley and later D'Arcy Wentworth to build the first general hospital in Macquarie Street. The contractors were required to pay 3 shillings per gallon on the 45,000-60,000 gallons of rum they sold and to provide the new hospital buildings. The buildings remain on site as the Parliament and the Mint while Sydney Hospital was replaced in 1876 with a new hospital building. A foundation stone was laid in 1811 and the hospital buildings opened to patients in 1816. (Royal Australian Historical Society)

The first Australian hospital developed for women giving birth was the Royal Hospital for Women in Sydney which was established by a committee of women of the Benevolent Society formed in 1820. The first lying in hospital was established in 1821 in the Benevolent Society Building in Pitt Street Sydney. In July 1878 the Benevolent Society sought the support of the Government of NSW to expand the Lying-in Hospital in Pitt Street and when it was confirmed that the site was not required by the railways, the Colonial Secretary offered Parliamentary support for a £7000 contribution to equal the investment of the Benevolent Society. (SMH 17 July 1878) The Lying –in Hospital expanded and developed in Pitt Street until a new hospital was built in Paddington and opened in 1901. The Benevolent Society remained the owners, developers and administrators of the hospital until 1997 when it was deeded to the State Government.(RHW Thread of Time)

In a similar way to the Royal Hospital for Women, the initial funding of the Royal Womens came from public subscription, obstetric nurse training and student fees, with assistance from the Government in obtaining furniture and surgical instruments according to the State Records Office of NSW.(NSW State Records Office 2014)



Figure C.1 Royal Hospital for Women, 1902
 Source: The Benevolent Society Sydney

There was no supervision of hospitals until a Director General was created in 1891 in response to the shortage of accommodation in hospitals, particularly in Sydney. (Cummins 1979)page 136)

C.7 Victoria

The Alfred Hospital in Melbourne also had a colourful beginning. In 1869 a Fenian gunman shot the Queens’ son, Prince Alfred, in the back. In an expression of public loyalty funds were donated by citizens in both Sydney and Melbourne for the establishment of new hospitals in his honour. The Prahran City Council donated some low lying land for the creation of a hospital.(Alfred Hospital Archives).



Figure C.2 The Royal Womens Hospital, Victoria

The Royal Womens Hospital in Victoria was founded by a group of women and doctors headed by Mrs Frances Perry in August 1856 less than 20 years after the founding of the Port Philip colony. Initially housed in 2 terrace houses the hospital was known as the Melbourne Lying-in Hospital and Infirmary for Diseases of Women and Children. Wives of prominent Anglican clergy continued to manage the hospital and raise funds. In 1857 the colonial government allocated land in Swanston St for the building of a larger hospital. Funding for the hospital was by subscription and it was a condition of the land grant that the Committee of Management raise sufficient funds through subscription for the hospital to be built.(The Age 11 May 1857) Subscription levels entitled subscribers to admit certain numbers of patients to either the indoor wards or outdoor facilities.

In 1896 the first Australian hospital funded by women, staffed and managed by women and for women and children was opened in William Street Melbourne. Victorian women contributed to Dr. Constance Stone's 'Shilling Fund' during the Sovereigns Diamond Jubilee.(Australian Womens Register 2014) These funds permitted the hospital to move to larger premises in Mint Lane Melbourne. (Australian Womens Register 2014)In 1928 additional funds were required for an extension of facilities and equipment. It was the hospital boards' responsibility to raise £18,000 and allocate the funds. After some debate the State Government agreed to contribute \$6,000 to the funds.(Hansard Parliament of Victoria 1928a)

Similarly in 1925 the Geelong Hospital Board let contracts for £85,000 for capital works of which the Victorian Government contributed £8,000 while most was fundraised and donated. (Hansard Parliament of Victoria 1928a) Initial funding of the hospital was by public donation to a committee formed in 1849. The hospital was opened in 1850 but proved too small so by 1853 the laundry was converted to a ward and additional funds were sought from donors and the government. (Committee of Management Geelong Infirmary and Benevolent Institution 1853 1854)

Other hospitals began a private homes including the Royal Melbourne Hospital which began at a house donated by John Pascoe Fawkner in 1842.(Royal Melbourne Hospital)

“Until 1841 provision of medical and hospital services within the Port Phillip District was limited to a Government hospital catering for convicts, prisoners, military and public servants, although non-Government patients without means for medical services could apply to the superintendent for admittance to this hospital. The provision of public hospital services in the District did not however commence until the opening of the Melbourne Hospital on 15 March 1848, although the committee

which managed the Hospital dates from 5 March 1841. On that date a public meeting was held in the Police Office, chaired by Superintendent La Trobe, which moved a resolution to establish a public hospital in Melbourne. After the resolution was passed a committee of citizens was appointed to organize a building fund and to approach the Government for financial assistance.

In the meantime a second meeting, held in January 1842, decided to establish a temporary hospital for urgent cases. For most of its existence this temporary hospital was situated in a two-storied house in Bourke Street West owned by John Pascoe Fawcner.

In 1845 the New South Wales Government finally agreed to a grant of land as well as a building grant of one thousand pounds, providing that a similar amount could be raised locally.

In January 1846 tenders were called and the foundation stone was laid on 20 March. With the opening of the permanent hospital on 15 March 1848 the temporary hospital closed its doors.

To establish the legal status of various hospitals in the Colony of New South Wales a New South Wales "Act to enable certain Public Hospitals to sue and be sued in the name of their Treasurer, and to provide for the taking and holding of Real Property belonging to such Hospitals" (11 Vict., No. 59) was assented to on 17 June 1847".(NLA 2015)

After the *Hospitals and Charities Act Victoria 1928*, planning for Preston and Northcote Community Hospital (PANCH) began with the City of Preston Council in 1941. The Charities Board advocated for the establishment of 150 bed hospitals in Preston, Box Hill and Sandringham in 1943 but did not have government approval. (The Argus 1943) Funds were raised continued to be raised by local communities with Eisteddfods, gymkhanas, balls and other events and in 1952 the Hospitals and Charities Commission awarded £32,000 capital funds to equal the £32,000 raised by the community committee.(The Argus 1952) Land for a hospital was purchased by the Charities Board but early works stopped between 1952 and 1955 due to lack of government funds.(Darebin Heritage)

While the impetus for hospital development in the World War II and post-war era may have originated with the community, it was the Victorian Governments' Charities Commission which provided most funding. PANCH provides a useful example of the transition as the small initial project was within the scope of the local community to fundraise during the war, but post-war cost increases, medical specialization, technological advances and the expanded scope of the hospital services firmly moved the funding of the project to the government level. PANCH hospital operated for 38 years

after opening before staff and beds were moved to the Northern Hospital at Epping in 1998 as a result of a capital planning audit. (Darebin Heritage)

C.8 WA

Fremantle Hospital originated as one of the most significant and opulent homes of the Swan River Colony. The Knowle was built by convict labour as the private residence of Captain Henderson, the Comptroller General of Prisons. It was taken over as a 52 bed hospital in 1897 in response to a typhoid outbreak. Extensions and on-going maintenance were performed by prisoners from the adjacent Fremantle Goal. The Knowle remains in use as offices and education spaces at the centre of Fremantle Hospital. (Heritage Council of WA; West Australian 1933).

The next major extension to Fremantle hospital, the Doig Wing , formerly the Emergency Department, and now housing the Renal Unit, was funded by ‘passing the hat round’ after the 1932 WA Football League semi- final when the South Fremantle captain-coach Ron Doig (23) died. (Stubbe J.H. 1969)

Armadale-Kelmscott War Memorial Hospital began as a private hospital in a leased house and as local demand increased was purchased by a committee formed at a public meeting by local people using donations. As demand increased the Armadale Kelmscott Roads Board (as the local authority) sought to take out a loan to purchase the hospital for public use but was prohibited so the hospital lease was funded by donations for the first 22 years of operation. (Anon. Thursday May 29 1924,; Anon Friday 5 July 1946) (Anon. 2 March 1946, Thursday 28 February 1946)

Similarly in rural Australia hospitals were established and developed by community fund raising. Katanning Hospital, the war memorial hospital, was built with funds donated by local residents to serve the local community. It was opened in 1926 with half the capital cost being met by the local community through the Katanning Roads Board(English A 1926). The total cost was estimated to be £1000. The importance of the hospital at Katanning for the community was marked by the donation of an operating table worth £175 by the local repatriation committee and the other furnishings of the operating theatre costing £100 donated by the local RSL. The Deputy Premier agreed to fund half the cost of land and further hospital requirements. He further promised £100 for that year and £150 per annum in future. (The West Australian 27 April 1925)

The most celebrated story regarding the establishment of a hospital in WA was the story of the foundation of the Childrens Hospital in Perth. A prominent shop keeper Mr Charles Moore was commanded by a little girl to use her thrupence to begin fundraising for a hospital for sick children.(Princess Margaret Hospital Foundation 2014) There followed 12 years of community fund raising including 200,000 pennies from school children, £10,992 in personal donations and £652 from the Sunshine League. The Government granted the land in Subiaco and £1,500 toward the building fund. The total cost of building and equipping the childrens hospital was £12,000 in 1909. (Editorial 1909)

C.9 Queensland

The first public hospital in the Moreton Bay Colony was also built by convicts and for the use of convicts. It fell into disrepair and residents petitioned the NSW Government for funds to repair and furnish the hospital. Patients were admitted in 1849 if they had or could obtain subscribers tickets for medical treatment. However the Government grant was insufficient and residents were required to pay 1 pound per year to have access for themselves and one other to the hospital. (Editorial 1851; Phillips A)

However there were a larger number of impoverished non-subscribers who failed *“in their hours of revelry to think for a moment on the sorrow and destitution which might arrive, and to subscribe a few shillings for that time of affliction.”*(Editorial 1851; Phillips A)

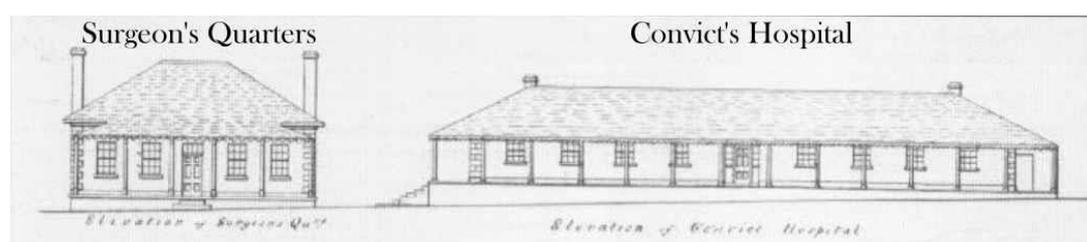


Figure C.3 Moreton Bay Convict Hospital Plan

The government was not inclined to establish general hospitals with the exception of providing places for the mentally ill and those with “unacceptable” infectious diseases such as Hansen’s disease (Leprosy).General hospitals were largely community funded until the *Hospitals Act 1923* began assuming responsibility for the funding and operation of hospitals in Queensland. (Gregory H 2010)

The Queensland Lying-In Hospital, like the Melbourne hospital, had land granted by the colonial government. The chair of the committee was Lady Bowen, the Governor’s wife, the colonial architect Mr. Tiffin, drew up plans and supervised the building of the hospital

pro bono. More than half the funding (£500) for the building was provided by the Legislative Assembly, £200 by public subscription and £295 as a loan. (Douglas MA 1866)

Rockhampton and Yeppoon hospitals were founded by community donations to the Port Curtis and Leichardt Hospital on the Fitzroy river in 1858. As the population increased a funding for a second hospital was sought from government. The Hospital committee were obliged to fundraise for the second hospital in 1867 opening the first wing in 1868 and the second wing in 1879. The Government provided funds to relieve the debt carried by the hospital from construction and equipping. Later expansions in 1910 and 1914 were funded by local fundraising notably a Fete. A disused hospital building was purchased by the Hospital Committee and transported from the Mt Chalmers Mine to become Yeppoon Hospital in 1915. Donations from locals residents met the cost of the new hospital building and equipment and all capital expenditure until after World War II (Carment 1949)

In August 1923 the Queensland Legislative Assembly debated the adequacy of fund raising for hospitals and in particular the major Brisbane public hospitals.

The Home Secretary noted that the subscription system had failed using the example of Toowoomba Hospital where capital funds were so difficult to raise that they “ found it difficult even to install a septic system and they hung on for years before they were able to afford such a system.” (Hansard Parliament of Queensland 1923)

Funding hospital growth was an issue in 1922 the Assistant Under Secretary to the Home Department, Mr Chuter in a report to the Queensland Government clarified that “ hospitals are a local government function...” (Hansard Parliament of Queensland 1923) (Carment 1949) The view that health was a local issue in the early 20th century is also confirmed by the Abbott Government statement of the roles and responsibilities on health. (Department of Prime Minister and Cabinet 2014) (Hansard Parliament of Queensland 1923)

C.10 Conclusions

The initial capital for building and equipping the earliest Australian public hospitals in 4 states appears to have 3 main sources:

- Directly funded by Government for the benefit of soldiers, prisoners, the mentally ill, those with infectious diseases and other residents for whom the government was responsible

- Funded by public subscription, charitable fund-raising committees, donations with some contribution from the Government including land grants or
- entirely funded by local people.

In addition religious orders and philanthropic organizations established hospitals in each state many of which later became either private or public hospitals. (Sax 1974)

Regarding responsibility for hospitals, parliamentary records show that in 1928 Victorian Minister for Health cautioned “One striking omission from the measure (the *Health Act 1928*) is that there is no provision that the administration of the Hospitals and Charities Act shall be brought under the Minister of Health, because the Treasury officials placed good reasons before the Government that it would not 'be wise at this juncture 'to bring the administration of that Act under the Minister of Health.”(Hansard Parliament of Victoria 1928c)

Earlier legislation sanctioned capital fundraising practices for hospitals. These were that Ladies Benevolent Societies and committees were responsible for the funding and operation of most hospitals.(Hansard Parliament of Victoria 1928b)(NSW Hansard unavailable for this period).

The impetus for changing funding methods was determined to be changes in clinical care capacities, patient access to appropriate care, medical technology and the costs associated with hospital capital.

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Appendix D Health Official Interview Results

Chapter 5 addresses the process for capital allocation in Australia. Appendix B is the questions put to Health officials with responsibility for health infrastructure funding.

D.1 Determinants of the process for capital allocation for public hospitals

Questions 1-7 asked how funding requests originate, were progressed, who made decisions, if there was a state plan for capital allocation, priorities and how political influences were managed to determine how capital is allocated in Australia.

Table D.1 Where does the process for capital allocation originate?

Informant	Clinical Service	Hospital	Regional	System-wide Improvement	Planned Allocation
NSW			3		
Victoria			2		
Queensland		2			
WA					2
ACT					1
Total	0	2	5	0	3

Funding decision points

Table D.2 At which level are capital funding decisions made?

Informant	Clinical	Hospital	Regional	Department	Minister	Cabinet	Treasury
NSW				1	2		1
Victoria					2	1	1
Queensland				2			1
WA				2			
ACT				1			
Total	0	0	0	6	4	1	3

Note: Some informants identified more than one decision maker

Questions 8-11 asked about annual and three-yearly funding and the involvement of Treasury with the health department prioritisation process.

Table D.3 Who sets the size of the annual and three yearly projected capital allocation?

Informant	Clinical Service	Hospital	Region	Department	Minister	Cabinet	Treasury
NSW				1			3
Victoria					2	1	2
Queensland				2			2
WA				2			2
ACT		1		1			1
Total	0	1	0	6	2	1	10

Note: Some informants identified more than one decision maker

Departmental capital prioritisation processes

Table D.4 Determining the annual amount for hospital capital

Informant	<i>Is the amount for hospital capital ...</i>				
	Function of budget	Similar annually	Planned replacement	Planned investment	Project by project
NSW		3			
Victoria	2				
Queensland			2		
WA			2		
ACT					1
Total	2	3	4	0	1

Note: Some informants identified more than one decision maker

Medical equipment and ICT

Questions 13-14 asked the degree to which medical equipment and ICT funding was aligned with built capital funding or if there were independent processes.

Table D.5 Capital allocation processes for Medical Equipment relative to major hospital developments

Informant	<i>Relative to hospital builds the process for allocating capital for medical equipment is...</i>			
	Independent process	Sometimes aligned	Usually aligned	Fully integrated
NSW		1	2	
Victoria	1	1	1	
Queensland	2	2		
W.A.			2	
ACT			1	
Total	3	4	6	0

Table D.6 Capital allocation processes for ITC relative to major hospital developments

<i>Relative to hospital builds the process for allocating capital for information technology and communications is...</i>				
Informant	Independent process	Sometimes aligned	Usually aligned	Fully integrated
NSW		2	3	
Victoria		2	1	
Queensland		2		
W.A.			2	
ACT	1			
Total	1	6	6	0

Evidence

Questions 19-21 asked how evidence was incorporated into capital decision making for estimation methods for critical care areas, clinical pathways and evidence-based design.

Table D.7 Preferred method for estimating critical care beds, operating theatres and procedure rooms.

<i>Estimating Critical care beds and operating theatres by...</i>				
Informant	Beds per 1,000 population	As a fixed percentage of beds in the hospital	Using trend benchmarks	According to the State Plan
NSW				2
Victoria		2		
Queensland			2	
W.A.		2		
ACT				1
Total	0	4	2	3

Table D.8 Clinical pathways and evidence-based design

Informant	Clinical Pathways			Evidence-Based Design		
	Used	Referenced	Not Used	Used	Referenced	Not Used
NSW		2	1	2	1	
Victoria		2		1	1	
Queensland		2		2		
WA		2		2		
ACT				1		
Total	0	8	1	8	2	0

Standards

Question 18 asked if capital planning for hospitals was patient-based planning or diagnosis-based.

Table D.9 Clinical service and capital allocation planning

Informant	<i>Clinical service & capital allocation planning are...</i>				
	Patient-based	Service-based	Hospital-based	Regional	Diagnosis-based
NSW			1	2	
Victoria			2		
Queensland	2				
WA		2			
ACT					
Total	2	2	4	2	0

Clinical standards

Question 15 asked how the capital allocation process facilitates contemporary clinical standards.

Table D.10 How is it determined that capital allocation facilitates contemporary clinical standards?

Informant	<i>How is it determined that capital allocation facilitates contemporary clinical practice standards?</i>				
	Clinical Service Plan	Consultation In Planning	Hospital-based	Regional	Diagnosis-based
NSW	3	1	1		
Victoria	2				
Queensland	2	2	2		
WA	2	2	2	2	
ACT	1				
Total	10	5	5	2	0

Sustainability

Question 16 asked about capital funding for Environmental sustainability.

Table D.11 Sustainability of existing hospitals

Informant	<i>How are hospitals made more sustainable?</i>			
	At major redevelopment	On a facility by facility basis	By Regional program	By Statewide program
NSW	2	1		
Victoria	2			
Queensland	2			
W.A.		2		
ACT		1		
Total	6	4	0	0

Innovation

Question 17 asked how capital funding supported Innovation.

Table D.12 How is innovation in clinical service delivery supported in the capital investment system?

Informant	<i>Innovation is Funded...</i>				
	As required	At the Project Clinical level	At the Hospital level	At the Regional level	On a Statewide basis
NSW	2	1			
Victoria		2			
Queensland				2	
WA			2		
ACT			1		
Total	2	3	3	2	0

Timespans for capital allocation

Question 12 sought the timespans for capital allocation.

Table D.13 Time spans relevant to the allocation of capital

Informant	Electoral	Timing of the Plan	Building Life 20-50 years	Diff. lifespans x item x area
NSW	1	1	1	
Victoria	1		1	
Queensland				2
W.A.				2
ACT		1		
Total	2	2	2	4

D.2 Officials answers by jurisdiction

D.2.1 NSW

Where does the process begin?

All NSW interviewees identified that the process for allocating capital for acute healthcare begins at the District or Area level. Since 2008 plans for capital investment over \$10million were provided by the Area to Health Infrastructure. Before then the capital projects were managed at area level. Areas within NSW compete for capital funds for their high priority projects. Projects within the areas are prioritised and the academic interviewee mentioned political influences as significant in determining allocations. The other two interviewees placed a greater emphasis on the Asset Strategic Plan as the guiding influence determining the priorities for funding.

Informant 2 advised that all health services prepare an Asset Strategic Plan which is linked to the services plan and the asset and maintenance schedule, the documented asset registers and population health services planning all of which are based on health service need.

These documents are all prepared in a standard format following the guidelines and using common methods of estimation and templates to ensure greatest comparability and integrity.

These are combined at district level and a district population health service plan is formulated. When the district plans and the State wide service plans for areas such as ambulance for example are added a combined plan State is created. Currently the State plan is being developed and is building on the foundation of the previous State plan.

The development of the State plan is being undertaken to ensure the highest level objectivity using a population health approach which mirrors the District plan drivers along with overall system goal of treatment nearest a patients home, minimising the distance a patient and their family has to travel and enhancing access to services for those who need them. The overall system goals are translated in to strategies for service delivery which will in some circumstances have asset implications.

Another informant noted that in theory local health districts (LHD) prepare prioritised lists of capital requirements based on service need and the gaps identified between assets and requirements to meet projected demand. This is called the Asset Strategic Plan. Each local area includes the risk of not acting on an infrastructure need in their submission. The

overarching document of reference for a business case for health infrastructure spending is the NSW Treasury infrastructure procurement document.

In practice some LHD are less able to prepare a high quality Asset Plans than others and so the quality of the asset plans provided to NSW Health vary. There is concern that the final Statewide prioritised list might not comprehensively or fairly reflect need due to different ability levels from the local areas. Deeble noted this disparity was found across all other Australian States in his 2002 review.(Deeble 2002b)

Resolution of this problem could be achieved by the provision of specialised support from NSW Health and directions with respect to prioritising methods. Scope exists for better use of cost benefit analysis in preparing the case for asset investment to move beyond the most obvious asset requirements to a more informed and strategic view of assets. Alignment of assets requirements and their cost with recurrent costs would strengthen the basis for Strategic Asset Plans.

The third informant advised that in practice there some regions and LHD are more able to secure capital resources than others. Some projects are seen as having higher priority than others for a range of reasons including political sensitivities.

However informant 1 was clear that a degree of objectivity is built into the model to allow criteria to link service requirement objectives with the assets to enable them. Questions are asked at this point to ensure the overall objectives of value for money and efficiency are met before a project is further advanced. Questions are also asked about the quality of existing infrastructure and the options which exist or may potentially exist to meet the population health requirements in the most cost efficient manner. At all times the position of the patient is considered. Informant 3 described the absence of a state plan as an opportunity for political interference.

Increased transparency has been achieved now that all State health services have access to the model said informant 1. It is challenging to bring the competing priorities of Districts together in the State plan and the work now is to increase transparency in the screening process. The screening process begins at the service level where a project is identified and progresses to the preparation of a business case in the standard format. Informants 2 and 3 suggested that the strong communications between Health Infrastructure and Treasury enhanced transparency. Informant 3 said the role of the Minister in setting priorities was important.

Who sets the size of the annual and 3 yearly projected Budget allocations?

All informants agreed that historically Treasury set the annual capital amount for health of \$620million subject to CPI. This, with the addition of successful bids to the Health and Hospitals Fund (HHF) money which comes without an escalation factor, provides for the annual capital budget. The figure is a standard established by Treasury and difficult to vary. It can be argued that an annual amount double the figure would permit appropriate maintenance and refurbishment. However Treasury strictly enforces the \$620 million for health care capital ensuring no overspending in any year. Final funds from the HHF should flow in 2015-6 financial year.

It was reported that the Director General said that it is ‘a system designed to fail’ as the inevitable and unavoidable delays often associated with planning, design of hospitals do not fit within the fixed amount for capital and the 3 year planning framework according to informant 2.

Treasury have examined embedding a capital amount within the DRG but were not happy with the method or the amount. Capital remains centrally controlled. For hospitals and regions capital is regarded as a free good. NSW struggles with replacement and refurbishment of health facilities. It would be preferred to have a regular refurbishment program which kept facilities up to date. There is concern that maintenance and replacement have not been well supported in most facilities and the quality and utility of the assets has been eroded as a consequence. This view was put to the Productivity commission who supported it. (Productivity Commission 2009d)

Rather than anticipating trends in service provision, the short term approach to capital funding may have held NSW facilities in an older model of care not directly linked to maximising productivity of health services. While there is confidence that the building functions are provided in a value-for-money manner, the overarching approach to capital planning and funding may not be providing the best possible outcomes said informants 2 and 3.

Medical equipment and ITC purchasing are matters managed within the Ministry of Health according to informants 2 and 3. Informant 1 elaborated on the importance of the Treasury role throughout the funds allocation process. While maintaining consideration of the patient experience Health has also to be mindful of the Asset Acquisition Limits which apply to all departments and ultimately to Treasury’s policy direction and position on debt and the State’s credit rating. Budget limits are relevant to the consideration of Services

Procurement Plans and Project Definition Plans. Service plans will be refined to include estimates of costs and the impact on recurrent funds and assets which inform the Health annual Budget submission.

The capital allocation is intended to fund maintenance of the acute care assets in working order plus growth in demand. Based on Treasury guidelines, the capital allocation focus is on the capital asset as an asset rather than the clinical role and significance of health facilities. So the reconfiguration of services and changing models of care are not taken into account. There is no strong connection between the assets and the services they facilitate making the implications of reductions in funding for capital difficult to relate to service volume and quality. It is probable that there would be different built solutions if models of care developments were taken into account.

Informants 2 and 3 argue that the short-term view of capital development and assets and the sense of capital as a free good means that upgrades of existing facilities are not used often enough. Smart managers would take advantage of capital monies to improve older facilities especially when there is an opportunity to upgrade older areas associated with a new build or renovation. A more holistic and comprehensive look at how best to use capital monies is required from managers. The potential benefits of refurbishments are not explored by health service managers often enough. Frequently capital bids are the result of insufficient attention to maintenance and refurbishment opportunities over the years. So a significant number of the proposals are a process of catch-up aimed at getting facilities to contemporary standards. Informant 2 gave as an example RNSH is 36 years old and would have been a structure expected to have a 50 year life but for perhaps the last 16 years the level of maintenance and refurbishment has reduced the functionality of the facility to a level worthy of condemnation. This can lead to significant service inefficiencies. Informant 3 argued that there were greater political influences in the determination of funding priorities than planning considerations.

NSW Infrastructure has introduced 'systemised design' for acute health care. Features include standard columns, standard floor to ceiling heights, post-tensioning and thickened floors to provide more flexible structures for future renovation and changes of function. Blacktown Hospital is an early example of this process in which a flexible structure is created which permits fit-out as required at the time said Informant 2. However informant 3, with a more detailed experience of health facility standards, was less enthusiastic about standardising of rooms advising it can reduce future flexibility.

A recent innovation was to have an airport planner review ED operations examining the size of the corridors and pinch points which impede efficiencies. The report identified a number of process issues. A second round is examining EDs from a GE perspective. These are experimental approaches to inform the capital formation process and are identifying useful insights, process issues and models.

Part of the process of identifying the capital solutions is to question assumptions made in the process including bed numbers, the process of prioritisation which has taken place and whether the solution provides the most up-to-date solution and therefore best value for money. The questions being asked in relation to the efficiency and effectiveness of the capital investment in acute health projects should link more closely to the outcomes required from the health service. Much can be gained by drawing from the improvement made in other infrastructure development areas particularly in terms of efficiency, process and logistics. This was solely the view of informant 2.

All informants agreed that decisions on priorities for the Total Asset Management priorities are regularly discussed with the Ministers Office. An unpublished 10 year plan sits behind the State service plan which informs discussions with Treasury and the Minister. This plan is updated annually. The absence of funding for systematic maintenance over many years has meant replacement assets are required earlier than would normally be expected. An asset management system is being introduced.

In the event of a new 'need' being identified by a local member what happens? In the view of Informant 1 it is extremely unlikely that a new need will emerge without the local health service being aware of it and having informed the District and then Health in Sydney. However a perceived need could be raised by the local member through the normal ministerial system and a request for further information would be made of the local health service. The 10 year plan advises where that project would sit within the range of priorities and the minister would inform the local member of the relative priority of the matter raised.

Informants 2 and 3 confirmed that the normal channels would identify service delivery processes but that change was procedurally based when new needs were identified. On occasion project approvals could be viewed from a more tactical perspective. Priorities however could change overtime as pressures were acknowledged at various levels.

Capital for hospitals and other public healthcare providers within NSW Health are subject to the portfolio spending limit. The case for a variation to the limit can be put and the Government would decide. The HHF funding provided by the Commonwealth has related

to priority projects and health services in regional and rural areas. Acceptance of funds from the HHF has required a process with Treasury which has permitted a variance of the limits equal to the amounts provided by the Commonwealth.

Life-cycle costing for projects is preferred to simply examining the initial capital cost to ensure the most economically sustainable option is developed. The Australian Health Facility Guidelines (AHFG) are the preferred option used to ensure clear costs are well defined. All informants agreed on the use of the AHFG and life cycle costing as the gold standard and consistent with NSW contemporary practice. Informant 2 concurred with the opinions of Informant 1 but Informant 3 argued that in reality time frames considered were brief and project based.

Medical Equipment and ICT

HealthShare NSW was established in 2011 to manage a range of functions including the procurement of medical equipment as outlined in Director –General Mary Foleys 2011 Report: http://www0.health.nsw.gov.au/resources/govreview/pdf/governance_report.pdf

In the same report the DG outlined that *eHealth NSW*, would provide support for health services in ICT services and procurement. This is a state wide strategy that is implemented locally. A formula was being developed for the distribution of ICT funding proportional to the area requiring funding. Funds for ICT to each area are expected to be allocated on an annual basis. Informants 2 and 3 were concerned that the backlogged maintenance issues, the absence of funding for regular upgrades and spare parts caused major problems. Expenditure on ITC is prioritised so not all departments are completely resourced. There are challenges in defining terms within the ITC environment and area health services are not good at getting the best ICT outcomes as central office decisions are priority funded according to Informant 3.

Clinical appropriateness

Clinical advice is sought at each stage of project identification and development. From ESRG clinical involvement to demand and activity projections to evidence based development of models of care, clinical opinion is sought. Service planning has a very high requirement for clinical involvement. Indeed clinically driven projects which arise and which might be locally funded can be supported by small seed funding investments if there is an improvement in service or an improvement in operational costs resulting in savings overall. This was the view of all three interviewees.

Sustainability

Hospitals built in NSW were encouraged to provide sustainable solutions and achieve Greenstar ratings in new buildings or improved energy outcomes for older refurbished facilities. Sustainable outcomes were explored from the initial planning phase and all projects have to demonstrate sustainability both on individual projects and at the larger organisational level. Informants 1 and 2 held this opinion while informant 3 was less certain of processes and outcomes. Informant 3 argued that capital works for older facilities were also influenced by political considerations.

Innovation

The planning process actively encourages innovation and it is generally accepted that service delivery innovation is well supported in the existing process of prioritising capital projects. This was the view of informant 1, however informant 3 strongly disagreed instead saying that change was driven by Treasury imperatives and many ways of providing services were being challenged on that basis. The introduction of change managers would progress clinical redesign more effectively.

Clinical Pathways

Clinical pathways are actively considered amongst a number of different responses to the patient journey. A number of potential models are being considered and judged depending on the most appropriate clinical response for that place. This recognises that there is not a significant body of clinical evidence relating clinical pathways to patient outcomes. The issue is manifest in decisions of whether to put all OPD departments together or have them closer to the acute inpatient areas and the design issues associated with departmental and patient flows. This was the view of informant 1.

Clinical pathways are under particular scrutiny in redevelopments like those at Westmead where 3 wards are being converted to a combination of ambulatory, day only and inpatient facilities by service type. Informants 2 and 3 had no comment on this area.

Evidence based investment in health facilities and equipment

Through the Health Infrastructure Alliance of health departments, NSW Health has an interest in evidence based design exemplified in the AHFG.

Critical care

NSW is working to enhance their understanding of demand indicators for critical areas including ICU, CCU, theatres and procedure rooms. From having standards aligned to per 1000 beds and population health needs they have moved to acute projections based on the number of hours required and the requirements for mechanical ventilation.

ICU planning is for the whole of the state on a state network basis sensitive to how the patient moves through the whole health system and the requirements for critical care in that context. Royal North Shore Hospital (RNSH) is the apex of the critical care network, the state referral centre and data host linked to other facilities with less advanced services. Informants 2 and 3 had no comment on this area.

Patient-centred care

NSW has a range of instruments to monitor patient satisfaction including state-wide patient experience surveys, patient complaints data and clinical surveys. In 2015 NSW Health outlined the 26 strategies being employed to improve patient centred care in NSW hospitals. ([Luxford K 2015](#))

D.2.2 Victoria

Where does the process begin?

The Victorian Auditor General found that the State Budget is the key determinant of capital funding for public hospitals and that the finite amount available for Victorian hospitals is not distributed evenly. Depreciation and asset replacement costs are also not being met by 80% of public hospitals over the 5 years to 2014-15. ([Frost P 2015](#)) In theory the Victorian model is a standard bottom-up system prioritising projects at the higher level against State objectives. However Informant 4 commented that there is no evidence of a system and the system is open to political influence.

While there is no practical state health plan, but the state health plan is under constant preparation the informant said. No health capital or resource plan has been agreed by the department and published. The health capital technical paper was due for publication in late 2011 but has not yet been completed. In its place a Health Capital and Resources Plan was prepared by a Government parliamentary committee and published on the Victorian Health website. ([Victorian Department of Health 2014](#))

Informant 5 referenced the Victorian Capital Projects Website ([Victorian Department of Health 2010b](#)) which outlines the processes of health facility planning, model of care development and asset audit which has been discussed in NSW planning. A key driver for prioritising the list of capital options is critical replacement particularly for the aging assets within the Victorian portfolio. Capital is rationed and prioritised.

Service planning is collaboratively developed between hospitals and the Department in a system of joint governance with major services quarterly service planning building to develop the overall 1 plan. At that stage the department issues a call to invite business cases to be brought forward. Overall the Victorian government has an annual review cycle into which service planning, and capital works fits. Capital expenditure is carefully prioritised and rationed. Most projects are between \$30,000 and \$800,000 and to prioritise these projects considerable detailed work is required. Major hospital developments are typically very 'lumpy' allocations year to year. These include the Victorian Comprehensive Cancer Centre, the Royal Childrens Hospital, Bendigo Hospital, Box Hill Hospital through to the major redevelopment at Monash Hospital.

In planning terms the aim is to build up the middle to outer metropolitan rings of hospitals, to increase ambulatory care and mixed space developments.

Asked about the potential for political involvement in prioritising hospital investment Informant 5 observed that 'decisions can be made outside the process'. Departmental priorities for investment are sent to the Minister before being sent to Treasury.

There has been some work in the Health Department on capital related to DRGs for system management

Who sets the size of the annual and 3 yearly projected Budget allocations?

There is no specific annual allocation for capital. Treasury has a strong role in the major project committees and has management of the guidelines for business cases. There are early budget cycle discussions looking at high risk areas and high value projects to inform the process. The material from these conversations is sent to a Government subcommittee which advises the elements that can go forward. Treasury has strong commercial and portfolio areas.

The annual allocation for hospital capital is largely a function of the budgetary situation and takes on board the prevailing debt policy of Treasury.

The standard time span considered for planning for capital is 10 years.

Clinical Appropriateness

Clinician advice is included in the health planning stages for each area and during the preparation of clinical service plans for new developments.

Medical Equipment and ITC

The Victorian Health Plan emphasised improved knowledge management, ehealth and the use of communications technologies to be developed in the Health Capital and Resources Plan including alignment of ICT and capital infrastructure development and operations. ([Victorian Department of Health 2011](#))page 67) Best –practice patient pathways and local clinical guidelines are embedded in the communications and IT approach. Seeking productivity improvement the Health Plan looks to more efficient resource allocation, effective policies for clinical technology and ICT and clinically effective service configuration. ([Victorian Department of Health 2011](#))page 60)

The Capital and Resources Plan advocates shared planning for health services and greater sharing of equipment and infrastructure between the private and the public sectors. ([Victorian Department of Health 2014](#))page 56)

Funding for equipment comes from a state-wide business case allocation of \$55 million of which \$30 million is equipment and \$20-25 million is infrastructure. Half of the total is devolved to health services for smaller replacement items. More than \$300,000 of funding is for state-wide priority funding using a ‘robust methodology.’

There are quite detailed time span calculations within capital projects and on a state-wide basis one informant advised

Sustainability

The Victorian Health Plan sets the financial sustainability of the health system as a priority but does not specifically address environmental sustainability. ([Victorian Department of Health 2011](#)) However in the Capital and Resources Plan reducing water and energy use is described in terms of savings to total floor areas while carbon emissions per separation are reported to have decreased. ([Victorian Department of Health 2014](#))page 55)

Since guidelines for sustainability were released in July 2010 all new major projects have been required to meet sustainability standards benchmarked against the GreenStar Healthcare standard and supervised by independent sustainability consultants for all projects over \$15 million. Sustainability principles are embedded in the projects at design and master planning stages with the opportunity to use up to 2.5% of the project budget for leading sustainability initiatives. There are some small allocations for sustainability Informant 5 advised.

For on-going sustainability a web-based system for environmental data management system (EDMS) has been trialled and is progressively being implemented during 2014-15 and 2015-16 in all Victorian public hospitals.

Innovation

The 2014 Health Capital and Resources plan develops the concept of innovation foreshadowed in the Health Plans by stating support for change and innovation where proven efficiencies and more effective care result. ([Victorian Department of Health 2014](#)) Innovation is being fostered in specific program areas such as cardiac services and renal care plus general unfunded encouragement of innovation on a state-wide basis to evoke system wide capacity.

D.2.3 Clinical Pathways

The Health Plan 2012-2022 states that *"coordination of care needs to occur based on clinical evidence and best-practice clinical guidelines and patient pathways. The development of clinical guidelines and patient pathways will require a concerted and ongoing development process, starting immediately. The guidelines and pathways will provide the basis for future service and workforce planning."* ([Victorian Department of Health 2014](#))page 49)

The involvement of the Health Innovation and Reform Council through the development of both the Health Capital and Resources Plan and the broader Health Plan was acknowledged. In 2014 the Victorian Healthcare Experience Survey was introduced for quarterly surveys of patient experiences and feedback. ([Victorian Department of Health 2014](#))

There is a growing use of clinical pathways for capital planning according to Informant 5. The basis for planning is at the area level rather than at the service level or patient-centred.

Evidence based investment in health facilities and equipment

Evidence based design is endorsed in the Health Plan 2012-2022 and supporting documents([Victorian Department of Health 2014](#)) and major projects usually begin with a study tour and require working mock ups for clinicians to use prior to finalising plans. The Government sought savings from targeted medical technological investment in 2014. ([Victorian Department of Health 2014](#))page 27) Evidence based analysis should be part of the governance system informant 5 said.

Critical care

Benchmarks are used to determine the number of critical care beds required. ([Victorian Department of Health 2010a](#))

D.2.3 Queensland

Where does the process begin?

The advice of both informants is that the Queensland processes begins several years before the project funding stage with health service planning and every 3-4 years these are formed into a state-wide plan and a district plan. From these flow the particular health service plans and investment plans which with the Asset Strategic Plan become the focus of the list of priorities. Alongside these are the capital review and allocations process.

However on 1 July 2012 Queensland was split into 17 autonomous health services removing the requirement for a state health plan. The planning functions have devolved to the 17 autonomous health services leaving specialist resources in Brisbane to inform the process as systems to assist the health services manage capital works. Between 2006 and 2012, central capital planning staff had provided a range of options for local health services in the development of area strategic plans with an emphasis on clear and transparent health service and asset planning driving the priorities for funding.

The process was well-accepted with district review of service plans and asset priorities and prioritisation. Between 5 and 7 district plans and priorities were developed in a similarly transparent way and published. The State Plan was in turn formed from the priorities of the district plans. Finally the State Plan for health services and prioritised development was approved by the Minister and then the Cabinet and then published. Local

health issues and priorities of parliamentarians would be raised with the Minister in light of the explicit State planning process and published planning documents.

Who sets the size of the annual and 3 yearly projected capital allocations?

Queensland Health puts forward existing commitments to Treasury informing them of key drivers including technology, deferred maintenance and ITC. Then there is a process of negotiation with Treasury involving Treasury fiscal limits. This can lead to revisions of the Health proposals and finally a plan which is agreed.

The process is consultative and informed by formal annual and mid-year reviews, and analysis of the 3 year program.

Treasury, the Budget and annual allocations for capital

Queensland is nearing the end of a major hospital building program of \$3 billion so between \$1.5 and \$1.8 billion will be required for 3 years. In addition there are 6 large regional hospitals requiring \$200-280 million per annum. The Sunshine Coast hospital is the largest remaining project and it is scheduled for completion of all phases in 2016.

Lifecycle costing of hospitals is preferred taking into account the type of asset being considered- office, public space, ward or industrial environment.

Medical Edquipment and ICT

In practice informants advise that there are a combination of approaches for funding medical equipment and ITC. Some equipment is part of pre-existing commitments and is financed through hospital development or redevelopment projects while other expenditure for equipment arises from applications from health services. Queensland hosts the national health technology assessment unit, disseminating information on new and emerging health technologies to other States and territories.(Queensland Health 2015d) In addition the Commonwealth has provided considerable funding for medical equipment as part of the HHF projects funded and through other Commonwealth funding initiatives. A 30 year life span is generally accepted rather than a differential lifespan calculation for major medical equipment. Treasury have agreed to a 10 year major equipment life span. Replacement equipment is a difficult area with an annual allocation from Treasury. There tends not to be a like for like replacement policy. This is an area which requires close monitoring in the devolved health service arrangements post-2012.

New equipment and ITC purchased for new projects are vetted by a Health Technology Assessment program to assess new and emerging technology. If a technology has promise to improve patient outcomes and reduce costs it will be piloted and tested. Examples given were of green light lasers and robotic funding. For redeveloped or transferred health services it is recognised that around 30% of the technology and equipment can be transferred from the original to the new service.

ITC has been part of the strategic plan since 2009 but was not funded by 2015. The ITC allocation has been advanced by association with Queensland's major hospital developments in recent years. Prior to that ITC tended to be built progressively on existing systems.

Clinical appropriateness

The standard processes for health service planning apply and well-structured and rigorous processes have delivered facilities and equipment which have met with local, national and international clinical approval. The voice of clinical experience is embedded in the planning process and the review processes. Clinicians are consulted at each stage of the process for planning, design and occupation of new health facilities or refurbishing existing services.

When clinical processes change or there is clinical redesign the mechanisms for capital investment in revised facilities or new equipment are managed on a project by project basis. For example with paediatric services there was pressure for expansion and redevelopment. A clinical director was funded at half time to facilitate new equipment and state wide processes with one clinical group over 6 projects. There is a high tech advisory group providing a state-wide service.

Sustainability

Since 2006-7 there has been a major hospitals unit looking at sustainability issues from an asset management, energy use and facility management view. A working group developed ESD Guidelines which have been agreed by the Minister in 2012. The economic case was examined for doing nothing, business as usual and of a major effort on sustainability. Quantity Surveyor estimates of these 3 cases demonstrated the benefits of establishing a contingency fund for environmental sustainability. This has influenced a number of hospital redevelopments.

For existing hospitals, efforts have been made to monitor and improve energy efficiency. Improving the functional and facility basics with respect to sustainability has been rolled out on a state-wide basis. Improving sustainability is a driver of hospital redevelopments in Queensland.

The developments towards sustainability in Queensland Health have won a Premiers Award.

Innovation

Queensland health has aimed for a system of encouraging innovation but has moving on a project by project basis. The experience was that too much change too soon was not optimal and so innovation in relation to workplaces and services is the focus. It is a requirement that health service planners identify innovation in clinical service delivery in the initial planning.

Australian and international experts such as Prof. Roger Ulrich of Texas A&M University and Prof. Frank Becker of Columbia University have been used to expand the innovation and service delivery on the broader scale. The aim is not to prioritize clinical redesign and innovation in clinical service planning but to develop good exemplars on a project by project basis. Queensland has used the substantial capital investment in hospitals to push changes in clinical services and to facilitate the delivery of change.

Clinical Pathways

Clinical service planning is patient-centred and begins at the local service delivery model. At this stage clinical pathways are not used for the improvement of clinical services.

Evidence based investment in health facilities and equipment

Throughout clinical service planning and at the design stage evidence is used to underpin decision making. Evidence based design is endorsed and is embedded in the capital as an agent of change. The Centre for Healthcare Improvement works on a project by project basis for minor changes and clinical redesign.

Critical care

The preferred method to estimate the demand for critical care or hot areas such as ICU/CCU/ theatres/ procedure rooms etc. in Queensland is Benchmark ratios.

Summary

Queensland has had a high functioning system of capital allocation based on independent clinical service planning, and a published State Health Plan and Strategic Plan between 2006 and 2012. An autonomous system of 17 health areas has been responsible for health service delivery, planning and attracting capital funding since July 2012. Over \$3 Billion worth of leading hospital facilities have been built primarily before 2012.

D.2.4 South Australia

Although several requests were made, no senior South Australian official was willing to be interviewed.

D.2.5 Western Australia

Where does the process begin?

In WA the agreed fundamental document is the Clinical Services Framework which outlines service delivery for the next 10 years. Directly derived from this document is the State Health Infrastructure Plan (SHIP) which is the 10 year plan for infrastructure investment for both metropolitan and country health services. This is primarily for hospitals but includes all State operated health services. A review of the health facilities asset base has been completed in recent years and this review with the activity projections of the Clinical Services Framework informs the SHIP specifying same day and overnight beds and where future infrastructure work is needed. (Health Department of WA 2010)

SHIP is a detailed document including cost estimates and has been agreed at Cabinet level and is not in the public domain. It forms the basis of the conversation politicians and the Department have with the Minister and is a document understood and supported by Treasury.

Priorities

The main concern in prioritising health infrastructure requirements is ensuring future service delivery. Also of importance in prioritising future investment is the age of the asset and fitness for purpose of the facility and equipment. However, age is not a determinant by itself as the examples were given of three acute hospital blocks built in the 1970s which have proved to be highly flexible and suitable for refurbishment due to the generous

engineering spaces provided at the time, the good floor to ceiling heights and the thoughtfulness of construction.

Who sets the size of the annual and 3 yearly projected capital allocations?

Business cases for new works or equipment are advanced through facility, regional and departmental systems and tested for the appropriateness of the capital option as opposed to other contracting or service delivery solutions. If the capital option is regarded as the best value for public money it is then discussed with Treasury who also inquire about alternatives and optimal service delivery options prior to being advanced by the Minister for Health to Cabinet for final scrutiny and agreement.

The SHIP is the road map which guides decision makers and frames conversations with other organisations and political groups. It has a general level of agreement between political parties while at the periphery there might be some minor differences of emphasis and priority, SHIP has unilateral political support.

Exploring the issues raised in question 7 (Appendix C) it was made clear that if a situation arose which may require capital investment outside the SHIP a local member would begin with the normal Ministerial letter process. The issue raised would be referred to the local area health service who would investigate and report on the gravity and implications of the issue raised. If a real requirement was found a Business Case would be prepared within 12 months of the inquiry for the attention of the Minister. Prior to the Ministers' consideration, the full range of options for service delivery would be expected to be explored including alternative sites for service delivery (e.g. transferring patients to another hospital for treatment), contracting options from the private sector, ambulatory and day only service delivery options and other service delivery methods within existing resources. Treasury would also be consulted and they would expect to have any capital option demonstrate that it was the best option for value for money, would provide the best value for the State, why it was a variation from the SHIP and how it affected the projections in the CSF and the impact on recurrent funding (5, 10, 15 and 20 years out) and State Debt. Treasury would also expect to see that any option maximised flexibility with respect to public and private service providers and patients.

Politically there has been well-informed, detailed and well understood involvement in the issues by the Health Ministers of recent years and a very good level of understanding and engagement with Treasury. The 'Cost of Capital' is a very serious matter for ministers and

governments with health expenditure at 24% of the State budget(Nahan 2014). The Reid Review and acceptance of the two CSFs and the SHIP resulting from it have meant that there is little influence to vary from or add to the planned work.

The major program of works initiated by the Reid Review in 2004 is reaching its conclusion. Royalties for regions has provided useful funding for the expansion and redevelopment of significant country health service buildings. Managing, restoring and maintaining the stock of health assets continues to require significant funds to be allocated each year, this will continue to be challenge.

The annual allocation for health capital is established by Treasury and Health in a joint process primarily based on the SHIP projections but drawing from the 2 reviews of expenditure each year. The effect of capital on future net debt is also an important consideration regularly examined. Forward estimates for health capital requirements are also informed by the twice yearly reviews factoring in how projects were progressing at the end of last year and what will be required to be placed in the forward estimates to complete works.

Risks are also considered and are expected to be managed by Health. The risk reviews Treasury is concerned about are general risk, risks arising in the planning stage, risks arising during design and construction risks. They can be up to 30%- 40% of the required budget for project forward estimates. Existing facilities pose a range of challenges in ensuring their future ability to support health services.

While the Reid Report and SHIP have been the frameworks for health capital development it cannot be expected that such intense and expensive development will continue to be provided. Having said that the amount which can be allocated for health capital is a function of the range of responsibilities for funding faced by the government of the day and therefore subject to the budgetary situation.

Lifespans of buildings are considered based on their functionality. For example great flexibility has been discovered within the structural shells of the 3 main 1970s constructions at RPH, SCGH and Fremantle which permit 'regeneration' for newer requirements. In the future these facilities will be suitable for the upgrades which are increasingly expected for infection control and clinical safety. Upgrades under consideration include changing existing small ensuite bathrooms to fully assisted bathrooms permitting wheel chair access.

Medical Equipment and ICT

Medical equipment acquisition and replacement has had \$40 million allocated for the 2012-13 financial year. Facilities identify their requirements for medical equipment and these are aggregated and prioritised by Area Health services and added to the requirements of the Statewide services such as imaging. The allocation of funds for medical equipment uses the traditional prioritised list method and funds all that can be funded each year. The question of how this process will be done in the future is under consideration with a view to creating a process which better identifies the service improvements possible with new and emerging technologies. Again value for money and improvements in recurrent costs as a result of strategic investment are cornerstones of the processes being considered.

Some medical equipment has been superseded such as analogue technology and there is consideration of the appropriate level for capital replacement. One area of efficiency is the effective recycling and reuse of equipment within the health system by transferring equipment to other sites where it improves the efficiency of the services provided.

In medical technology adoption the aim is to bring greater clarity to the process and the objectives and a clearer strategic relationship to the service aims embedded in the CSF. Medical equipment allocation is sometimes aligned to the built capital allocation associated with new projects and refurbishments. The aim is to have greater alignment of medical equipment and built capital allocations. It is expected that business cases include estimates of the Group 1, Group 2 and Group 3 items.

The allocation process for ITC is an area under examination and the WA Government has changed its view of the Health information Network and is moving towards creating a demarcation document. Costings for ITC are expected to be included in business cases for hospital capital. However the question of the application is a difficult one. At the moment ITC hardware is linked to the build and the cost of licences is included with an indication of the costs of later stage applications. It can be difficult (given the speed at which applications change) to predict at the early budget setting stage, what the exact costs will be 6-8 years later.

There are issues emerging of managing the applications and the expectations of staff for those applications. Simple questions like how far the Wi-Fi range should extend on hospital grounds require resolution. The CSF is the core document in this regard answering the question of what is needed to provide this level of service.

Refurbishments do not often include the ITC cost. It will be interesting to see the expectations which arise in other facilities from the opening of FSH and Albany hospital with their enhanced systems and electronic medical records. The progressive adoption of new ITC along with improvements in workforce productivity will be managed over the next few years based on the example and experience at the new hospitals and partially through learning from other States.

The WA Government is interested in ITC roll out and there are base requirements to run a hospital. Planning, articulating and estimating expenses are underway with the aim of inclusion in the State Asset Plan. ICT is a key enabler and there are 3 pilot sites for telemedicine and support for regional and remote EDs with an ED physician available for telehealth consultations over the weekends now. One area of note is the need to ensure respect for patients' privacy at all times during telehealth consultations. So shared telehealth and lunchrooms are less well regarded than individual telehealth rooms at both ends of the consultation.

The Commonwealth was a key player in ehealth and Albany hospital is being used as a pilot site to examine improved data management.

Sustainability

Environmental sustainability is incorporated in each project with the aim of achieving Green 4 Star level or better. This has to first be measured in value for money terms and is being considered on a facility basis initially with new builds then progressing toward refurbishments. NSW is working on energy and water sustainability and WA hospital developments will be informed by this research.

Innovation

It is the aim for innovation to be encouraged systematically. The adoption of the 4 hour rule is one example and the new facilities such as FSH will be used as exemplars and change champions for clinical improvement and building and systems innovation.

Clinical Pathways

Clinical pathways are not used formally but could be expected to be factored into operations on a service by service basis.

Evidence based investment in health facilities and equipment

Evidence based design is recognised and fully incorporated in WA hospital projects. Results of evidence based design frequently match time –honoured good practice in building, operation and design.

Critical care

Critical care beds and hot area facilities are calculated using trends estimated from historic data rather than ratios per 1000 population or beds per 1000 population.

Other matters not incorporated in the questions but worthy of inclusion:

- The performance of healthcare capital could be improved by a diminution of the troughs and peaks healthcare capital investment over time. For example, over the past 40 years there have been brief periods of intense investment and then long periods of modest investment.
- Would prefer greater consistency of funding to match future planning and system wide demands on health services.
- Closer alignment of funding for health care capital with the health services which provide the services is desirable for a number of reasons relating to efficiency and effectiveness.

D.2.6 Tasmania

Several approaches were made to the relevant Tasmanian official who was unable to grant an interview due to pressures of work.

D.2.7 ACT

Where does the process begin?

Following on from the systems operating in the States the ACT begins the process of capital formation with a health services plan, asset analysis and consideration of methods of service delivery. A health infrastructure plan is the result of this process. From there a business case is made regarding asset replacement, augmentation or new builds. The ACT is deeply involved in planning and tendering for a new Royal Canberra Hospital (RCH).

Who sets the size of the annual and 3 yearly projected capital allocations?

Improved efficiency is one of the key drivers of redevelopment and Treasury seeks evidence of innovation and changes in the model of care to improve service costs in the major hospitals.

Health infrastructure looks to plan for 10 years in advance. Cost estimates at this stage are \$600 million for stage 1 of the 20 year plan. Projections are for 2 to 3 stages of development of a similar size. Managing the process of building and equipping new facilities in a working hospital are of concern.

Sustainability

The aim is for world class buildings with high GreenStar ratings.

Medical Equipment and ICT

Medical equipment and ITC are purchased after business cases for replacement or acquisition are approved. For new builds the cost of medical equipment and ITC is included in the building cost.

Critical care

The ACT maintains a good working relationship with NSW Health in the critical care area and in a range of other services.

D.2.8 Northern Territory

The Northern Territory could not identify an official who would be suitable for interview.

D.2.9 Commonwealth

Where does the process begin?

In 2013 the Commonwealth official responsible for managing health infrastructure advised that the Health and Hospitals Fund (HHF) received applications for funds from State and Territory governments on behalf of public hospitals which had progressed through the processes of clinical services planning, asset review, model of care and business case stages. The business cases were recommended by the local jurisdiction as worthy of funding but were outside the capacity or willingness of jurisdictions to fund.

The HHF examined proposals for a range of criteria to assess if the infrastructure project would provide significant, sustainable and measurable ongoing improvement in health care and was supported by a good evidence-base. When a project met those and other criteria it was advanced for consideration to the political level.

Appendix E International Capital Allocation Systems

E.1 Scoring system for Access to Capital and Access to public hospitals

To answer the research question -Can diagnosis-related capital facilitate more appropriate, sustainable and innovative public acute health facilities?- Australian and other national methods of allocating capital for public hospitals were investigated. Chapter 6 assesses methods for capital allocation in selected, comparable international healthcare settings.

You are asked to consider the scores that you would award to each national system for their capital allocation systems for public acute inpatient care and their score for patient access to public acute inpatient care. A scoring system is offered for your use.

E.1.1 Background

Three factors are scored within Objective 3 of Chapter 6:

- Public Hospitals ability to access capital funds (which has 4 qualities)
- Patient access to public hospital care and
- Efficiency of care.

These measures are combined to assess the ability of public hospitals to fund patient access to efficient care.

E.1.2 Public hospitals ability to access capital funds

Effective hospital capital funding has been found to have the following qualities:

- Timely access to capital
- Flexibility of funding
- Affordable capital and
- The fairness of distribution.(Hellowell 2012b; Murray 2001)

E.1.3 Methodology

Data selection

A two stage literature review of peer reviewed and grey literature for key words “hospital capital” or “public hospital investment process”, “capital allocate*” and “medical equipment” with “hospitals”, and)“hospital” and “capital” and “investment” also “patient access” is detailed in Chapter 6. World Health Organisation template Health in Transition (HiT) studies of each nation provided the most comprehensive and comparable information. Additional information was identified to expand, challenge or verify the information from the HiT studies.

The 18 nations were selected from WHO nations based on (a) the availability of information on capital investment and (b) as comparable or influential nations in capital funding systems.

So information on each selected nation’s capital investment processes was compiled. Data on capital allocation is not commonly identified so a method for extraction and scoring was devised. The approach continued the method of Deeble, Chapter 4 and 5 by aligning the capital allocation system with recurrent expenditure for hospitals and with patient access to acute health services.

Data Transcription

The WHO HiT series template requires information for each nation on:

- Capital Stock and investments
 - how capital investments are funded.
 - whether investment funding is separate from or covered through reimbursement for service delivery
 - whether capital investment reflects stated public health priorities
 - money borrowed through public allocations and the criteria for public investment
 - the nature of any private borrowing
 - public–private partnerships for investment in capital facilities
 - investment funding through donation or sale/disposal of assets and

- Beds in acute hospitals per 1000 population in country and selected countries, 1990 to latest available year
- Health Planning
 - whether it is based on health needs or inputs
 - infrastructure/capital planning
 - health plans at other levels (regional, district, local government, health insurance funds, etc.)
 - policy development/priority setting by different tiers in the system
 - evidence regarding the effectiveness of the planning system in implementing change
- Medical equipment
 - how major pieces of medical equipment are funded:
 - whether basic equipment is available in sufficient quality and quantity
- Information and communications technology
 - Electronic medical records or electronic health cards or plans for introduction
 - electronic hospital appointment booking systems.

The above categories of information display aspects of national capital allocation framework and processes that are often shared rather than mutually exclusive and were apportioned under to the four domains:

1. Timely access to capital
2. Flexibility of funding
3. Affordable capital and
4. The fairness of distribution

However;

- the HiT reviews did not always provide the required template information on capital, and
- the template information only partially addresses the information required in each domain to complete scoring.

So additional information from sources identified in the literature review was included to supplement HiT information where available. Additional sources are acknowledged in the country précis.

Data extraction

These sections were extracted for each nation and the key points of relevance to each quality of capital or patient access and summarised. Care has been taken to avoid interpretation and to convey the information from the HiT reviews and other sources.

Some nations collect information on investment, some on bed numbers as a proxy for investment and access and some have limited or no systems for considering capital investment in hospitals, medical equipment in hospitals and hospital ITC. Where no information was available from the national review, or other published sources, the absence of information is significant and was listed as 'no information'. Some health systems do not have a published process for funding capital that was available for expert national reviewers to report.

Information is provided on average length of stay and occupancy levels. Average occupancy over 90% is an indicator of insufficient investment and has been shown to increase risk of adverse patient events and mortality. (Wise 2015)

Extracts are also provided on medical equipment capital funding and ICT funding where available or on the level of provision when funding information is not explicitly mentioned.

The extracts and scoring system are at Appendix F. To avoid repetition, information on capital funding arrangements is provided once for each nation. Aspects of capital funding will be often be relevant to more than one domain.

3.3 Scoring system design

A scoring system has been designed based on:

- the interviews with Australian officials discussed in Chapter 5 using the grades of access to facilities described in those interviews
- in Australian government publications (role delineation, service and hospital levels are described as Levels one to six)
- Clinical interviews discussed in Chapters 7 and 8
- The scoring system also develops from Chapter 4 in describing the adequacy of funding systems to deliver contemporary hospital care, flexibility of funding and fairness of distribution.
- In addition, the scoring system has been designed to account for different experiences of capital allocation trends in OECD countries since 1990.

A relative scoring system for the 18 nations ranges between 0 and 3 where 3 corresponds to the highest possible score and 0 represents the lowest possible score within in the range of countries reviewed. The scores are not relative to all health systems but only relative to the 17 health systems selected.

Weightings have not been adopted as there is insufficient evidence in the literature on capital to verify weighting of the qualities against each other. So scoring for each quality is based on a common scale. This aims to address internal consistence of values between qualities and domains. For the same reason there are overlaps of measures from the HiT templates between the four qualities to encourage common measurement of qualities.

Scores

Within the four domains of capital for health care and for patient access to public hospitals the scale of 0-3 reflects:

Table E.1 Capital funding and patient access scoring system

Score	Timely access to capital for hospitals	Flexibility of funding for hospitals	Affordable capital for hospitals	Fairness of distribution between hospitals	Patient access to hospitals
3- highest score; good standard;	Timely access to capital	Flexible funding at local level	Low cost capital for contemporary health service delivery	Fair or equitable distribution of clinical assets	Good patient access to public hospitals
2- satisfactory or adequate standard	Access to capital within a reasonable period of time	Funding that responds to health service requirements	Some time or cost issues impede access to capital for clinical requirements	Distribution of assets that meets most population requirements	Permits most patients to access hospitals within clinical requirements
1- poor or inadequate standard	New capital is slow, delayed or infrequent (> 9 years)	Capital is highly rationed or difficult to obtain	The cost of capital influences service delivery	Distribution or volume of assets is very unequal	Barriers to some patients accessing care
0-lowest level; very poor standard; no effective system for capital	Little evidence of effective capital allocations or public investment in public hospitals.	Tightly controlled top-down regulations restricting access to capital; unconnected to clinical need.	Capital funds dependent on asset sales or privatisation of services; investment restricts service delivery	Only a small number of hospitals can obtain capital funding; funding not patient or clinical need-based.	Significant barriers for many patients seeking care

Scoring references

Note: not all indicators are relevant to all countries.

Quality 1 Timely access to capital

Considering the alignment of the capital allocation with recurrent expenditure for hospitals and with patient access to acute health services

- Is capital for hospital development available through a timely, established system of capital allocation?(3)
- Are there functioning well-established systems for allocation of capital for medical equipment and ITC? (3)
- Is there evidence that there is an adequate provision of beds per 1000 population? (2)
- Are there significant (2 -5 year) lags in the capital allocation system(2)
- is capital provided on an infrequent basis? (2)
- is the system unduly burdensome or unwieldy for hospitals making application?(1)
- is there infrequent capital funding for public hospitals (> 15 years)? (1)
- is funding dependant on creating vehicles for private financing of capital or philanthropic donation?(1)
- There is little or no capital funding for public hospitals? (0)
- There is no policy or system evident or information available on accessing capital funding?(0)

Quality 2 Flexibility of Funding

Capital funds for public hospitals

- can hospitals apply for funding outside specific national or regional priorities? (3)
- can decisions on capital deployment be made at the hospital or clinical level?(3)
- are capital funds only available if funds are dedicated to specific projects or purposes?(2)
- are capital funds limited to national or regionally directed investments(2)
- is investment funding determined only by regional or national plans? (2)
- are capital funds not accessible to all clinical areas or are some specialities better able to access funds? (1)
- are funds centrally allocated only for political or system requirements? (1)
- is there no flexibility in capital funding? (0)

- is there no evidence of, or information on, flexibility or responsiveness of capital funding to patient or clinical requirements?(0)

Quality 3 Affordable Capital

- Are capital fundraising repayment and transactional costs low?(3)
- Is capital an available resource to maximise productivity in the clinical environment?(3)
- Is capital for development available in a shared-risk and shared expense process with government?(2)
- Are capital payments only aligned to the cost of capital consumed or depreciation?(2)
- Do capital costs change or limit clinical service delivery?(1)
- Is capital only affordable for better-resourced or larger hospitals?(1)
- Do capital funding costs adversely affect hospital recurrent expenditures?(0)
- Do capital costs cause most or many hospitals to operate deficits or privatise services?(0)
- There is no information on how the cost of capital is managed within the system.(0)

Quality 4 Fairness of Distribution

- Are capital allocations well aligned with patient demand and recurrent expenditure?(3)
- Is capital for hospitals equitably distributed according to patients and population needs?(3)
- Are clinical standards for disease management supported by the distribution of capital for hospitals?(3)
- Do the majority of patients have access to appropriate hospital facilities and equipment?(2)
- Is there evidence that the distribution of capital for hospitals is usually adequate?(2)
- Are some geographic populations less well served by capital distribution than others?(1)
- Do hospitals with significant populations have more limited access to public funds for capital than other hospitals?(1)
- Is public funding of public hospitals severely restricted or non-existent?(0)
- Is there no evidence of, or information collected on, the distribution of capital, hospital beds, medical equipment between regions, areas or population groups?(0)

Patient access to public hospital care

- Are patients from all population groups able to access contemporary public hospital care?(3)
- Do population life expectancy, DALEs and other measures show positive treatment outcomes? (3)
- Is access to public hospital care generally within clinical limits for most of the population?(2)
- Are hospital bed numbers per 1000 population close to norms for other similar countries? (2)
- Do some socio-economic or geographic patients have difficulty accessing care or are their outcomes distinctly poorer than for other citizens? (1)
- Are there personal cost impediments for patients accessing care?(1)
- Are there significant cost impediments to care for large portions of patients?(0)
- Is accessing acute healthcare difficult for large portions of the population? (0)
- No information is available on patients access to hospitals.(0)

E.1.4 Task

To provide a score for each of the qualities for each nation based on the information in the extracts. To provide a score for patient access to public hospital care measuring access for the population as a whole (including rural, poor and urban people) based on the précis for each country.

Rules

After 1reading the relevant précis:

- It may be most effective to score from the lowest level (0) up.
- If the answer is no at the zero score progress up
- Where two levels may apply adopt the higher level unless you feel the weighting is greater for the lower level.

Score sheet

Table E.2 Scoring system for hospital's access to capital and patient access to public hospital

Criteria:	Capital				Average	Patient Access to Public Hospitals
	Timely Access	Flexible Funding	Affordable Capital	Fairness of Distribution		
Australia						
Austria						
Belgium						
Canada						
Denmark						
Finland						
France						
Germany						
Italy						
Japan						
Netherlands						
Norway						
Portugal						
Spain						
Switzerland						
Sweden						
UK						
USA						

E.2 Extracts

E.2.1 Austria

1. Timely access to capital

All hospitals can access capital funds from the regional government and some from the regional health fund as well. Health net capital stock (defined as investment capital minus depreciation) per capita grew faster than other sectors of the economy to 2005. Austrian hospitals have high capital intensity with capital funds increasing by 35.8% between 2004 and 2010, a rate higher than staffing costs. The Austrian population has above OECD average access to hospital beds and major medical equipment. (Hofmarcher 2013)

2. Flexibility of funding

Austrian hospitals have been successful in applying for capital funds for building and equipment with above average levels of investment. Hospitals can seek funds through the regional Lander or the Regional Health Fund. Capital grants for hospitals can be for the entire investment area (new hospital buildings, extensions and refurbishment, as well as major medical-technical equipment) or just a smaller area. National planning priorities seek to improve health status for all Austrians, develop system connectedness and reduce sub-acute bed numbers. (Hofmarcher 2013)

3. Affordable capital

Capital is available at low cost from the Lander and Regional health funds. High capitalisation of the health sector, internationally high levels of beds: population, and access to medical equipment. Capital is included in DRG (LKF) payments. In response to the global financial crisis of 2007-2013 the 2013 Health Reform plan capped Austrian capital expenditure at 2012 levels.(Czypionka 2014) There is no evidence of issues with affordability of capital. Public private partnerships and borrowings are not used in Austria.(Hofmarcher 2013)

4. The Fairness of distribution

In 2010 beds per 1000 population vary between regions by one bed per 1000 population from the national ratio of 5.9 beds. Unlike most countries Austria monitors and publishes investment capital costs per bed by region noting significant differences between the national average investment (€26,078), Vienna (€35 521) and other regions such as Styria (€19,516) and the rural low population region of Burgenland (€ 12,744) close (20 minutes) to Vienna in 2010.(Hofmarcher 2013)

5. Patient access to public hospital care

Patient access to public hospitals is legally guaranteed. “A series of international indicators confirm that the Austrian health-care system ensures relatively equal access to health-care. Only 2% of the population report difficulty accessing services, with only a very small proportion of those making reference to barriers resulting from costs. (Allin & Masseria, 2009).”(Hofmarcher 2013)page 248)

There are high levels (95%) of public satisfaction with the healthcare system according to a Europe –wide survey Eurobarometer 2010.(Hofmarcher 2013)

E.2.2 Belgium

1. Timely access to capital

Most Belgian hospitals are private hospitals (70%) with public hospitals owned at the municipal level. All hospitals have equal access to recurrent and capital funds with public hospital operating deficits met by municipal authorities. Infrastructure for hospitals in Belgium is paid by a separate budget to recurrent expenditure captured by DRGs. Around 60% of infrastructure is paid by the Belgium government and 40% shared between the hospital and the region. The results of investment are shown as bed numbers per 1000 population have remained constant to 2008.(Gerkens 2016) There were 6.2 beds per 1000 population in 2014 including psychiatric, private and long-term aged care beds. (OECD 2017) Information on the frequency of funding and capital investment per region was not available. Information was not provided for:

- money borrowed through public allocations and the criteria for public investment
- planning for hospitals is based on health needs or inputs
- infrastructure/capital planning.(Gerkens 2010; Corens 2007; Cleemput 2014; Wright 2010; Gerkens 2016)

2. Flexibility of funding

Hospitals negotiate individually with the Ministry for Health for inclusion in the investment budget. (Wright 2010) Heavy medical equipment in a hospital must be approved by the Minister of Public Health and funding is from the National Institute for Sickness and Disability Insurance (RIZIV-INAMI). (Corens 2007) Communications and IT budget are nationally funded based on historic budgets. (Wright 2010; Gerkens 2010; Cleemput 2014) Distinctions between long-term care beds and acute beds are not strong.

Information is not provided on:

- whether capital investment reflects stated public health priorities
- money borrowed through public allocations and the criteria for public investment
- the nature of any private borrowing or
- detail of the processes for funding application. (Gerkens 2010; Corens 2007; Cleemput 2014; Wright 2010; Gerkens 2016)

3. Affordable capital

Infrastructure for hospitals in Belgium is paid separately to recurrent expenditure based on DRGs. Around 60% is paid by the Belgium government and 40% shared between the hospital and the region. Amortised capital costs of up to 40% of the total cost are included in recurrent expenditure met through payments for patient care by national health insurance and the federal government. Significant diagnostic and medical equipment are usually funded by the medical practitioners and the hospital but sometimes there is also remuneration from the government within the hospital budget.(Wright 2010; Corens 2007; Gerkens 2010)

Due to the age of hospitals, “priority” construction works can benefit from a ratio of a maximum of 10% subsidy and 90% amortization to be met within the recurrent budget of the hospital. Priority constructions relate to rationalizing bed supply, improving patients’ comfort or complying with new standards. (Gerkens 2010)page 124)

Information is not provided on:

- money borrowed through public allocations and the criteria for public investment
- the nature of any private borrowing
- public–private partnerships for investment in capital facilities
- investment funding through donation or sale/disposal of assets. (Gerkens 2010; Corens 2007; Cleemput 2014; Wright 2010; Gerkens 2016)

4. The Fairness of distribution

Hospital locations are historical rather than planned so access to beds varies between regions from 7.2 acute beds per 1000 inhabitants in Brussels to 4.9 beds per 1000 population in the Walloon area. Medical equipment distribution is amongst the highest in Europe. Information was not provided on national health planning objectives patient satisfaction with health services.(Gerkens 2010; Gerkens 2016)

5. Patient access to public hospital care

Reviewing access to all hospitals a 2010 study found differences in access to hospital care by region, socio-economic status and education level of the patients. Accessing hospital care was costly for lower socio-economic groups. (Gerkens 2010)page 229)
Life expectancy varied between regions by 4 years for males. (Gerkens 2010)

E.2.3 Canada

1. Timely access to capital

Timely access to capital has been directly affected by models of capital funding, the efficiency of the investment process and restrictions in planning. (Klein 2013) Canada has less than 2 acute beds per 1000 population in 2008 compared to 3.3 in Australia and 2.7 in the UK. In 2014 capital for all health activities was 4% of total health expenditure.(Canadian Institute for Health Information 2016a) As regional health authorities (RHA) are required to hold capital expenditure as a current liability, private public partnerships or P3's are the preferred model to access capital for hospitals. So capital expenditures have been reduced and almost all medical laboratories and diagnostic clinics are owned by private corporations.(Marchildon 2013)page 84) Private philanthropy is also an important source of capital funding. (Klein 2013)

Medical equipment is the responsibility of RHA's but items are purchased through "arms-length health organizations" so clinicians purchase most medical equipment as part of their practices. (Marchildon 2013)page 84) RHAs determine the timing of major medical equipment purchases. Information is not provided on capital investment per province. (Marchildon 2013)

2. Flexibility of funding

Funding for hospital redevelopment and medical equipment is through a variety of sources linked to P3 arrangements. (Marchildon 2013; Ettelt 2008) However in 2011 most new capital investment was provided by government grant linked to specific hospital projects. (Klein 2013)page 10) Philanthropic donation is important to finance Canadian hospital development and medical equipment.(United States Congress 1995) Regional health authorities operate within state health plans for bed numbers and developments.(Ettelt 2008) Information is not provided on;

- money borrowed through public allocations and the criteria for public investment
- the nature of any private borrowing.

3. Affordable capital

The federal Department of Health is responsible for funding Regional Health authorities for capital acquisitions.(Health Canada 2014; Marchildon 2013)Hospitals may also fundraise for capital using markets. (Dixon 1990)Capital expenditure for public health was found to be \$256 per capita with 32.5% provided by the Canadian

government(Jacobs 2011) Toronto General Hospital was funded by a bond issue with a fixed rate of return of 5.64% with operational decisions impacted by debt service and accounting related to the bond. (Klein 2013)page 11) As most hospitals operate deficits funding capital or buying equipment is difficult. (Ettelt 2008)

While medical equipment is the responsibility of regional health authorities the national government has supported medical equipment replacement and health information technology since health agreements of 2000 and 2003.Canada requires government entities including regional health authorities to hold capital expenditure as a current liability. Consequentially governments have preferred PFI or P3 rather than having the cost of infrastructure as a liability. Contracted care to private companies has therefore become common with all pathology and imaging provided by private companies.(Health Canada 2014; Marchildon 2013) In a recent review it was observed that individual clinicians often determine the equipment to be provided and the vendor while the RHA determines the timing. (Marchildon 2013)

4. The Fairness of distribution

No information is provided on regional distribution of hospital capital or beds. Beds per 1000 population are not provided by region. International comparisons show Canada had internationally low bed to population ratios in 2008. (Marchildon 2013) The adequacy of capital investment and planning is questioned by clinical groups.(United States Congress 1995) Major medical equipment varies significantly between regions, particularly for remote areas or small populations. Information was not provided on national planning aims and achievements. (Marchildon 2013)

5. Patient access to public hospital care

Rationalization of health services in the 1990s created voter concerns that have been addressed by governments. Regional comparisons for benchmark treatments such as hip and knee replacement found waiting times were not meeting targets for all but 2 provinces. “In 2015, 87% of patients were treated within the benchmark of 48 hours — an increase of 8 percentage points from 2011.” Page 5(Canadian Institute for Health Information 2016b)

E.2.4 Denmark

1. Timely access to capital

In Denmark health and capital funding for hospitals are regional responsibilities. Sustainability and utilization are managed at the local level but since 2007 there have been limits on borrowing for investment set at the national level. Innovation and capital funds for improved service delivery can be provide from the national level often based on political considerations. Funds for capital are allocated to the regional governments based on a population based formula. (Strandberg-Larsen 2007) Hospital developments are financed through a combination of self-financing by the region, federal grants and loans within the borrowing limits.(Olejaz 2012) Quality improvements and improved governance have provided enhanced access to capital targeted at specific projects.(OECD 2013b)

The National Board of Health plans the distribution of expensive equipment and highly specialized services but investment in these services is at the regional level.(Ettelt 2008) In 2010 Australia and Denmark had 3.77 beds and 3.5 beds per 1000 population respectively. (OECD 2013b)

2. Flexibility of funding

In addition to the above information, capital for healthcare is funded outside the DRG system with separate budgets for buildings and equipment. (Wright 2010) The Financial Crisis of 2007-2013 did not affect capital investment in hospitals.(Rudkjøbing 2014) Regions have limits on borrowing which vary over time for political and other reasons. There are no private-public partnerships. (Olejaz 2012) Responsibility for hospitals is with regional authorities but rehabilitation is a municipal area. (Ettelt 2008)

3. Affordable capital

Capital funding programs to enhance hospitals efficiency and quality of care over 10 years were 60% funded by the national government.(OECD 2013b) The remaining 40% is met by regional authorities. There is a well understood system of capital allocation with minimal costs managed through the hospitals.(Olejaz 2012; OECD 2013b)

4. The Fairness of Distribution

Regional inequalities are less well tolerated by the Danish Government since activity based funding was introduced.(Ettelt 2008) Health inequalities are low and a resource allocation system responds to geographic variation. (OECD 2013b) Seventy per cent of Danes rate their health as good or very good and life expectancy is high. (OECD 2013b)

A panel of experts was appointed in 2007 to recommend to the government which hospitals should receive funding to centralise and rationalise services. A total of 16 hospital projects were recommended and approved (Good Hospital Building, 2011).(Ettelt 2008)

5. Patient access to public hospital care

There are large differences in investment in the sector due to regional differences. (Olejaz 2012) Regional planning for improved quality of care has improved access to safe services. (OECD 2013b) Policies of extended free choice combined with the government “treatment” guarantee have put pressure on the regions to optimize patient flow. (Olejaz 2012)

Bed numbers (2.9) per 1000 population were at the lower end of European provision in 2009.(Olejaz 2012)

E.2.5 Finland

1. Timely access to capital

Capital costs are paid within the DRG.(Vuorenkoski 2008)Since 1993 capital funding for hospitals has been a local government responsibility. State level intervention is expected only in an emergency. (Vuorenkoski 2008) All investment costs are included in the DRG system in Finland.(Wright 2010; Scheller Kreinsen 2011a) Finland has a decentralised health system with no overarching national infrastructure plan to the point where hospital bed numbers are not nationally collected.(Vuorenkoski 2008) Finland has a limited role for private capital in either infrastructure or in service provision of clinical services or patient accommodation.(Barlow 2010) DRG pricing varies between hospital systems who adopt different approaches to cost groups including capital interest costs.(Kantola 2014; O'Reilly et al. 2012b) Regional authorities also fund medical equipment. (Vuorenkoski 2008)

2. Flexibility of funding

All capital investment costs are paid within the DRG .(Vuorenkoski 2008)

In Finland 10-year capital needs are planned by the hospital district based on projected demand, technological change and existing stock and maintenance schedules. Hospitals can advance cases for short-term investment to be considered as well. (Ettelt 2008)

3. Affordable capital

All investment costs are met within the DRG with no outside grants system remaining in place.(Wright 2010) As investment funding is within regular payments there are minimal procurement costs. Finland has a limited role for private capital in either infrastructure or in service provision of clinical services or patient accommodation.(Barlow 2010) DRG pricing varies between hospital systems who adopt different approaches to cost groups including capital interest costs.(Kantola 2014; O'Reilly et al. 2012b)

Medical equipment is also funded from budgets by regional authorities leading to variations in distribution throughout Finland. There are no controls for high cost equipment such as MRIs, PET scanners and CT scanners but the MUMM program provides information and support to local authorities.(Vuorenkoski 2008) IT adoption is also funded through municipal budgets but a broad national profile is developing. (Vuorenkoski 2008)

4. The Fairness of distribution

Finland has a decentralised health system with no overarching national infrastructure plan to the point where hospital bed numbers are not nationally collected.(Vuorenkoski 2008) Sweden and Finland have the lowest bed: population ratios in Europe with 2.3 beds per 1000 population in 2003.(Vuorenkoski 2008) Access to doctors in the community has been the subject of reports finding pro-rich inequity in doctor visits was found to be one of the highest in Finland in 2000 (along with the United States and Portugal) (Van Doorslaer, Masseria, Koolman 2006)

5. Patient access to public hospital care

Häkkinen in 2005 identified differences in health status are diminishing between different sections of the population and socioeconomic however differences in mortality have increased.(Vuorenkoski 2008) There are also geographic differences

in hospital admissions. (Vuorenkoski 2008) but survival rates for cancer have improved. An important reason for differences in socioeconomic morbidity is the use of private services by wealthier individuals. (Vuorenkoski 2008)page 151)

E.2.6 France

1. Timely access to capital

In 2009 the HPST Act encouraged private sector providers to bid for public services and for private-public enterprise cooperation. (Chevreul 2010; Chevreul 2015) Since 2001 the Regional Health Agencies (*Agences Régionales de Santé*, ARS) have had responsibility for hospital planning, regulation and funding. (Thompson and McKee 2004)A system of DRG based hospital payments has covered private hospitals since 2005 and all public hospitals since 2008. (Or 2011)[note: Authors name is Or] Social health insurance permits a large private elective surgery sector and some PPP investment in public sector patient accommodation. (Barlow 2010)There is considered to be an oversupply of beds and hospitals in France.(Ettelt 2008)

Capital costs for public hospitals are provided in DRG financing where formerly there was direct capital funding from the State for hospital developments .(Wright 2010; Scheller Kreinsen 2011a) (Thompson 2011b) Hospitals are required to transfer recurrent revenue into investment accounts to cover the costs of depreciation. (Thompson 2011b) Loans from the government or the European Investment Banks are repaid from individual hospital investment accounts. (Thompson 2011b) National health plans cascading to regional health plans define investment objectives. For example the national Hospital Plans of 2007 and 2012 provided a framework, €12 billion in grants and €2 billion in loans and expertise for the expansion of both public and private hospitals. The objective in 2012 was to complete the process for upgrading French hospitals, to improve computer-based record systems in hospitals and restructure based on regional plans. Paralleling the 2012 plan were objectives to improve efficiency and productivity to fund future investment.(Guerrero 2009) Two new forms of hospital investment were also permitted with long-term leases (*bail emphytéotique hospitalier*, BEH) of public hospitals to private companies and tendering for build-construct-maintain contracts for public hospitals. (Chevreul 2010)

While the Ministry of Health licenses new hospitals, local ARS manage planning and infrastructure redevelopments within the national framework endorsed by the Ministry. Perhaps because health provider representatives and members of the public

are included in health planning, France has bed to population rates of 7.8 per 1000 population compare to the Australian rate of 2.6 beds per 1000 population. (Chevreul 2010; AIHW 2014a) Capital expenditure for hospitals was maintained during the financial crisis of 2007-2013.(Chevreul 2014)

2. Flexibility of funding

Depending on the public health priorities, capital investments in the health care sector are either covered by reimbursements for service delivery or funded by specific national or regional programmes. Hospital Plan 2007 (*Plan Hôpital 2007*) and Hospital Plan 2012 (*Plan Hôpital 2012*) part funded investments in hospitals also underwriting 20 year loans to hospitals. PPPs were also used but the French Accounts Commission (*Cour des comptes*) criticized the realization of these partnerships as being insufficiently planned and executed (Cour des comptes, 2014a).(Chevreul 2015)

The 2012 Hospital Plan permitted a broad spectrum of additional projects under the objectives: hospital information technology systems, restructuring of hospital facilities at the regional level (e.g. collaborations and mergers between hospitals) and improvement of compliance with safety standards (e.g. seismic compliance and asbestos removal).(Chevreul 2015)

3. Affordable capital

Capital is located within the DRG payment and additional capital funding programs supplement hospitals major up-grades. The bed to population ration of 8.7 beds per 1000 population is high. France under arrangement with the European Investment Bank financed public and private hospital construction and renovation projects under the Hospital of the Future Programme.(Chevreul 2015)

In an econometric analysis of a range of health factors, the French health system was rated by WHO as having the highest efficiency in a healthcare sector of the 191 WHO member nations.(Tandon 2002) An OECD study also found France had a more efficient closely monitored prospective budgeting system of health financing than Germany and the OECD average. (Schoenstein 2013)

Medical equipment is also authorised through the local ARS. ICT costs are also managed at the regional level although there are national programs with legislative backing to promote the electronic medical record (DMP) which receive national funding. (Chevreul 2010) Depreciation as the total cost of an item depreciated over its economic life provides a better return for hospitals than infrastructure spending

with longer pay-back periods and so investment favours equipment over infrastructure.(Thompson 2011b)

4. The Fairness of distribution

Planning for French hospitals depends on patient numbers rather than bed/population ratios.(Ettelt 2008) Regional Health Agencies (*Agences Régionales de Santé, ARS*) have had responsibility for hospital planning, regulation and funding. (Thompson and McKee 2004) which is closely connected to national health plans and funding. Capital costs provided in the DRG align the distribution of capital with patient activity.

5. Patient access to public hospital care

French life expectancy has been steadily increasing over the 21st century at a faster rate than the OECD average or the UK and Germany.(World Bank 2017) France has the world's highest national life expectancy after Japan.(D. Squires 2015) For life expectancy adjusted for incapacity, France ranked first among the 14 countries studied by the European Commission. French patients have a relatively high level of satisfaction with the health system with 88% rating the overall quality of the health care system as good or very good, compared with 71% of the EU28. Waiting times are not an issue of significance.(Chevreul 2015)

E.2.7 Germany

1. Timely access to capital

In 2012 Germany had 2017 hospital of which nearly half were public hospitals and 18% were for profit private hospitals. The remainder are not-for-profit private hospitals (34%). Only 2% of hospitals are not entitled to capital funding from the state under either the University Capital Investment Act or the Hospitals Financing Act. The federated German States have a system where taxes pay for the capital costs of hospitals and state health insurers pay for the operational costs of hospitals. To obtain the free capital from the local state authority (Bundesland) hospitals have their plans approved and accredited by the regional hospital plan (Krankenhausplan). (Busse R 2014) Capital funding is outside DRG funding.(O'Reilly et al. 2012b)To avoid the obligations of accreditation some hospitals raise funds through commercial markets with combinations of equity and debt. (Dewulf 2009) Germany has a system of regulated competition between private and public providers. (Hofmarcher 2013; Barlow 2010) In 2010 Germany had a ratio of 8.3 hospital beds per 1000 population,

significantly higher than the OECD average of 4.9 and the Australian average of 3.7 beds at the same time. (Schoenstein 2013)

Unlike most nations the review of the German health system lists annual investments in hospitals since 1991.

2. Flexibility of funding

All hospitals can apply for free funding under hospital plans (*Krankenhausplan*) if the investments are within the criteria of the hospitals plan and there is money available. Germany has developed a dual funding process and a system favouring over-provision of capacities and major items of equipment (Rürup et al., 2008)(Busse R 2014). Additional programs like electronic medical records, the electronic health card(eGK) were federally funded.(Busse R 2014)

3. Affordable capital

A system of cost allocation for DRGs is based on hospital Master and maturity asset registers that allocate annual capital costs to cost modules and cost centres linked to operational expenditure on DRGs.(Vogl M 2014) Reimbursements are based on the hospitals' assets so a poorer hospital is paid a lower price than a well-endowed hospital for the treatment of the same DRG. But hospital investment costs are fully met through the DRG system.

Hospital infrastructure, medical equipment and other equipment associated with hospitals is generally provided by the Lander through subsidies based on the hospital requirement plans submitted to the provincial authority .(Wright 2010; Busse R 2014) The Financial Crisis of 2007-2013 did not affect capital expenditure.(Henke 2014)

Information and communication technologies in the health care sector are funded to improve the efficient utilization of resources, service quality and an increased patient numbers. (Busse, Zentner & Schlette, 2006).(Busse R 2014)

4. The Fairness of distribution

There were 6.2 beds per 1000 population for acute care which was above the OECD average of 3.4 in 2011. (OECD, 2013a).(Busse R 2014) Regional hospital bed to population data is collected and reported annually. The variations of bed numbers are less than 2 per 1000 population and at the lowest level remain above the OECD average. Hamburg and Bremen, have higher than average capacities; in fact, Bremen has the highest capacity, at 7.9 beds per 1000 population. Schleswig-Holstein(5.7)

and Baden-Wurttemberg(5.4) together with Lower Saxony(5.4) have the lowest density of hospital beds. Bavaria has moved to average per capita levels while Bremen, Thuringia, Saxony-Anhalt and Hamburg have the highest capacities(7.0-7.9)(Busse R 2014)

5. Patient access to public hospital care

The German system aims to be patient-centred and there are low co-payment costs for patients and waiting lists are very short by European standards. Surveys of the Commonwealth Fund – as well as other studies – often conclude that Germany comes out best on the question of access to medical care (Schoen et al., 2010, 2011). For example, a Commonwealth Fund survey showed that 83% of respondents waited less than four weeks for an appointment with a specialist and 78% answered that waiting time for an elective surgery was less than one month.(Busse R 2014)page 257)

E.2.8 Italy

1. Timely access to capital

The Italian DRG system includes all costs associated with the care of the patient during their episode of care. This includes room and board, equipment, staffing costs and medications. In addition some capital assets are financed by specific programs strictly linked to public functions or public services. (Wright 2010) Italy has a small private hospitals sector and limited PPP involvement.(Barlow 2010)

Using 1997 information to assess a range of health factors, WHO rated Italy as having the second highest level of efficiency in healthcare.(Tandon 2002) Responding to the global financial crisis of 2007-2013 the government reduced the number of beds per 1000 population to decrease hospitalization rates.(Ferrè 2014)

Medical equipment is also funded through the DRG system and equipment is purchased through tenders using group purchasing for a number of providers. The European epSOS (European patients Smart Open Services) has been adopted and extended to include the IPSE which focuses on the trans regional transfer of medical data and the establishment of a patient summary as well as e-prescription. Building on the investment in TELEMED the European ‘Renewing Health’ system promotes remote patient monitoring and the management of patients with chronic condition. (Ferré 2014)

2. Flexibility of funding

To 1988 a central committee of the National Health Fund approved funding for hospital projects. The process successfully delivered regular funding and was resumed in 1998 with additional investment for general hospital building and specific funding for national objectives including radiotherapy facilities.(Ferré 2014)

Many hospitals have adopted 'lean management' techniques grouping patients by level of care rather than clinical specialty. One example is Careggi Hospital in Florence, where clinical activities are performed in 10 clinical departments created on the basis of health needs (Rechel et al., 2009). These and other experimental delivery models have been funded by regions to improve efficiency and quality.(Ferré 2014) A range of investments in experimental systems such as Eprescribing, EMedical Records and telematics health are being trialled and evaluated for roll-out across Italy.(Ferré 2014)

3. Affordable capital

Decentralisation of responsibility to the regions for hospitals encouraged additional sources of funding for health infrastructure including, European Union funds, asset sales, mortgages, loans and budget advances. An independent national assessment body reviewed the implementation of publicly funded facilities' investment(de Belvis 2012) (*Nucleo valutazione e verifica investimenti pubblici*(de Belvis 2012)

The mean age of Italian hospitals is 70 years and since 2012 there has been a reduction in funding for investment. Bed numbers have been reduced to 2.73 per 1000 population in 2012 which is below the EU15 average and the EU27 average.(Ferré 2014)

4. The Fairness of distribution

Resources used within for the treatment of the patient are reimbursed within the DRG payment. In addition capital investments can be funded through programs for the benefit of the public.(Wright 2010)

Italy had 2.73 beds per 1000 population with an average hospital age of 65 years in 2001 (Thompson and McKee 2004). There were 3.4 beds per 1000 population but legislative targets in 2014 were 3.7 beds per 1000 population of which 0.7 should be for non-acute care beds.(Ferré 2014)

However the diffusion of medical technology is not evenly distributed across the country. Some regions, such as Liguria, the central regions, as well as Molise, Basilicata and Sardinia have high levels (higher than the national average) of technologies available in public facilities while others in the south have constantly lower levels (Campania, Puglia, Calabria and Sicily).(Ferré 2014)

Some Italian regions have fully deployed a patient summary that includes administrative data and medical history (Tamburini et al., 2010). Italy is also involved in the European epSOS (European patients Smart Open Services) project where the Italian initiative – IPSE – focuses on the trans-regional transfer of medical data and the eprescription system. (Ferré 2014)

5. Patient access to public hospital care

In the 2012 Eurobarometer survey of EU-27 countries, Italy had one of the lowest scores in terms of citizens' perception of the quality of health-care provision, ranking 20th with long waiting lists outpatient specialist care and diagnostic services. A 2010 Ministry of Health survey found no significant geographical variation for access to hospital services and equitable access based on care needs across Italy.(Ferré 2014)

E.2.9 Japan

1. Timely access to capital

Government set reimbursement rates do not include capital and access to capital was an issue raised by the OECD. (OECD 2015b) Capital has to be raised from the resources of the hospital or borrowed from members of the hospital corporation and/or on the financial market. Some hospitals issue unsecured bonds set at one percent above the long term bond rate.(Japan Times 2003)

Japanese hospitals are well-endowed with medical equipment even psychiatric hospitals due to the fee-for-service payment system. Medical practitioners often purchase equipment.(Tatara 2009)

2. Flexibility of funding

The Health Care Structural Reform Act 2006 introduced detailed descriptions and indicators on health service resources, utilization and outcomes for four diseases (cancer, stroke, acute myocardial infarction and diabetes) and five areas of health care (emergency medicine, disaster medicine, rural medicine, prenatal medicine and child health care) into prefectural health care plans to ensure well-coordinated health care services.(Tatara 2009)

3. Affordable capital

The cost of capital infrastructure is met by hospitals from their patient payments. Having trialled the DRG system Japan turned to a diagnosis and procedure code (DPC) system for per diem payments to hospitals. Payments to cover room, board, nursing and laboratory costs decrease after the average length of stay has been exceeded. DPC payments vary between hospitals for the same codes. Medical costs are funded through a fee-for-service system. There are no planning restrictions on private hospitals but public hospitals are required to fit within prefecture planning guidelines. Public hospitals tend to be quite large and clinically dominant. (Tatara 2009; OECD 2015b)

4. The Fairness of distribution

In 2006, Japan had 8.2 acute hospital beds per 1000 population when Australian had 3.6 beds per 1000 population. In 2006 the average length of stay was thirty –five (35) days when Australia’s length of stay averaged to 3.3 days. (Tatara 2009; AIHW 2008) By 2012 average length of stay had reduced to 32 days but a number of financing issues resulted in both long-term aged care patients and acute patients using acute hospitals.

Japanese hospitals are in general well equipped with high-technology medical devices(Tatara 2009)

5. Patient access to public hospital care

Japan has the highest bed to population ratio in the OECD. Japan’s health care system emphasizes “free access”. This does not mean that patients can receive care free of charge, but instead patients may choose any provider of their choice; there is no system of GP gate-keeping. So patients can choose either a clinic or a hospital as their first point of contact with the health system. The OECD found half hospital patients were there for help with daily living rather than acute care (page 130(OECD 2015b)

“Japan has achieved the longest life expectancy in the world. To some extent, this achievement can be attributed to the health care system” (page 145(Tatara 2009)

“Moreover, Japan has the lowest rate of avoidable deaths among females, and the second lowest for deaths from ischaemic heart disease (Nolte and McKee, 2008).”

E.2.10 Netherlands

1. Timely access to capital

Capital, ITC and medical equipment costs are included in the reimbursement for patient care through DRG type payments (DBC's). (Scheller Kreinsen 2011a) After 2006 centralised planning and approval of hospital facilities ceased although all hospitals are licensed. Hospitals are individually responsible for building and equipping. ZBCs are 23 hour independent treatment centres providing non-urgent care. They are also funded through diagnosis based funding. (Schäfer 2010)

A range of equipment is covered by DBCs however List B DBCs also cover capital. (Wright 2010)

2. Flexibility of funding

As compensation for investments is included in the DRG payments, health institutions are fully responsible for carrying out their (re)constructions and for the purchase of equipment. (Kroneman 2016) No external approval of building plans applies, although the quality of premises is externally assessed every five years. (Schäfer 2010)

3. Affordable capital

Capital for medical equipment is identified as List A or List B. Some capital costs are included in list A and all capital investment costs are included for List B equipment. (Wright 2010) List A covers high capital value services such as Emergency medicine including a 'closing tariff' of historic capital costs. List B are negotiated with numbers of insurers and individual hospitals and has come to reflect negotiating power rather than actual costs. The system has led to deficits and investment plans not proceeding. (Wright 2010) Since 2010 hospitals have been able to borrow through the collective Foundation Health care Sector Guarantee Fund (*Stichting Waarborgfonds voor de Zorgsector*, WFZ) at lower interest rates (1-1.5%) With hospitals managing the risk of capital investment, more care is being provided in patients' homes, and in 23 hour centres (ZBCs). Since 2010 investment in hospitals has decreased. (Kroneman 2016)

4. The Fairness of distribution

In 2006, bed supply was 3.0 acute care hospital beds per 1000 people. (WHO Regional Office for Europe 2009). Despite central bed planning ending in 2008, acute beds had increased to 3.32 beds per 1000 population in 2012. Balancing the relatively

low bed to population ratio it would appear that beds are not fully utilised as average bed occupancy rates are relatively low at 46%. (Kroneman 2016) All mainland Dutch people are within 25 minutes' drive of a hospital.(Kroneman 2016)

Early century IT adoption had not been strong with low ITC spending in the health sector compared to other parts of the economy. (Schäfer 2010) hospitals are responsible for purchasing their own medical equipment. The Netherlands had lower ratios of MRI and CT equipment per million population than the average for other EU15 nations in 2013 but more PET scanners.

5. Patient access to public hospital care

In 2006, the nearest hospital with an emergency department was available for 99.6% of the population within 30 minutes of travel time. For half the population, travel time was less than 10 minutes (Deuning 2008)(Kroneman 2016). Eurobarometer data for 1999 and 2001 also suggest geographical accessibility that is among the best in the EU.(Schäfer 2010)

“In 2006, it has been estimated that the total effect of health care in the Netherlands has increased the overall life expectancy by three to four years since the 1950s (De Hollander et al. 2006; Meerding et al. 2006).” (Schäfer 2010)page 196)

E.2.11 Norway

1. Timely access to capital

The central government owns the hospitals although health trusts are required to finance investment in hospitals from their incomes. In the case of large investments grants can be sought from the owners and loans may be sought from the Norwegian Central Bank. Hospitals are funded by block grants including reimbursement of capital costs.(Ringard 2013) Hospitals are funded through a mixture of block grants and DRG payments.(Ringard 2013)

So ultimately all investments for hospitals are obtained from the private sector after approval. There are few restrictions on the acquisition of medical equipment and technologies other than approval by the Health Ministry.(Ettelt 2008)

2. Flexibility of funding

Each of the Regional Health Authorities has authority to plan and manage infrastructure needs according to their needs so decisions about capital investment

reside with the hospital Board. Hospitals finance investments from their general incomes. In the case of large capital investment projects, they may apply to the Ministry of Health for special investment grants. The RHAs may finance investments in the health trusts by borrowing (debt financing). RHAs are not allowed to borrow money in the private market but can borrow money from the Norwegian Central Bank. As the owner of the hospitals, the ministry shares responsibility for the control and monitoring of investments in health enterprises. In addition, the ministry has the authority to approve larger building projects in accordance with special regulations (for such projects 30% of the funding has to come from the RHA).(Ringard 2013)

Similarly medical equipment costs are met by the health trusts although the Helseforetaketnes Innkjøpsservice (HINAS) purchases major medical equipment for the trusts. However important items of equipment may have political input as with the purchase of the first PET scanner in 2004 which was decided by parliament.

The Norwegian Health Network provides secure electronic exchange of patient information via a health communication network. ITC for hospitals is funded through hospital income. (Ringard 2013) yet the Commonwealth fund identified Norway as having the least patient centred system of 11 advanced nations reviewed.(Davis 2014)

3. Affordable capital

Hospitals have to prepare careful business cases to prove they can repay capital costs raised from private sources.(Ettelt 2008) As the hospital board can only borrow from the Norwegian Central Bank their cost of capital is relatively low. Municipalities may pass block grant funds for capital to the hospitals and may take out loans to fund local hospital investment. (Ringard 2013)

4. The Fairness of distribution

The number of hospitals and hospital beds is positively correlated with the population density. In 2010, the number of acute hospital beds in Norway, at 2.4 per 1000 population was below the EU27 average of 3.9.

Annual reports on the age and condition of hospitals are legally required. Norwegian hospitals are comparatively new with a 2009 survey finding the average age of the hospital buildings was approximately 40 years and 21% of hospital buildings were built after 2000.

A single entity the , Helseforetakeres Innkjøpsservice (HINAS) coordinates the purchase of medical equipment and technology on behalf of all hospitals. with the aim of equality of access.

5. Patient access to public hospital care

Waiting times for specialist treatment are high by European standards with to wait four months or more for elective surgery (the third highest score after Canada (25%) and Sweden (22%)) (OECD, 2012b). According to a recent report by the Directorate of Health, the proportion of violations of maximum waiting times was reduced between 2006 and 2011(Directorate of Health, 2012b).

The attempt to secure equal geographical access has been and still is given high political priority in Norway.(Ringard 2013) The Public Health Act of 2011 places the responsibility for reducing health inequalities at the heart of the government's public health efforts nationally, regionally and locally.(Ringard 2013)

E.2.12 Portugal

1. Timely access to capital

Health financing is one of 6 areas of reform recommended by the OECD.(OECD 2015c) Capital is managed through separate grants for hospital redevelopments and medical equipment unconnected to DRG payment systems. (Wright 2010) The Health Ministry funds capital investments using government grants (from a financially constrained government) and some EU co-financing.(OECD 2015c; Barros 2011) Capital budgets for health are set within the Program of Investments and Expenditure for Development of the Central Administration (PIDDAC) operated by the Finance and Planning ministries.(Correia de Oliveira 2003)

Portugal has PPPs providing both patients accommodation services and clinical services. (Barlow 2010; Barros 2011) However the experience of PPP's is that "The process of each public-private partnership is very complex and lengthy, involving preparation and previous evaluation, the approval and launch of the contest, the proposals and the evaluation of these proposals, followed by a round of competitive bargaining and the final bargain with the winner. Each step of the process takes months and sometimes the process has to start from scratch all over again, because of bureaucratic problems." (Barros 2011)page 83) Major medical equipment distribution is aligned to British-style models including PPP, outsourcing and leasing. (Barros 2011; OECD 2015c)

2. Flexibility of funding

Portugal has reduced bed numbers to improve economies within the hospitals sector. Funding is constrained. As part of health reform to improve quality and financial sustainability in 2011, hospitals became Hospitais SPA (managed by the regional health authority), incorporated public hospitals (Hospitais EPE) responsible to their board and contacting services to the regional health authority or public-private partnership hospitals (PPP). The later were created to gain finance for “urgent hospital investments”.(OECD 2015c)page 119) Portuguese hospitals require national government approval for investments greater than 2% of their statutory capital.(Durán 2013)

3. Affordable capital

Hospitals are managed by regional health authorities and capital is not included in DRG’s.(OECD 2015c) DRG payments provide 50% of hospital recurrent funding with block, outpatients and performance grants providing the remainder. So directly managed hospitals have to find capital from national grants, as do incorporated public hospitals (Hospitais EPE) boards who are responsible for obtaining and managing the cost of investment capital. Public-private partnership hospitals (PPP) obtain capital from private equity and borrowing and are also required to meet these costs from hospital income. Hospital reforms are focussing on more efficient hospitals with mapping and centralised purchasing of medical equipment and strategic planning.(OECD 2015c) Information was not available on national capital allocations since 2002

4. The Fairness of distribution

Hospitals are grouped according to their function and population requirements. (OECD 2015c) In 2012 there were 3.4 beds per 1000 population similar to Australia but lower than the EU average. Significant reorganisation of hospitals since 2011 has improved financial sustainability and quality of care while ensuring access to appropriate services for patients. There is a legal requirement for “equity in the distribution of resources and use of health care services (Law 48/90, 24 August 1990, with changes introduced by Law 27/2002, 8 November 2002).”(Barros 2011)page 128) in 2010 Portuguese men and women had a six year life expectancy gap with average life expectancy of 80.5 years, similar to the OECD and the European averages. Average life expectancy has increased to 81.3 years in 2014.(Eurostat 2016)

Hospitals were found to be aggregated near the coast and in urban centres leading to poor access for rural residents in a 2003 study.(Correia de Oliveira 2003)

5. Patient access to public hospital care

Portuguese Law 48/90 also requires equality of access to health care for the citizens, irrespective of economic condition and geographic location”(Barros 2011) In 2008 there were 2.27 beds per 1000 population which is amongst the lowest in EU27. (Barros 2011) Patient confidence in the hospital system is not good with 54% of residents reporting the system required fundamental change.(OECD 2015c) Access is most commonly measured as access to medical services rather than hospitals.(OECD 2015c)

E.2.13 Spain

1. Timely access to capital

- Spain has one of the lowest levels of health expenditure in Western Europe and the 1991 Abril Commission criticised the lack of efficiency, flexibility and poor clinical involvement in hospitals. The resulting legislation empowered regional governments to use private sector delivery of services if free and integrated access to hospital services for patients could be assured.(Serrano 2009) While capital is not funded through the DRG system capital funding is made available by grants and subsidies.(Scheller Kreinsen 2011a) (Wright 2010)
- National legislation in 2002 created a framework for the development of nationally consistent computerised medical records. Medical equipment purchases and technology assessment are the responsibility of regional governments(Granados et al. 2000) but are not well regulated and “ subject to the individual policy-makers”(Durán 2006)page 92)
- There have been two major investment cycles for hospitals preceding and following the 2002 transfer of responsibility for hospitals to regional authorities so capital grew by 150% between 2000 and 2007.(García-Armesto 2010) Funding has decreased since 2007.

2. Flexibility of funding

Spanish hospitals are configured as public health care companies, hospital foundations, consortia or administrative concessions, varying by degree of autonomy.

- public health care companies are chaired by the regional health minister
- Foundations can make independent investment decisions

- Public health care foundations are led by local and regional health department authorities (Álvarez 2013)
- Administrative Concession hospitals in Spain can hold up to 7.5% of profits to fund future investment.(Durán 2013) These hospitals are usually joint venture arrangements with health insurers and financiers.(Álvarez 2013)

3. Affordable capital

Hospitals are managed by regional health authorities and capital is not included in DRG's.(OECD 2015c) DRG payments provide 50% of hospital recurrent funding with block, outpatients and performance grants providing the remainder. So directly managed hospitals have to find capital from national grants, as do incorporated public hospitals (Hospitais EPE) boards who are responsible for obtaining and managing the cost of investment capital. Public-private partnership hospitals (PPP) obtain capital from private equity and borrowing and are also required to meet these costs from hospital income. Hospital reforms are focussing on more efficient hospitals with mapping and centralised purchasing of medical equipment and strategic planning.(OECD 2015c) Information was not available on national capital allocations since 2002.

4. The Fairness of distribution

There are 3.43 beds per 1000 population which is similar to Australia but below EU averages. Bed distribution across regions has “Catalonia, Cantabria and Aragón as the highest total beds ratio per 1000 population (above 4), whereas Valencia, Andalucía and Castilla-León show rates below 3 per 1000 at the other end of the range, however the range of variation is quite narrow (from 2.68 to 4.41). “ page 142(García-Armesto 2010)

5. Patient access to public hospital care

Even before the legal requirement for equality of access studies identified that patients across Spain had “equity in access to health care (i.e. doctor visits, emergency room visits and hospitalization) over the period 1987–2001.” (García & López 2007). More recent figures were not available in 2010. (García-Armesto 2010)

E.2.14 Sweden

1. Timely access to capital

In Sweden 21 county councils (local government) own public hospitals which are funded through taxation and grants from the States.(Thompson 2011b) (Thompson and McKee 2004) Swedish hospitals were government funded from the great expansion of the 1970s and closely linked to the welfare sector. In the late 1980s competition was introduced using quasi-market mechanisms (Martinussen 2009; Anell 2012). Decentralisation failed to deliver new hospital building or modernisation and was seen as deficient in improving standards.(Martinussen 2009) The new Karolinska Solna Hospital is the first PFI in Sweden.(Anell 2012)

All costs including capital are covered within the Swedish system of DRGs.(Wright 2010; Scheller Kreinsen 2011a) However, as the system of health capital allocation in Sweden is based on taxation funding there are limited opportunities for PPP in public hospitals. (Barlow 2010)Medical equipment is funded in the DRG but there are no statistics kept on major medical equipment. (Anell 2012; OECD 2013a)

2. Flexibility of funding

It is up to every hospital and their county council to procure medical equipment. ITC is purchased at the county level but directions are being coordinated nationally.

3. Affordable capital

All capital investment costs are funded through the DRG. (Wright 2010)

4. The Fairness of distribution

Differences between the 21 county councils capacity to invest in hospitals and medical equipment is resolved through a national risk adjusted resource allocation system and extra grants based on population differences.(Anell 2012) Annual reports on county health services performance covering national quality registers, the National Healthcare Barometer Survey, the National Waiting Times Survey and the National Patient Survey are published annually. (Mossialos 2016) There is a funded guarantee to patients (the 0-7-90-90 rule) that includes waiting no more than 90 days to receive treatment after being diagnosed.

5. Patient access to public hospital care

The Commonwealth Fund International Care Survey of 2015 and the European Union Statistics (EU-SLIK)found the UK had the lowest levels of unmet care needs followed

by Sweden.(OECD 2015a; Mossialos 2016) Sweden has a national portal –My Healthcare Contacts-that has allowed one quarter of Swedes to request, cancel, or reschedule healthcare appointments, renew prescriptions, and request contact with a specific clinician or hospital.(Hägglund 2015)

In international comparisons of mortality amenable to medical intervention by Nolte and McKee (2003, 2008, 2011), using data from 1997to 2007, Sweden consistently ranked among the best. Sweden has minimal disparities of health amongst residents(Mossialos 2015).

E.2.15 Switzerland

1. Timely access to capital

Capital for hospitals has been reimbursed through DRG payments since 2012 often supplemented by local (canton) investment funds. Capital costs included in DRGs were estimated at 10% of recurrent expenditure. (De Pietro 2015)

Like Germany Switzerland has both public (65% of beds) and private sector providers in a system of limited competition. (Hofmarcher 2013; De Pietro 2015) Switzerland included capital within the DRG costs in 2012 (at a rate of 10%of recurrent costs) but is working to define the actual costs. The main issue in Switzerland has been judging the correct amount to allocate to each DRG for capital. (De Pietro 2015) some capital for special cases is also provided as grants from the cantons or through inter-cantonal arrangements. Since 2012 investments have been higher due to the need to replace 1970's hospitals and the DRG funding system.

The Commonwealth Fund identified Switzerland as ranking second for patient-centred for care of 11 advanced nations (Davis 2014). Switzerland has one of the highest ratios of diagnostic equipment to population in Europe. Major medical equipment is funded through the DRG system of payments with limited use of technological assessment to inform decisions. (De Pietro 2015)

2. Flexibility of funding

As hospital capital funding is set at 10% of recurrent expenditure, investment decisions are made by the hospitals. Canton payments for capital continue but are declining since the change to DRG funding in 2012. (De Pietro 2015) As planners of local services the Cantons influence capital decision making as does inter-cantonal planning for specialised services (trauma, burns, neonates, cancer)

3. Affordable capital

Most Swiss hospitals were built before 1970 and have been found to need replacement by an extensive survey. There is considerable need for investment (PwC, 2013). Swiss health costs are relatively high

4. The Fairness of distribution

Since 2012 patients have been free to choose care in any canton.(Mossialos 2015)). There are 3.9 beds per 1000 population; density is highest in North-western Switzerland (5.7 beds per 1000 population)and lowest in Central Switzerland (3.2 beds per 1000 population).(Mossialos 2015; De Pietro 2015)

5. Patient access to public hospital care

Health inequalities are not regarded as significant in Switzerland particularly when compared to other OECD countries.(Mossialos 2015) The European Health Consumer Index (Björnberg, 2015) found that Switzerland was best at accessibility (together with Belgium).(De Pietro 2015)

E.2.16 United Kingdom

1. Timely access to capital

Unusually, in the UK the Department of Health includes in the definition of health capital expenditure on demolition, building, acquisition, adaption, renewal, replacement and maintenance of buildings, equipment and vehicles.(Boyle S 2011)

Since 2004 capital financing of acute clinical services has been the responsibility of the NHS Acute Trusts under the supervision of the UK Department of Health and executive non-departmental public bodies including Monitor and the NHS Trust Development Authority. (Boyle S 2011) NHS Acute Trusts are publicly owned corporations responsible for providing hospital services in a defined geographic area of England. They were established by the *National Health Service and Community Care Act 1990*. (Monitor 2014) Since 2007-8 NHS Trusts have had prudential-based capital allocation limits imposed to limit borrowing by trusts either from banks or from the Health Departments Foundation Trust Financing Facility.(Boyle S 2011; Dixon 1990)

NHS trusts and Primary Care Trusts are responsible for identifying investment requirements and preparing business cases for funding. The business case process has

extensive guidelines with planning processes varying according to the size of the project. Spending limits (£1 million to £10 million) depend on the national rating of the trust and the “prudent borrowing limit” allocated to the trust. Approval processes are lengthy and complex. While leasing thresholds are lower, approvals from the Department of Health and the local health authority are required for Private Finance Initiatives(PFI).(Ettelt 2008) Obtaining capital finance is complex, expensive and imposes bureaucratic burdens. A plan for developing 100 new hospitals resulted in 48 of 57 built by PFI. (Ettelt 2008) Capital expenditure is restricted (Dunhill 2019)

2. Flexibility of funding

The process for obtaining capital is highly restrictive. The NHS Trust Development Authority (TDA) published Capital Regime and Investment Business Case Approvals Guidance for NHS Trusts in July 2014 (NHS Trust Development Authority 2014) outlining the principles and process for capital acquisition for hospitals. NHS Trusts are required to prepare Capital Investment Plans with Capital Cash Management Plans reflecting local investment priorities and affordability for approval by the TDA. Trusts can allocate funds from surpluses, receipts from the disposal of assets, cash associated with the charge for depreciation, grants or donations, or unspent capital brought forward from previous years. Funds may also be accessed as interest bearing loans from the TDA when approved by the Department of Health under strict conditions of affordability. These capital investment loans (CIL) are described as the primary source of funds for capital investment. Additional capital can be sourced externally from Exceptional Public Dividend Capital (PDC). (NHS TDA 2014) The PDC is used when the trust cannot afford to:

- take urgent remedial action required for patient safety recommended by the Care Quality Commission;
- to achieve Quality, Innovation, Productivity and Prevention (QIPP) targets to achieve future savings
- for an agreed service rationalisation or
- if the service is part of a national programme.

PDCs are not grants and require repayment however assets created under a PDC attract the 3.5% capital charge all assets are required to provide. Private financing through Private Finance Initiative (PFI and PF2,) and Local Improvement Financial Trust (LIFT) financing is also available to Trusts. All capital expenditure is subject

to the annually allocated Capital Resource Limits (CLR). The NHS TDA in conjunction with the Department of Health adjust CRLs. (NHS TDA 2014)

External financing limits are examined closely in relation to the cash flow of the Trust on a year to year basis. Capital expenditure has to be closely examined to minimize disruption to acute service funding. Trusts are able to retain depreciation costs for reinvestment and borrow using a CIL if it can prove affordability and that it can meet the interest payments and replay the principle within the designated time for savings achieved. ((NHS Trust Development Authority 2014)Section 2.74 page 12)

NHS TDA Board approval is required for all cases above £35 million, except managed service, managed equipment, leases and IM & T schemes which will only require Capital Investment Group approval up to a value of £50 million.((NHS Trust Development Authority 2014)Section 3.6) (NHS TDA 2014) These relate to whole of life costs for the lease or contract rather than annual costs. In addition the the Office For Government Commerce gateway project review process is applied to most hospital reconfiguration projects to highlight risks and review standards of the business cases.(Boyle S 2011)

Private Finance Initiative (PFI) Funded Build Scheme reflect the total capital cost to the private sector including the cost of construction, equipment, professional fees, rolled-up interest and financing costs such as bank arrangements fees, bank due diligence fees, banks lawyers fees, and third party equity costs plus irrecoverable VAT. Any capital cost that will be incurred directly by the NHS in progressing the schemes must also be included.((NHS TDA 2014)Section 3.20) A number of studies have disputed that PFI has reduced costs for hospital construction and operation in England.(Boyle S 2011; Pollock 1999; Pollock A M Gaffney D 1998; Hellowell 2012b; Shaoul 2011) The National Audit Office found that when the cost of additional tendering and contract administration and the value apportioned to risk was included there was evidence of cost-creep after the selection of the preferred bidder. (Boyle S 2011)page 178)

Remarkably with over 6,250 hospital and treatment sites (UK National Audit Office 2015) no major hospital capital works were completed in 2013-14 in England. In the prior 2 years a one development at University Hospitals Bristol NHS Foundation Trust was completed in 2014 and in 2013 new endoscopy unit which opened in May 2013 at Guy's and St Thomas' NHS Foundation Trust.(Monitor 2014)page 20) The main income source for capital works was from the sale of assets, particularly mental health assets.

The 4% efficiency dividend required of Trusts may have effected capital expenditures.(Monitor 2014) The requirement for 2-3% annual efficiency dividends to 2020 foreshadowed in the NHS 5 Year Forward View (NHS England 2014) may inspire the limited range of capital works projected for the next 3 financial years. (Monitor 2014) Hospital administrators argue the capacity of the hospital system has been exceeded and expected growth in patients will put quality of care at greater risk.(Filochowski 2015)

Capital charging is within the UK's system of Health Care Resource Group (HRG) funding covering 1400 groups mixing ICD-10 diagnosis groups by anatomical system and procedures including surgery. Capital charges include both depreciation costs and interest on the value of stock retained, to express the opportunity cost of using money in health capital and the depreciated replacement cost. There is a 2 year lag in estimates.(Wright 2010)

In his review of DRG-based hospital payment systems Scheller-Kreinsen argued that the UK had embedded capital in its DRG-type hospital payment system.(Scheller Kreinsen 2011b). However, the UK situation is more complex as revenue allocated to the hospital for depreciation is not insulated for future development funding. (Thompson 2011b)

Medical equipment is funded from within the budget of the hospital or Trust or through central government funding under the rules that apply for all infrastructure spending. (Boyle S 2011)

3. Affordable capital

The *NHS and Community Care Act 1990* fundamentally reorganised the funding of hospitals and the financing of investment. Previously there had been separate funding for recurrent and capital expenditures. In addition the Act introduced a 6% of asset base Capital Charge to be paid to the Government. Capital charging made new investment difficult as any new building would increase capital charges. Therefore new facilities or equipment were required to be funded by asset sales, operational savings and encouraged leasing of new equipment. This meant the NHS net contribution to capital expenditure via loans from the Department of Health fell from 86% in 1990–91 to 19% in 1996–97, and became negative in subsequent years.(Shaoul 2011) Shaoul found that the introduction of capital charging had a negative impact on hospital trusts causing staff reductions to enable capital charges to be met(Shaoul J 1998).

Under capital charging there was a loop where the capital charge and interest payment were received from the Trust by Treasury and then allocated to the Department of Health who paid the funds into hospital and community services annual allocations.(Mayston S 1995) It was a completed loop. However when PFI was included the capital charge continued to be made but funds then flowed out of the loop to the private sector reducing the overall funding not only of the Trust paying for PFI but also of the pool from which other hospitals and community health services were funded. (Pollock A M Gaffney D 1998) PFI facilities are exempt from capital charging.(Pollock A M Gaffney D 1998)

The consequence of capital charging in the UK NHS (England and Wales) seems to have been devolution of capital funding responsibility to the Hospital Trusts (within an owner-funder-occupier model), a subsequent diminution of government funding responsibility for capital for acute healthcare and withdrawal of the government from funding but not regulation. The introduction of Capital Charging in 1991 diverted hospitals “operational funds into paying for buildings and equipment that were already owned outright.” (Pollock 1999)page 180) While the PFI initiative contributed to a 31% decrease in hospital bed numbers for areas using the PFI model. (Pollock 1999)

Capital charging was imposed to improve efficiency as capital was regarded as a free good and to return both interest and a dividend on capital invested in hospitals.(Pollock A M Gaffney D 1998) However the capital charge averaged 9 % of trusts annual revenue resulting in only two options –increase revenue or decrease assets. Adding depreciation hospital trusts found capital costs closer to 11.5% of revenue.(Pollock A M Gaffney D 1998; Mayston S 1995) (Boyle S 2011)

From 1992 PFI (Private Finance Initiative) became the preferred method to fund public sector infrastructure in the UK.(Hellowell 2013) Transport, schools and hospitals were funded by this method. Evaluating the returns on investment of 10 PFI hospitals of the 150 projects signed to February 2010 a long term public sector liability of £72 billion pounds was found for privately financed hospitals worth £12.8 billion.(Hellowell 2012b) However Pollock notes that under the regulations there is no requirement for an assessment of need or the involvement of clinicians or public health doctors. (Pollock 1999)

Chronic underinvestment in buildings, infrastructure and equipment was acknowledged in the NHS Plan. Commenting on the NHS Plan, University of York researchers note that the NHS has traditionally been weak in capital investment giving

capital a low management priority and that under PFI major capital investment has been driven by “which schemes can be made attractive to private financiers.” (Dawson D 2001)page 6) From an economic point of view the York team argued that the situation with capital was so serious that investment should target the largest opportunity costs rather than be divided up equally between areas. (Dawson D 2001)

PFI as a source of capital funds has achieved the renewal of some hospitals and permitted new hospitals to be built. However Edwards argues that the backlog of maintenance problems caused inappropriate investment, underutilisation of existing assets and fixed service delivery at a point in time due to over-specified, inflexible buildings. He finds that as a whole the NHS estate is not well managed or strategically positioned.(Edwards N 2013) Balancing that view Boyle finds that by 2008-9 PFI provided 25% of funds invested in English hospitals and that public funding for hospitals grew from £1.6 billion in 1990-91 to £4.6 billion in 2008-9 and £5.6 billion in 2009-10. (Boyle S 2011)page 176)

In 2003 independent sector treatment centres (ISTCs) were procured from the private sector to provide services to NHS patients by the UK government to provide greater capacity for diagnosis and treatment, choice, a space for innovation, reduce costs, improve competition between providers and reduce waiting times.(Naylor 2009; Boyle S 2011) Under 2 Waves 35 private ISTCs were funded providing low intensity services varying from a narrow range to multispecialty outpatient clinics, diagnostics and day surgery. The Department of Health also pays a guaranteed fixed value payment to cover the providers fixed costs reducing incrementally over the period of the contract. This replaces the ‘take or pay’ guarantee for first Wave contractors where the full value of the contract was paid even if all contracted services were not consumed. In 14 cases when the initial contract expires the NHS will be required to take possession of the ISTC facilities and pay the residual value to the companies.(Naylor 2009) Capital funding has been used to meet recurrent costs.(Wenzel 2016)page 14)

4. The Fairness of distribution

Manchester financial accounting academics tracked the changes in capital investment for hospitals to 2010. They noted that many of the hospitals the NHS inherited were 19th century workhouses and have a significant backlog of maintenance. Post-war conditions and economic reversals in the 1960s, 1970s and 1980s meant there was only modest investment in hospital facilities and equipment. (Shaoul 2011; Barlow J

Koberle-Gaiser M 2008) Tudor Hart noted that former Local Authority hospitals and regional hospitals initially improved under the NHS fared less well than better endowed, better equipped voluntary hospitals from more affluent areas. (Tudor Hart J 1971) Public hospitals have a legacy of under-investment in plant and equipment.(Dixon 1990)

In contrast Prof Mayston of York discussed the consequences of the prevailing capital system to 1996 as highly subject to political influence(Thompson 2011b), poorly spent with minor annual expenditures and grasping ‘penny packet schemes’ causing long term recurrent cost challenges.(Mayston S 1995) Responsible capital decision making where the full cost of capital was included in the balance sheets of Trusts was seen as the conducive to competition and improved efficiency.(Mayston S 1995)

The Nuffield Trust affirmed the results of 3 studies of the UK (Bogdanor 1999, McLean of 2000 and Holtham 2009) finding resource allocation in the NHS remained “vulnerable to political lobbying” (Bevan 2014)page 108) Quoting Tudor Hart’s Inverse Care Law that: “The availability of good medical care tends to vary inversely with the need for it in the population served” the Nuffield Trust identified issues for governance, fund raising and accountability that occur throughout the UK. (Bevan 2014; Tudor Hart J 1971)

5. Patient access to public hospital care

Accessibility is measures as waiting times by the European Consumers Survey finding that the UK had the lowest level of unmet need.(Mossialos 2015) However patient access to safe care has been questioned (Filochowski 2015)

While the NHS aims to provide patient-centred, clinically appropriate, sustainable care and encourages innovation in service delivery, the capital funding systems are limited in value, difficult to access and not aligned to clinical care. (UK National Audit Office 2015; Boyle S 2011) The highly complex system of capital investment in English hospitals was found to be unresponsive to changes in public demand.(Edler 2007) Innovative service changes designed to decrease costs to the NHS are supported through competitive grants provided by the BCF since 2013. However PFIs have been found to be less effective in stimulating and supporting innovation than the system it replaced. (Barlow J Koberle-Gaiser M 2008)

E.2.17 United States of America

1. Timely access to capital

Prospective payments to hospitals under the US DRG system also include a component for capital through the Capital Base Payment Rate of the DRG.(Department for Health and Human Services USA and Centers for Medicare & Medicaid Services 2013)

The Affordable Care Act 2010 focussed on improving access to healthcare for Americans and has many elements to stimulate innovation. One small element of the Accountable Care Organization (ACO) component included capital grants for organisations for IT improvements. (Abrams 2015)

2. Flexibility of funding

Hospitals receive capital funding through DRG payments which are a major component of revenue.(Department for Health and Human Services USA and Centers for Medicare & Medicaid Services 2013) So investment in hospitals in the USA is determined by the ROI for the individual hospital with modest supplementation for the adoption of interconnected ITC by the federal government.

3. Affordable capital

Aggregated health investment figures for the USA include total expenditure on medical research, buildings and equipment. Investment expenditure is estimated to be relatively steady at 5.6% of all health expenditure in 2013 but isolating capital expenditure on hospitals from the published statistics is problematic.(Secretary of the Department of Health and Human Services USA 2014) So surveys of hospital executives has become the more common way to understand dynamics in hospital capital expenditure in the USA.

Coye surveyed American hospital administrators regarding their proposed capital expenditures. She found a fragmented hospitals sector facing challenges to assess medical technology that are disruptive to business practices and compounded by government and insurers requirements for higher standards of patient safety, clinical transformations to improve the quality of care and performance monitoring. The distribution of medical technology and access to capital are dependent on the earning capacity of individual hospitals and the Return on Investment (ROI).In highly competitive environments she documents 'arms races' to rapidly purchase profitable

technologies particularly for ‘profit-niche’ specialty hospitals. A limited number of municipalities are able to support required capital purchases for public healthcare. (Coye M J Kell J 2006)

The Commonwealth Fund recognising that investments in health information systems and evidence based care, particularly for safety-net, rural hospitals and medical practices, and to facilitate a national electronic system to share patient records, were necessary to slow the annual growth in health costs, improve access and safety of care.(Davis K 2009) By 2008 17% of US doctors and 12% of hospitals used electronic medical records. The fee-for-service system of payment for medical services was seen as a major impediment to adoption and interconnectedness of electronic prescribing, information exchange, and electronic reporting of quality of patient care. In 2009 the Information Technology for Economic and Clinical Health (HITECH) Act was passed to gain efficiency and connectivity improvements in American healthcare through \$29 billion of federal funding to encourage doctors to change their practices. (Blumenthal D 2011)

As with medical technology and ITC, changes to make hospitals operate in an environmentally sustainable way and reduce energy costs have been implemented on a hospital by hospital basis and are determined by profitability.(Kaplan S Sadler B Little K Franz C Orris P 2012)

Medical equipment is also purchased from funds from within the hospital or the hospital system or through “ borrowed money (debt), equity offerings, venture capital, capitalized leases, real estate investment trusts, public grants and donations” (Rice 2013)page 164).Reimbursement of the cost of equipment is amortised through the payment systems for Medicaid patients .(Rice 2013) Data on major medical equipment is sporadic.(Rice 2013; Coye M J Kell J 2006)

4. The fairness of distribution

The USA had 2.5 acute care beds per 1000 population in 2013 which is lower than Australia at 3.4 and the OECD average of 2.9 beds per 1000 population.(D. Squires 2015) Government owned beds are 0.4% of beds and 1.7 % are in the not for profit sector. Total beds per 1000 population vary from 1.7 beds in Oregon and Washington State to 4.7 in South Dakota.(The Henry Kaiser Family Foundation 2015) The distribution of hospital beds has been a problem in the USA prompting the charitable Commonwealth Fund to build hospitals when “in 1926, more than half of U.S. counties, many of them rural and impoverished, had no hospital at

all.“(Commonwealth Fund 2018) Subsequently Commission on Hospital Care documented the inadequate, haphazard distribution of hospitals across the USA resulting in national funding for hospital capital through the Hospital Survey and Construction Act of 1946(or Hill-Burton Act).

Access to hospitals is not measured in the USA as the prevailing metric is access to medical care. However, the USA has, with Japan, the highest rates of medical equipment per million population. MRI and PET machines are found at triple the OECD median rate while CT scanners are two and a half times the OECD rate. (D. Squires 2015)

5. Patient access to public hospital care

Life expectancies for the wealthiest American males are 14.6 years greater than for the poorest American males and 10.1 years difference for American women. (Dickman 2017)There are wide disparities for access to hospital care in the USA based on the ability to pay for hospital treatment. (Mossialos 2015) Public hospital beds operated by local governments are 0.4 beds per 1000 people. Comparing the USA with 10 other advanced economies the Commonwealth Fund found that the USA had the worst access to acute health care due to cost, the poorest level of health service efficiency, the poorest level of equity of access to healthcare and again the least healthy population with higher rates of death in every age group and a shorter life expectancy than the other 10 countries. Yet rated the US system in the top 4 for delivering patient centred care (Davis 2014). Expressing similar concerns the American Institute of Medicine (IOM) reported the fee-for-service reimbursement system, a diversion of attention away from the needs of patients and the population, pervasive inefficiencies, an inability to manage a deepening clinical knowledge base and the consequent costs have made the system too expensive and unable to focus on safety and quality of patient care. (World Bank 2010; IOM 2013; Smith 2012)

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Appendix F Clinician Interviews

Chapters 7 and 8 drew on data collected by semi-structured interviews outlined in Chapter 7.5 and detailed in Chapter 8.3-8.5 with clinical experts in obstetrics and orthopaedics.

In this appendix the questionnaire sent to clinical experts in obstetrics precedes the questionnaire sent to clinical experts in orthopaedics.

F.1 Obstetrics questions

Interviews – Clinicians Obstetrics Questions

Thank you for your willingness to participate! The research seeks to answer the question:

Can diagnosis-related capital facilitate more appropriate, sustainable and innovative acute care facilities?

by costing the capital required in 2 significant obstetric DRGs and gaining advice on the appropriateness, effectiveness and sustainability of current health capital distribution systems.

The DRGs are:

- *Vaginal Delivery* without Catastrophic or Severe Complicating Conditions (O060B)
- *Caesarean Delivery* without Catastrophic or Severe Complicating Conditions (O01C)

THE METHOD FOR COSTING

1. Clinical pathway- to establish the requirements of the patient, her family and of obstetricians and the clinical staff in terms of rooms and major medical equipment
2. The time patients and clinicians need access to specific facilities or equipment and
3. Estimating each patient's requirements of common/shared facilities, medical equipment and Information technology and Communications (ITC).

REVIEW OF AUSTRALIA'S EXISTING CAPITAL ALLOCATION SYSTEMS.

The third and final part of the interview asks if the amount of money allocated for obstetrics for facilities, medical equipment and ITC, and the frequency of those allocations, is sufficient to keep pace with changes in contemporary best-practice patient care. And is the system for upgrading obstetrics facilities medical equipment and IT and Communications) responsive to evidence based improvements in clinical practice and changes in demand?

The aim is to cost the capital requirements for these DRGS from a clinical and patient level. The information from this study will be used to model a new system for hospital capital. Again thank you for your very valuable time to inform this project.

FOLLOW-UP

I will take notes of the conversation and send back to you my understanding of our conversation for your agreement or correction. The advice will be used to populate a list of rooms and equipment which will be costed and then costing for ancillary service areas will be included. These will inform a model to estimate a clinically-derived value for capital investment required for each patient by DRG. The aim is model a system to have frequent, regular, demand based allocations for capital for all public hospitals.

It is anticipated that the results of up to 10 interviews from clinicians across Australia will form the basis for a publication on the facilities required for contemporary obstetrics. Before a manuscript is finalised you will be contacted for your approval, should you wish.

Interviews – Clinicians Obstetrics Questions

ETHICS

Further information on the research can be obtained from:

Rhonda Kerr

T: 0438 645982

E: rhonda.kerr@postgrad.curtin.edu.au

or

Delia Hendrie

E: D.V.Hendrie@curtin.edu.au

This study has been approved under Curtin University's process for lower-risk Studies (Approval Number SPH-86-2013). This process complies with the National Statement on Ethical Conduct in Human Research (Chapter 5.1.7 and Chapters 5.1.18-5.1.21). For further information on this study contact the researchers named above or the Curtin University Human Research Ethics Committee. c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth 6845 or by telephoning 9266 9223 or by emailing hrec@curtin.edu.au.

Any concerns on ethical grounds should be made the Secretary of the Human Research Ethics committee on (08) 9266 2748 or by email at hrec@curtin.edu.au or by mail to the Office of Research and Development, Curtin University of Technology, GPO Box U1987, PERTH WA 6845

Interviews – Clinicians Obstetrics Questions

Question 1 Vaginal Delivery without Catastrophic or Severe Complicating Conditions (O060B)

Considering the patient clinical pathway for the DRG Vaginal Delivery without Catastrophic or Severe Complicating Conditions (O060B):

- 1.1 What facilities are requirements for a patient and her family?

- 1.2 On average, how much time does the patient or clinician use these spaces or require them to be available?

Space	Time Required
Antenatal Education	
Day Assessment	
Testing	
Ultrasound	
Assessment	
Other	
Clinic- Medical	
Nurse	
Physio	
Social Worker	
Other	
Pre-birth Inpatient	
For birth	
Reception	
Labour /birthing room	
Interview Rooms	
Family facilities, bathrooms, toilets	
Other	
Post birth accommodation	
Bariatric	
Access to specialist areas*	
ICU	
CCU	
NICU	
Physiotherapy	

Interviews – Clinicians Obstetrics Questions

Space	Time Required
Other therapies	
Nutrition	
Diabetes Education	
Social Work	
OT	
Psychologist	
Drug & Alcohol	
Other	
Interpreters/ Cultural /ATSI	
Nursing specialties	
Lactation	
Mothercraft	
Other	
Outdoor spaces	
Post natal care	

Clinical Requirements

Accommodation

Clinic

Offices

Physio

Social Worker

Registrar

Interns/Students

Interview Rooms

Other

Storage

Interviews – Clinicians Obstetrics Questions

1.3 What Major medical equipment is required or needs to be available?

Examples

Air flow meter
Cot and blanket heating
Infant resuscitaire

Light, operating, single, mobile
Lights x type
Monitor: Foetal, CTG
Monitor
Oxygen flowmeter
Oxygen/Nitrous Oxide Meter
Patient Call Handset

Scales
Staff/Nurse assist

Terminal
TV/ Screen
Bed
Cot

Indirect

Hotel Services

Imaging
Pathology
Monitoring
Air conditioning

1.4 What ITC systems are required?

Communications devices
Electronic Patient Medical Record platform
iPad
Tablet
Telephone
Other

Interviews – Clinicians Obstetrics Questions

Question 2 Caesarean Delivery without Catastrophic or Severe Complicating Conditions (O01C)

Considering the patients clinical pathway for the DRG Caesarean Delivery without Catastrophic or Severe Complicating Conditions (O01C):

- 2.1 What are the clinical requirements for a patient and her family?
- 2.2 On average, how much time does the patient or clinician use these spaces or require them to be available?

Space	Time Required
Antenatal Education	
Day Assessment	
Testing	
Ultrasound	
Assessment	
Other	
Clinic- Medical	
Nurse	
Physio	
Social Worker	
Other	
Pre-birth Inpatient	
For birth	
Reception	
Labour /birthing room	
Interview Rooms	
Family facilities, bathrooms, toilets	
Other	
Post birth accommodation	
Bariatric	
Access to specialist areas*	
ICU	
CCU	
NICU	
Physiotherapy	

Interviews – Clinicians Obstetrics Questions

Space	Time Required
Other therapies	
Nutrition	
Diabetes Education	
Social Work	
OT	
Psychologist	
Drug & Alcohol	
Other	
Interpreters/ Cultural /ATSI	
Nursing specialties	
Lactation	
Mothercraft	
Other	
Outdoor spaces	
Post natal care	

Clinical Requirements

Accommodation

Clinic

Offices

Physio

Social Worker

Registrar

Interns/Students

Interview Rooms

Other

Storage

Interviews – Clinicians Obstetrics Questions

Preparation

Anaesthetic Induction Room

 Theatre

 Preparation

 Anaesthetics

 Imaging

 Interns/Students

Other Storage

2.3 What Major medical equipment is required or needs to be available?

Examples

Air flow meter

Cot and blanket heating

Infant resuscitaire

Light, operating, single, mobile

Lights x type

Monitor: Foetal, CTG

Monitor

Oxygen flowmeter

Oxygen/Nitrous Oxide Meter

Patient Call Handset

Scales

Staff/Nurse assist

Terminal

TV/ Screen

Bed

Cot

Indirect

Hotel Services

Imaging

Pathology

Monitoring

Air conditioning

Interviews – Clinicians Obstetrics Questions

2.4 What ITC systems are required?

- Communications devices
- Electronic Patient Medical Record platform
- iPad
- Tablet
- Telephone
- Other

Question 3 Does the current system of capital funding facilitate best – practice patient care for these DRGs and obstetrics more generally?

Question 4 Is the frequency of capital allocations sufficient for changes in contemporary best-practice patient care?

- Buildings
- Major medical equipment
- IT and Communications

Question 5 Is the amount of capital funding appropriate to contemporary best practice clinical care?

- Buildings
- Major medical equipment
- IT and Communications

Question 6 Are the amount and the frequency sufficiently responsive to changes in demand or other variations in clinical requirement such as clinical innovation?

Question 7 Does Capital funding have an effect on patients being able to access appropriate clinical services?

Question 8 Is the current method of allocating capital (for buildings, medical equipment and IT and Communications) responsive to evidence based improvements in clinical practice?

Question 9 In your experience do you find that the funding and provision of capital have an impact on the operational efficiency of the hospital?

F.2 Orthopaedic questions for hip and knee replacement

Hip and Knee Replacement-Patient Clinical Pathway – Questions

Patient arrival

1. Admission and entry point

- a. Time for admission and waiting areas; access,
- b. Are patients usually elective/not emergency surgery?

2. Pre-surgery

- a. To the ward or another pre-surgery setting?
- b. Reception and waiting
- c. Time for preparation, interviews, assessments etc.
- d. Imaging? Other testing?

3. Theatre

- a. Australasian Health Facility Guidelines for OR- review
- b. Anaesthetic in theatre or anaesthetic induction room
- c. Storage & major medical equipment needed for procedure
- d. Theatre size
- e. Additional people- space or equipment
- f. Systems for imaging displays communications etc.?
- g. Time in theatre
- h. Preparation time between procedures/ procedures per room per day
- i. Stage 1 recovery
- j. Office space/meeting rooms
- k. 250 days per year?

4. Access to HDU or ICU

- a. Is the presence of an HDU/ICU always required?
- b. What portion of patients require HDU/ICU and for how long?

5. Ward

- a. Experience and preference/evidence for shared room or individual room
- b. Room and bathroom size
 - i. bariatric patient portion- [assume 2/30 rooms?]
 - ii. negative pressure rooms- [assume 1/30 rooms?]
 - iii. larger bathrooms-[all 6m² or a portion?]
- c. Is further imaging required ?

Hip and Knee Replacement-Patient Clinical Pathway – Questions

5 Ward (cont)

- d. Review list of AHFG inpatient facilities
- e. Clinical spaces- nursing and visiting specialist nurses
 - 1. Physio- storage of equipment/trolley
 - 2. OT- storage of equipment/trolley
 - 3. Dietetics
 - 4. Pathology
 - 5. Pharmacy
 - 6. Imaging
 - 7. Mental Health
- f. Length of stay
- g. Other items important to patients or clinicians?
- h. Office space , communications
- i. Beverage bay- flower bay?
- j. Size of store room (1x20m² or 2 x15m²?)
- k. Medical records management
- l. Medications in Clean utility or separate room?

6. Clinical Support

- a. Clinical specialists
- b. CSSD
- c. ICU/HDU
- d. Supply and stores
- e. Systems
- f. Security

7. Discharge

- a. To rehabilitation inpatient unit
 - b. Home
 - c. Elsewhere
8. Are there any other areas required for best practice patient care? Critical care areas?
Outdoor spaces? Outpatient department clinics? Imaging?
9. Is there major medical equipment which would improve patient care or clinical services?
10. Communications and IT requirements?
11. Any additional patient or family requirements?

Hip and Knee Replacement-Patient Clinical Pathway – Questions

The St John of God Health Care Human Research Ethics Committee has given ethical approval for the conduct of this study (Ethics Approval Number 1310). If you have any concerns or complaints regarding this study, you can contact the Executive Officer of the Committee (telephone number (08) 9382 6940) on a confidential basis. Your concerns will be drawn to the attention of the Committee that is monitoring the study.

Further information on the research can be obtained from Rhonda Kerr on T 0438 645982 or rhonda.kerr@postgrad.curtin.edu.au or Dr. Delia Hendrie (D.V.Hendrie@curtin.edu.au) This study has been approved under Curtin University's process for lower-risk Studies (Approval Number SPH-86-2013).

If you have any concerns about the conduct of this study or your treatment during this study contact the researchers named above or the Curtin University Human Research Ethics Committee

Appendix G List of Experts Consulted to Verify Information and Model Development

The following experts were asked for advice in the course of model development and agreed to be acknowledged in the thesis.

Chapter 7, Section 7.5.3

To verify the model and validate that appropriate tools were being used interviews exploring the concepts and data sources were conducted at:

- the National Centre for Classification in Health (NCCH) at the University of Sydney with Prof. Richard Madden, Head of NCCH and the Executive Manager of Classification Development on the contents, stability and limits of the selected DRG's and the method for apportioning indirect costs.
- The Australasian Health Facility Guidelines of NSW Health Infrastructure with Project Team Leaders Jenny Green and Liz Partridge on the methodology used for the AHFG
- The Australian Council on Healthcare Standards (Mona Ramsay)
- A/Prof Dr. Neale Fong, President of the Australasian College of Health Services Management
- WA Treasury- Steve Toutountzis, Director of Strategic Policy and Evaluation and Guilia Clifford, Health Lead,
- WA Department of Health – Angela Tooker A/Director Infrastructure, and David Jones, Project Director, Infrastructure.

Areas

Architectural experts:

- A/Prof. Warren Kerr AM, University of WA
- Prof. Kirk Hamilton, Professor of Health Facility Design at Texas A&M University, Fellow of the American Institute of Architects and the American College of Critical Care Medicine and author of *Area Calculation Method for Health Care*
- Prof. George Mann, Professor in Health Facilities Design, Department of Architecture, Center for Health Systems & Design, Texas A&M

- Prof Ray Pentecost III, Chair of Health Facilities Design, Director, Center for Health Systems & Design, Professor of Practice, Department of Architecture, Center for Health Systems & Design
- Jane Carthey, Chair, Australian Health Design Council, former Director, Australasian Centre for Health Assets, University of NSW

Costing methods

Curtin University professors of construction management were asked for advice on methods of costing (7.8.2) Consultations and correspondence recommended with:

- Dr. Oluwole Alfred Olatunji, Senior Lecturer in Building Surveying (September- 9 October, 2017)
- Director-level quantity surveyor Ian Silver, MBA, AAIQS, Dip QS.

Architects specialising in major health projects:

- George Raffa, Director of Silver Thomas Hanley Perth
- Warren Kerr AM Director, Hames Sharley
- James Edwards, Director, Hames Sharley.

Medical equipment

- to validate medical equipment required for costing (Ch.7.8.3, 7.11.4, 7.12.4) Dr. Cat Kealley and Dr. Curtise Ng Senior Lecturers in Medical Radiation(January 2018)

Chapter 7, Section 7.8.3

Curtin University professional experts on medical imaging:

- Dr. Cat Kealley and Dr. Curtise Ng, Senior Lecturers in Medical Radiation(January 2018)

Chapter 7, Section 7.9

- Ms Nicole Jarvis, Assistant Secretary, Digital Innovation & AHMAC Branch, Australian Department of Health 30 January 2018
- Ms Barbara Levings, Secretary, COAG Health Council Secretariat, 5 February, 2018.

Investing in acute health services: is it time to change the paradigm?

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Abstract

Objective. Capital is an essential enabler of contemporary public hospital services funding hospital buildings, medical equipment, information technology and communications. Capital investment is best understood within the context of the services it is designed and funded to facilitate. The aim of the present study was to explore the information on capital investment in Australian public hospitals and the relationship between investment and acute care service delivery in the context of efficient pricing for hospital services.

Methods. This paper examines the investment in Australian public hospitals relative to the growth in recurrent hospital costs since 2000–01 drawing from the available data, the grey literature and the reports of six major reviews of hospital services in Australia since 2004.

Results. Although the average annual capital investment over the decade from 2000–01 represents 7.1% of recurrent expenditure on hospitals, the most recent estimate of the cost of capital consumed delivering services is 9% per annum. Five of six major inquiries into health care delivery required increased capital funding to bring clinical service delivery to an acceptable standard. The sixth inquiry lamented the quality of information on capital for public hospitals. In 2012–13, capital investment was equivalent to 6.2% of recurrent expenditure, 31% lower than the cost of capital consumed in that year.

Conclusions. Capital is a vital enabler of hospital service delivery and innovation, but there is a poor alignment between the available information on the capital investment in public hospitals and contemporary clinical requirements. The policy to have capital included in activity-based payments for hospital services necessitates an accurate value for capital at the diagnosis-related group (DRG) level relevant to contemporary clinical care, rather than the replacement value of the asset stock.

What is known about the topic? Deeble's comprehensive hospital-based review of capital investment and costs, published in 2002, found that investment averages of between 7.1% and 7.9% of recurrent costs primarily replaced existing assets. In 2009, the Productivity Commission and the National Health and Hospitals Reform Commission (NHHRC) recommended capital, for the replacement of buildings and medical equipment, be included in activity-based funding. However, there have been persistent concerns about the reliability and quality of the information on the value of hospital capital assets.

What does this paper add? This is the first paper for over a decade to look at hospital capital costs and investment in terms of the services they support. Although health services seek to reap dividends from technology in health care, this study demonstrates that investment relative to services costs has been below sustainable levels for most of the past 10 years. The study questions the helpfulness of the highly aggregated information on capital for public hospital managers striving to improve on the efficient price for services.

What are the implications for practitioners? Using specific and accurate information on capital allocations at the DRG level assists health services managers advance their production functions for the efficient delivery of services.

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Introduction

Australian hospitals strive to meet the challenge of delivering high-quality clinical care, technological innovation with

expanding patient demand and enhanced efficiency. Capital investment in hospital buildings, equipment and systems aims to facilitate best practice care at the time of the investment.

However, although the gold standard for hospital design is ‘form to follow function’,¹ it is also true that form follows finance. So, this paper considers the relationship between the recurrent costs associated with delivering public hospital services and capital investment using published information, including the reports of six significant reviews of hospital services since 2004.

The Productivity Commission estimates that the annual cost of capital consumed providing hospital services is equivalent to 9% of recurrent expenditure² which is greater than the average annual capital investment over the decade from 2000–01 of 7.1% of recurrent expenditure.³ In 2012–13 capital investment was equivalent to 6.2% of recurrent expenditure, 31% lower than the cost of capital consumed in that year.

From the findings of two national hospital reviews and four state-based reviews regarding the published estimates of capital investment and costs, it is evident that there is poor alignment between the available information on capital investment in public hospitals and contemporary clinical requirements.

Five out of six major inquiries into healthcare delivery required increased capital funding to bring clinical service delivery to an acceptable standard. The sixth inquiry lamented the quality of information on capital for public hospitals. Aggregated data on capital investment is not service-specific or sufficiently sensitive to contemporary clinical requirements to be a useful tool for health managers pursuing the efficient price for services.^{4–6}

In 2010–11 Australia spent \$130.26 billion on healthcare of which \$38.4 billion was for recurrent expenditure in public hospitals and \$4.2 billion, or 3.2%, was for capital expenditure. The expenditure on public hospitals represented 3.6% of Australia’s gross domestic product (GDP) and investment in these hospitals was 0.35% of GDP.⁷

Judging the appropriate level for healthcare investment is of importance for our community, clinicians and politicians. Access to sufficient hospital beds and appropriate diagnostic and treatment facilities permits clinicians to effectively manage growing demand from populations with increasing chronic disease and an expanding demand for hospital care.⁸ While debates continue on the correct number of beds, the discussion of capital funding for the broader range of treatment and accommodation services has been lacking. Over recent years major inquiries have identified problems and challenges in the relationship between capital investment and hospital service delivery.^{9–13} Yet little is published on capital investments for healthcare and it has been acknowledged that estimates of the value of capital for healthcare and the appropriate level of investment in public healthcare are difficult to establish.^{8,9,14–17}

The present study examines published information on the investment in Australian public hospitals and how that investment relates to the acute service delivery it is required to facilitate.

Methods

The study used qualitative methods to review recent literature on capital investment in the healthcare sector and quantitative methods to assess levels of capital investment.

Literature review

Electronic bibliographic databases (Emerald, Medline, ProQuest) were searched for Australian literature published between 1980

and April 2013 on capital in healthcare using the keywords: Australia (n), capital, capital investment and acute healthcare, hospitals and infrastructure, and hospital building.

The grey literature

References to capital were found in six major health reviews, including the National Health and Hospitals Reform Commission (NHHC) Interim and Final Reports^{10,18} and the Productivity Commission Research Study into Public and Private Hospitals,⁹ the Garling Royal Commission in NSW,¹³ the Forster Review in Queensland,¹² the Reid Review in WA¹¹ and Stokes Report on the 4 h rule in WA,¹⁹ the Reports on Government Services prepared by the Industry Commission (1993–97) and the Productivity Commission (1998–2013) were also examined.

Data collection

Data on recurrent and capital expenditure in the health sector were obtained from Hansards for Commonwealth, State and Territory Parliaments and Budget Papers for 2012–13 for each Australian jurisdiction.^{20–29} In most instances, Commonwealth funding for hospitals included in state and territory budgets were extracted to prevent double counting. Expenditure data on healthcare was also extracted from the Productivity Commission and Australian Institute of Health and Welfare (AIHW) publications.³

Analysis

Statements on the value of capital, recommendations and actions in relation to necessary investments and issues of access to capital from the major reviews of health services and hospital services were extracted for analysis. Comparative historical data on public hospital recurrent and capital expenditure for buildings and equipment was drawn from AIHW publications and state and territory budget papers with capital expenditure specifically on hospitals calculated as a percentage of recurrent expenditure.^{2,8,15–17} Similarly, data on indicative capital cost and recurrent expenditure per case mix adjusted separation for each state and territory was drawn from each of the Reports on Government Services for 2010–13 and expressed as a percentage for comparison with results from an earlier study.^{30–32}

Results

Capital alignment with hospital services

The literature review identified only one comprehensive study costing capital for Australian public hospitals. Deeble’s national study found the built capital investment for similar patient treatments varied by up to 70% per bed within two large state systems, noting greater endowments in major teaching hospitals for built capital and equipment. He was concerned that centralised systems for rationing capital were ‘increasingly questioned on efficiency grounds’^(14 p. 53) with decision-making that was doubtful in terms of data and technique and lacked transparency.¹⁴ Commenting on the irregularity and evident ‘lumpiness’ of investment in hospitals, Deeble identified that ‘many health administrators see capital allocation. . . as a competition for funds whose total is fixed by some unfathomable budget process in which political sensitivity, historical precedent and rules of thumb are as important as demonstrated need.’^(14 p. 53)

Similarly, the Australian Industry Commission (1993–97) later the Productivity Commission (1998–2003), in their annual Reports on Government Services expressed concern about the valuations of public hospital capital described as ‘indicative’, ‘difficult’ and ‘unreliable’.^{8,16,17,33}

Subsequently, state and national reviews of health service delivery between 2004 and 2011 have commented on the adequacy of capital allocations for hospitals to achieve an acceptable standard of care (Table 1).^{9–13,19} As Table 1 shows, the four state-based reviews into the quality, efficiency and delivery of hospital services found that clinical service delivery was affected by capital allocation. Similarly the NHHRC found that additional capital expenditure was required to achieve clinical service improvement.¹⁰ The Productivity Commission Report compared the prices of services between the private and public hospital sectors by diagnosis-related group (DRG), estimating capital to be more expensive in the public sector.⁹

While initially valuing capital as one large historically based asset, in reviewing the evidence most reviews discussed the issues surrounding built, and medical equipment capital independently, and IT and communications capital as separate productive elements required to deliver contemporary care.^{9,10,12,13,19} Only Stokes examined the patient flow and clinical functions and then used capital as a support for improving the efficiency of clinical activity.¹⁹

Table 1 shows how capital for public hospital services was valued by the reviews, the outcomes of the reviews for investment in buildings, equipment and IT and communications, and identified issues relating to the process of accessing capital. Each of the reviews of clinical service delivery advocated for additional capital for hospitals, with the exception of Queensland and the technically focused Productivity Commission review.^{9–13,19}

As the last column of Table 1 shows, systemic problems in allocating capital were identified in NSW and Queensland and by the NHHRC with the Productivity Commission also expressing dissatisfaction, at a national level, with inconsistencies with the valuation of public hospital capital, depreciation, and for valuation of leases and public-private partnerships. More specifically:

- The Forster Review reported the Queensland health system as ‘being under significant pressure with insufficient resources to meet increasing demand’ (p. 268).¹² The inadequate supply of capital infrastructure resulting in insufficient beds was regarded as deficient, with funding for asset replacement, refurbishment, maintenance and building operation as significant issues. The NHHRC also noted the need to maintain, replace and repair existing capital.¹⁸ Forster¹² identified that decision making on capital was remote from the clinical services, unequal and that ‘securing adequate levels of funding for the capital works program has been problematic’ (p. 42). Inequality in the distribution of capital between clinical services was also noted by the NHHRC.¹⁸
- In NSW the Garling Royal Commission of review into hospital services also found a system struggling to deal with increased demand for care. The Commissioner noted: ‘In an industry where the state of equipment correlates closely to patient safety, it is important to routinely review the equipment in use and plan for the replacement of equipment as it comes to the end of its useful life or becomes unsuitable for use in the safe, modern

practice of medicine. As a piece of equipment nears the end of its useful life, I would expect to see the cost of a replacement machine being factored into the budget of the hospital, so that it could be sourced and funded without interrupting clinical activities. This does not seem to be happening at all’ (p. 1033).¹³ Similar comments were made about difficulties with investment in IT (p. 7) and communications, access to imaging (Section 1.175), beds (p. 30), emergency departments, intensive care unit beds and operating theatres (Section 1.172–3).¹³

- In WA the 2004 Reid Review addressed concerns about fiscally unsustainable costs to operate the hospitals’ averaging increases of 8.5% per annum. Major investment in new hospitals and significant expansions of metropolitan hospitals were among the key enablers for making the hospitals more efficient.¹¹
- In a review of the operation of the four-hour emergency department rule in Perth hospitals in 2011, Stokes noted that the processes of clinical redesign in both the UK and Western Australia had been characterised by a change in vision, improving the quality of care and focussing on patients. Capital to modify buildings, improve communications and IT and buy medical equipment was required to achieve the changes necessary for the four-hour rule to operate effectively. He noted that the success of clinical redesign in the UK involved a £600 million investment in infrastructure and support.¹⁹
- In 2002 Deeble’s¹⁴ findings from his detailed state-based studies were similar to these five public inquiries, that not all hospitals providing treatments for similar patients are equally endowed in buildings or equipment for acute service delivery.^{10–14,19}

On a broader scale, after extensively reviewing the health sector in 2009 the NHHRC questioned if the amount of capital investment was correct and identified capital as ‘vital to reshaping how care is delivered, filling service gaps, building new systems and capabilities and stimulating change’ (p. 168).¹⁰

In a subsequent 2009 study the Productivity Commission compared the costs between public and private sector hospitals and estimated the cost of capital for most DRGs. Since it affirmed NSW Health’s view that ‘nobody knows exactly how much capital is currently used by public hospitals’ (p. 303),⁹ approximations of the value of public hospital capital were required. The result was an estimation based on depreciation plus the user cost of capital (UCC) or the cost of the money rather than a clinically based system of capital estimation.⁹ The authors used a regression analysis to distribute the total capital endowment into individual DRGs, implicitly assuming that all public hospitals have access to an equal stock of built and equipment capital.⁹ This assumption contrasts with the finding of the reviews.

Consistency of measurement

Information on capital investment for hospitals in Australia is published at the state and territory level by the AIHW based on Australian Bureau of Statistics bi-annual surveys and extrapolations for intervening years.⁷

To estimate the value of capital consumption at the diagnosis level in the annual Report on Government Services, the

Table 1. Australian health service delivery reviews 2004–11: commentary on public hospital capital allocation
 IT&C, information technology and communications equipment; SCRGSP, Steering Committee for the Review of Government Service Provision; ABF, activity-based funding

Report	Author	Year	Estimation basis	Investment recommended					Access to capital
				Built capital	Equipment	IT&C	Level of investment	Recommended significant change to improve access	
Healthy Future for Western Australians	Health Reform Committee (Reid)	2004	Asset based	Yes	Yes	Yes	Major investment	Recommended significant change to improve access	
Queensland Health System Review	P Forster	2005	Asset based	Yes	Yes	Yes	To address inequities and delayed repairs	Not transparent	
Special Commission of Inquiry Acute Care Services in NSW Public Hospitals	P Garling	2008	Asset based	No	Yes within 4 years	Yes	Assessment of existing assets required		
A Healthier Future for all Australians	Requiring improvement National Health & Hospitals Reform Commission	2009	Asset based	Yes	No	Yes e-medical records	\$2.154 billion over 4 years	Recommended cost of capital be included in ABF	
Public and Private Hospitals Research Report	Productivity Commission (SCRGSP)	2009	Asset based	No	No	No	Improve data to value public hospital assets	Concerns about inconsistent valuations	
Four Hour Rule Program (WA)	B Stokes	2011	Productive value	Yes	Yes	Yes	To facilitate clinical redesign	Special application outside State Health Plan	

Note: most reviews did not progress to the detail of estimating capital project costs.

Productivity Commission used the total state (or territory) values of capital depreciation plus the UCC as previously mentioned. The information is 2–3 years old when the reports are made. The Productivity Commission has expressed concerns about the quality of the depreciation information.¹⁴

Deeble¹⁴ avoided depreciation values by pricing approximately 50 000 equipment items and the functional areas of over 140 hospitals at contemporary replacement standards. Deeble drew from the asset registers of hospitals in five states and the ACT assessing replacement cost valuations for hospital buildings and equipment.¹⁴

Levels of Public Hospital Investment

Deeble,¹⁴ in a landmark hospital-based costing study, found that there was a near constant ratio of capital to recurrent expenditure over 40 years to 2000, with capital representing 7.1% to 7.9% of acute public hospital recurrent expenditure. Data from his detailed study of the capital elements of public hospitals showed that only 0.4% of capital expenditure was for growth or new services. Almost all capital expenditure on public hospitals was for the replacement and updating of existing assets.

Table 2 outlines the investment in public hospitals between 2000–01 and 2010–11 (in constant prices) compared with the generally steady growth of recurrent expenditure for public hospitals. Over the decade 2000–01 to 2009–10, capital averaged 7.1% of recurrent expenditure. The period 2000–01 to 2002–03 had capital investment, relative to recurrent expenditure, at between 7.1% and 7.4% rising to 7.5% in 2005–06 to 2006–07 after a sharp decline, to 4.9% and 6.6%, in 2003–04 and 2004–5. According to the standard set in Deeble's analysis, the funding between 2000–01 and 2007–08 falls below replacement level. It is only between 2008–09 and 2010–11 that the substantially increased investments in public healthcare and hospitals reached levels which support growth.

Table 3 presents data on the capital allocations for hospitals in 2012–13 Commonwealth, state and territory appropriation bills and budget papers. Capital investment includes new equipment and buildings, replacement of infrastructure and improvements to

public hospitals.^{21–27,29} Capital allocations for hospitals in 2012–13 varied widely between states and territories, from 2.6% of recurrent expenditure in NSW to 25% in the ACT, with a national average of 4.9%. Comparing Table 2 with Table 3 it can be seen that in 2012–13 total investment has returned to 2008–09 investment levels while recurrent expenditure has increased by 61% since that time. As a percentage of recurrent expenditure the 2013–14 funds allocated by states and territories returned to 2003–04 levels.

The Commonwealth, through the National Health and Hospitals Fund (NHH), has awarded \$721.75 million for public hospital improvements in 2012–13.²⁰ The addition of NHH funds brings national capital expenditure for hospitals to \$3.405 billion or 6.2% of recurrent expenditure on health.²⁰ However, this remains below the level of 8.3% of recurrent expenditure Deeble estimated as representing the replacement level.¹⁴ So only in the period 2009–11 has public hospital investment been above replacement levels.

The cost of capital consumed in providing acute health services

As previously mentioned the Productivity Commission's annual review of all government services has developed an indicative cost for capital consumed each year by major public hospitals. Table 4 shows the resulting estimates for capital consumed as a percentage of recurrent expenditure per case mix adjusted separation.

Nationally the capital consumed relative to the cost of case mix adjusted separation averaged between 9% and 9.4% but varied between low investment levels in Tasmania of 5.7% in 2010–11 and 13.1% in Victoria in 2007–08. Significant challenges are evident for NSW, Victoria, South Australia and the territories with the consumption of capital at over 10% of their recurrent expenditure in 2010–11. An unequal pattern of capital consumption relative to recurrent costs is evident between states and territories. While Table 4 provides only indicative information at the separation level, it is the most detailed and specific information published on capital for Australian public hospitals.

Similarly, AIHW estimates that the rate at which public healthcare services are consuming capital is increasing from an average year to year growth rate of 3.6% between 2000–01 and

Table 2. Public hospital recurrent and capital expenditure, Australia, constant prices^A 2000–01 to 2010–11^B

Public hospital Year	Recurrent Expenditure (\$ million)	Capital Expenditure (\$ million)	Capital % of Recurrent %
2000–01	22 477	1592	7.1
2001–02	23 615	1758	7.4
2002–03	25 352	1835	7.2
2003–04	26 067	1278	4.9
2004–05	28 126	1855	6.6
2005–06	29 394	2195	7.5
2006–07	31 027	2332	7.5
2007–08	33 329	2158	6.5
2008–09	33 936	2751	8.1
2009–10	35 298	2950	8.4
2010–11	38 338	4290	11.2

^AConstant prices for 2000–01 to 2009–10 are expressed in terms of 2009–10 prices.

^BSource: AIHW.³⁶

Table 3. Capital allocation for public hospitals as a percentage of recurrent expenditure, 2012–13^B

Public hospital	Recurrent Expenditure (\$ million)	Capital Expenditure (\$ million)	Capital % of recurrent %
NSW	17 300	457	2.6
Victoria	13 684	480	3.5
Queensland	11 862	783	6.6
South Australia ^A	4895	239	4.9
Western Australia	3711	311	8.4
Tasmania ^A	1331	161	12.1
ACT ^A	795	202	25.4
Northern Territory	1229	50	4.1
Total	54 805	2684	4.9

^AIncludes some National Health and Hospitals Fund grants.

^BSource: State and Territory 2012–13 Budget Papers.^{21,22,24–29}

Table 4. Indicative capital cost per case mix adjusted separation as a percentage of recurrent cost per casemix adjusted separation 2007–08 to 2010–11

	NSW (%)	Vic (%)	Qld (%)	SA (%)	WA (%)	Tas (%)	ACT (%)	NT (%)	Australia (%)
2007–08	10.1	9.2	13.1	8.2	9.8	6.8	10.4	10.6	9.3
2008–09	10.3	10.2	10.9	8.5	9.9	7.4	9.8	9.1	9.1
2009–10	10.0	12.7	9.9	11.3	9.5	6.2	9.4	12.0	9.4
2010–11	10.3	11.9	8.4	10.4	8.5	5.7	10.7	11.8	9.0

Source: Calculated from Report on Government Services 2010–2013, Appendices Tables 10.A59 and 10A.61 of 2010, 10A.60 and 10A58 of 2011, 10A.53 and 10A.55 of 2012, and 10A.52 and 10A.54 of 2013 (see <http://www.pc.gov.au/gsp/rogs/2010>, <http://www.pc.gov.au/gsp/rogs/2011>, <http://www.pc.gov.au/gsp/rogs/2012>, <http://www.pc.gov.au/gsp/rogs/2013>, accessed September 2013).

2007–08 to 12.9% in 2008–09 and to 24.7% in 2009–10.³⁴ Significant funds are required for the replacement of capital stocks consumed in delivering the rising number of services each year.

Discussion

The emerging picture of capital investment in Australian public hospitals from the literature and the data is that:

- The most recent indicative cost of capital consumed per separation is estimated by the Productivity Commission to average 9% of recurrent costs in public hospitals in 2010–11 (Table 4)
- This estimate is higher than Deeble's calculation of capital consumption accounting for 8.3% of recurrent expenditure in 2002,¹⁴ but consistent with the AIHW estimates that replacement costs for the capital consumed in providing healthcare are rising significantly.³⁴
- These findings confirm that a sizable and growing level of capital expenditure is, and will continue to be, required to address the replacement of capital in public hospitals before new investments associated with growth, technological change or clinical redesign can be addressed.
- Yet the significantly increasing cost of asset replacement derives from two decades of investment in public hospital buildings and equipment which was, for all but 2 years, below replacement levels. So the available data makes clear that the capital stock of public hospitals has been consistently eroded over the past 20 years

In addition to the issue of the appropriateness of the total level of investment (relative to recurrent expenditure), there is an issue of the distribution of capital for similar patient services. Deeble found significant differences within states in the distribution of capital, particularly for medical equipment.¹⁴ Garling, Forster and the NHHRC also noted that the distribution of capital was not equal.^{10,12,13} Tables 3 and 4 also indicated appreciable differences in the total annual capital allocations of the states and territories; however, there is no more detailed information available on the investment in medical equipment, IT and buildings within states closer to the clinical service level.

The Productivity Commission, in its annual reports to government, comes closest to estimating what the indicative cost of capital per patient separation may be. However, the capital estimates remain based on the depreciated values of older assets rather than on the actual investment required to enable contemporary clinical care. High-value hospital investments of the past

40 years may not be the best predictors for the mix of future health equipment, IT and built assets required for clinical care. Indeed, Deeble¹⁴ argued that an 'allocation based on the present capital stock would simply perpetuate inequalities' (p. 54).

The NHHRC made clear that: 'Capital can drive change and is fundamental to achieving the efficiencies and reorientation of the health system we are recommending.'¹⁰ (p. 168) Duckett and others have argued that in an activity-based funding environment, where the focus is on achieving quality care at the efficient price for each DRG, health managers require accurate and specific information on capital to facilitate efficient clinical services.^{5,6,37}

The National Healthcare Reform Agreement aims for Australians to have equitable access to high-quality healthcare and access to transparent and nationally comparable information on hospitals. Responsibility for capital funding remains with the states and territories as capital is explicitly excluded from activity-based funding. So although recurrent funding for hospital services is focused on transparency and efficiency, capital funding arrangements remain largely unchanged.³⁵

With a requirement to provide services at the efficient price, information on the investment in buildings, medical equipment and technology should support best-practice contemporary clinical care. From the available information and the quality of the data, it is apparent that capital funding flows do not share the objectives of transparency and efficiency embedded in the National Health Reform Agreement.

Strengths and limitations of the study

This is the first study to examine the level of investment in Australian public hospitals, drawing material from budget papers, the annual Reports on Government Services and all the major reviews into public hospital services since 2002. It provides a comprehensive overview of the information publicly available on capital invested in hospitals. It sets the information on capital in the context of the recurrent expenditure that capital is required to facilitate. This study builds on Deebles' 2002 paper.

Due to limitations of the data the study examines capital allocation for public hospitals only at the jurisdiction level rather than at hospital levels. Therefore, the information inherently generalises about the allocation of capital across a state or territory between hospitals. The reviews quoted had varying terms of reference and made conclusions based on submissions and analysis, some of which were not research-based. It has not always been possible to distinguish between hospital-based services and community care based at a hospital from the available information. Minor works capital provided through recurrent

budgets also sits outside this analysis, as do charitable donations for the purchase of equipment in public hospitals. Capital costs associated with equipment leases and public-private partnerships for public hospitals include only funds allocated for capital purchases and do not include payments from recurrent allocations. The study is restricted to published information. The important issue of investment for clinical change and health service adaptation have been only lightly addressed in this paper. The central issue of standards is the subject of another paper.

Conclusions

Capital is a vital enabler of hospital service delivery. Estimates of the annual cost of capital consumed in providing services are between 8.3% and 9.4% of recurrent hospital costs. However, the total investment in Australian public hospitals has averaged 7.1% of recurrent expenditure per annum over 10 years to 2009–10 (Table 2), shrinking to 6.2% of recurrent expenditure by 2012–13 (Table 3). It is evident that the investment in hospitals over all but 2 of the past 10 years has not kept pace with the growth in hospital services. Capital is being consumed faster than it is being replaced relative to the growth in hospital care.

The available information on capital for hospital services does not relate to service delivery or contemporary clinical care. It references the residual asset values and depreciation. Information on capital is not aligned to service provision or clinical care; it is not transparently focused on improving efficiency in clinical service delivery or on improving equity of access to high-quality clinical care. The available information to assess the adequacy of investment in public hospitals is aggregated at the state and territory level, blurring differences in the distribution of capital between hospitals and DRGs.

Five out of six major inquiries into healthcare delivery required increased capital funding to bring clinical service delivery to an acceptable standard.^{10–13,19} The sixth inquiry lamented the quality of information on capital for public hospitals.⁹

The policy to have capital included in activity-based payments for hospital services necessitates a real and accurate value for capital relevant to the delivery of efficient, contemporary clinical care, beyond the replacement value of the asset stock. Health service managers, clinicians and the community require access to meaningful information on investment and resource use in hospitals which supports their pursuit of greater efficiency and safety in patient care. Capital funding for hospitals should align with clinical requirements more strongly than with the replacement of aged assets.

Competing interests

None declared.

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Concerns about the Australian Institute of Health and Welfare's information on capital investment for healthcare

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I write to draw your attention to the disparity between information published by the Australian Institute of Health and Welfare (AIHW) for 2012–13¹ and the Australian governments' budget allocations for that year tabulated in the article 'Investing in acute health services: is it time to change the paradigm?'.² Indeed, the AIHW presents data on capital expenditure in a manner that obscures significant investment trends in 21st century hospitals and is misleading and unhelpful for healthcare resourcing.

It is of concern that AIHW has reduced the information on our nation's investment in health to one new line of information per year as virtually all public sector investments on hospitals, community health buildings, medical equipment, IT and communications and other capital are reduced to one number. This number does not illuminate the important questions of healthcare investment: are we investing appropriately to support Australian clinical services and is the investment sufficient for the number of patients requiring clinical care?

Because there is only one line of new information published by AIHW on capital invested in healthcare it is important that it is meaningful. Table 3.4 of Health expenditure Australia 2012–13,¹ (Capital Expenditure, by source of funds. . .) shows three sources of funds: those from the Australian Government, those from State, Territory and local Governments and those from the non-government sector. The confusion arises where all but 1.3% of funds sourced from the Australian government are included in the State, Territory and local Government figure because that is where expenditure happened. There are two consequences of this data presentation that are of concern.¹

First, reading the information on health expenditure in 2012–13, one would not know that, since 2009, the Commonwealth Government has made an unprecedented A\$2.54 billion investment in health capital, particularly for hospitals, through the Health and Hospitals Fund (HHF). This represents a significant change in public policy on capital funding for hospitals and is worthy of note. If the AIHW decision had been to show the capital amounts by their funding source, the 2012–13 statement would have reflected the A\$721.75 million allocated through the HHF as capital for healthcare projects rather than the A\$72 million. Similarly, if the actual 2011–12 capital funding sourced from the Commonwealth was recorded, it would have shown an investment of A\$1.218 billion by the Commonwealth for health and hospital infrastructure, rather than the A\$217 million shown.^{1,3,4}

The second concern is that capital does not receive the detailed, careful reporting and analysis that is AIHW's usual standard. For example, confusion arises when AIHW (in Health Expenditure 2012–13) states that Commonwealth funding of health capital has had an average growth rate of –1% per annum over the decade to 2012–13.¹ Yet, in Health Expenditure 2011–12,⁴ Commonwealth funding of health capital had an average annual growth in health capital of 14.9% over most of the same years in the decade to 2011–12. Similarly, adjustments made to annual health capital expenditure between these two health expenditure publications result in significant changes in some figures, including total capital expenditure, which varied between publications by A\$767 million and A\$959 million for the 4 years to 2011–12.^{1,4}

It is understood that capital data obtained by AIHW for this report are sourced directly from the Australian Bureau of Statistics (ABS) biannual survey data with the challenge of receiving and reporting consistent information from all governments. For non-government sector investment the ABS survey may be the strongest option, but for Commonwealth, State and Territory Governments capital allocations and expenditures found in the appropriation bills as part of each budget provide clear and comparable information on investments in health.² These audited statements conform to accounting standards, are publicly available and subject to parliamentary scrutiny.

The AIHW has progressed the definition of Australian Government health funding to include grants made to the States and Territories under Section 96 of the Australian Constitution. If the Section 96 capital information was included in table 3.2 in Health expenditure Australia 2012–13¹ (or its equivalent), provided health funding by source of funds and was complemented by health expenditure by source of funds in appendix B of in Health expenditure Australia 2012–13,¹ the relative contributions of each level of government would be evident.

Commonwealth funding for healthcare capital is a figure worth watching given the pre-election commitment of the Abbott Government to include capital in activity-based funding and the previous governments' historic investment through the HHF. Technological change, clinical redesign, medical equipment and asset replacement will all require funding at unprecedented levels in the next few years. Historically, the States, and latterly the Territories, have been responsible for healthcare capital raising. The relativities of these contributions is gaining importance.

To progress from the old debate on 'the right number of beds' to the correct level of investment in 21st century health services requires us to gain accurate knowledge and improve the depth of our insight so we may be able to discern the best level of investment to effectively support 21st century clinical care across Australia at the efficient price. For this we need AIHW quality information.

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Appendix J Published Article 3

CSIRO PUBLISHING

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Is capital investment in Australian hospitals effectively funding patient access to efficient public hospital care?

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Abstract

Objective. This study asks 'Is capital investment in Australian public hospitals effectively funding patient access to efficient hospital care?'

Methods. The study drew information from semistructured interviews with senior health infrastructure officials, literature reviews and World Health Organization (WHO) reports. To identify which systems most effectively fund patient access to efficient hospitals, capital allocation systems for 17 Organisation for Economic Cooperation and Development (OECD) countries were assessed.

Results. Australian government objectives (equitable access to clinically appropriate, efficient, sustainable, innovative, patient-based) for acute health services are not directly addressed within Australian capital allocation systems for hospitals. Instead, Australia retains a prioritised hospital investment system for institutionally based asset replacement and capital planning, aligned with budgetary and political priorities. Australian systems of capital allocation for public hospitals were found not to match health system objectives for allocative, productive and dynamic efficiency. Australia scored below average in funding patient access to efficient hospitals. The OECD countries most effectively funding patient access to efficient hospital care have transitioned to diagnosis-related group (DRG) aligned capital funding. Measures of effective capital allocation for hospitals, patient access and efficiency found mixed government-private-public partnerships performed poorly with inferior access to capital than DRG-aligned systems, with the worst performing systems based on private finance.

Conclusion. Australian capital allocation systems for hospitals do not meet Australian government standards for the health system. Transition to a diagnosis-based system of capital allocation would align capital allocation with government standards and has been found to improve patient access to efficient hospital care.

What is known about the topic? Very little is known about the effectiveness of Australian capital allocation for public hospitals. In Australia, capital is rarely discussed in the context of efficiency, although poor built capital and inappropriate technologies are acknowledged as limitations to improving efficiency. Capital allocated for public hospitals by state and territory is no longer reported by Australian Institute of Health and Welfare due to problems with data reliability. International comparative reviews of capital funding for hospitals have not included Australia. Most comparative efficiency reviews for health avoid considering capital allocation. The national review of hospitals found capital allocation information makes it difficult to determine 'if we have it right' in terms of investment for health services. Problems with capital allocation systems for public hospitals have been identified within state-based reviews of health service delivery. The Productivity Commission was unable to identify the cost of capital used in treating patients in Australian public hospitals. Instead, building and equipment depreciation plus the user cost of capital (or the cost of using the money invested in the asset) are used to estimate the cost of capital required for patient care, despite concerns about accuracy and comparability.

What does this paper add? This is the first study to review capital allocation systems for Australian public hospitals, to evaluate those systems against the contemporary objectives of the health systems and to assess whether prevailing Australian allocation systems deliver funds to facilitate patient access to efficient hospital care. This is the first study to evaluate Australian hospital capital allocation and efficiency. It compares the objectives of the Australian public hospitals system (for universal access to patient-centred, efficient and effective health care) against a range of capital funding mechanisms used in comparable health systems. It is also the first comparative review of international capital funding systems to include Australia.

What are the implications for practitioners? Clinical quality and operational efficiency in hospitals require access for all patients to technologically appropriate hospitals. Funding for appropriate public hospital facilities, medical equipment and information and communications technology is not connected to activity-based funding in Australia. This

study examines how capital can most effectively be allocated to provide patient access to efficient hospital care for Australian public hospitals. Capital investment for hospitals that is patient based, rather than institutionally focused, aligns with higher efficiency.

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Introduction

Commonwealth government funding requires hospitals to deliver improvements in quality of care at the efficient price with limited growth in activity-based funding.¹ Yet patient numbers increase, clinical practice evolves and technological advances and replacement costs for medical equipment increasingly challenge hospitals.

Resolving this dilemma involves the key concepts of appropriate, sustainable and effective healthcare and three significant efficiency instruments. In this study these terms are understood to be:

- ‘Appropriate’ acute health facilities are suitable or fitting for their purpose.² Appropriate care derives from government agreements and Australian evidence-based standards.^{3–5} National standards affirm that all Australians are entitled to access safe, high-quality health care that is responsive to the needs of individuals.^{4,6–8} Appropriate health facilities provide access for individuals to contemporary standards of care.
- ‘Sustainable’ has two meanings in the health context: (1) financial sustainability for governments and health services; and (2) environmental sustainability. Financial sustainability within the health sector identifies the ‘desirable composition of the capital stock to bequeath to future generations.’⁹ Manageable and predictable levels of expenditure are determined by maximising efficiency^{10,11}
- ‘Effectiveness’ identifies whether the outputs of the service achieve the stated objectives of that service⁶ in terms of equity of access, appropriateness and quality.⁶
- ‘Efficiency’ has three elements, namely allocative, productive (or technical efficiency) and dynamic efficiency.¹² Efficiency in hospitals considers the quality of health services, access to care and cost.¹³
- ‘Allocative efficiency’ optimises the distribution of assets to achieve the greatest community well-being or outcomes at a point in time.¹² In health, allocative efficiency involves priority setting for the distribution of resources between elements of the health system.¹⁴ Allocative efficiency is the optimal choice of input proportions, given their respective prices, according to their cost-effectiveness.¹⁵ Productive efficiency and allocative efficiencies together provide the concept of economic efficiency.
- ‘Productive or technical efficiency’ maximises outputs for a given level of inputs so that achieving an additional output requires additional inputs.¹⁶ Productive efficiency can be measured as a ratio of outputs to inputs.⁶
- ‘Dynamic efficiency’ is the allocation of resources to achieve the greatest possible community well-being or outcomes over time.¹² Dynamic efficiency examines how effectively capital distribution systems respond to emerging risks for public hospitals, including sustainability, patient demand, technological change and increased acuity.^{17–19}

An effective system of capital allocation for public hospitals would provide equity of access for patients, be appropriate, efficient and would fund quality services.²⁰ So the aim of the present study was to ask the question, is the system of capital funding for Australian hospitals effectively funding patient access to efficient public hospital care?

Hospitals achieving productive efficiency have been found to require access to capital that is timely, flexible, affordable and fairly distributed.^{21,22} Allocative efficiency of capital in public hospitals requires capital resources to be optimised for maximum social benefit, which, in the case of public hospitals, is described as patient access to appropriate treatment. In considering assessing which systems most effectively fund patient access to efficient public hospital care, comparative measures of the access of hospitals to capital, patient access to hospital services and productive efficiency have been identified in Fig. 1, which illustrates the relationship between the qualities sought for Australian hospitals and the measures used in this study to assess the ability of hospitals to fund patient access to efficient care.

Methods

To investigate whether the capital funding of Australian hospitals effectively funds patient access to efficient public hospital care, we addressed the following questions: (1) how is capital allocated for acute care to public hospitals in Australia; and (2) what is international best practice for allocating capital to hospital infrastructure for acute care? To understand Australian processes and priority setting for hospital capital funding, 10 senior health officials,²³ experienced in the process of capital allocations to hospitals, were interviewed about capital decision making across three domains: (1) the process of capital allocation for public hospitals; (2) decision making about funding levels; and (3) health system objectives, including clinical appropriateness, sustainability, approach to innovation and evidence-based change, patient-centred care, clinical pathways and evidence-based design. This study was granted ethics approval (SPH-86-2013) by Curtin University. Semistructured interviews were conducted over a 12-month period with the senior health officials sharing responsibility for capital funding systems covering 84% of Australian public hospitals.²³ Officials from two states and one territory declined invitations to participate in the study.

In addition to interviews, a literature review was conducted to identify publications addressing Australian and overseas capital allocation systems with the following objectives: (1) to determine the methods for allocating capital for public hospitals in Organisation for Economic Cooperation and Development (OECD) health systems; (2) to assess the ability of public hospitals to fund access to efficient care; and (3) to identify the attributes of an effective system of investment for public hospitals.

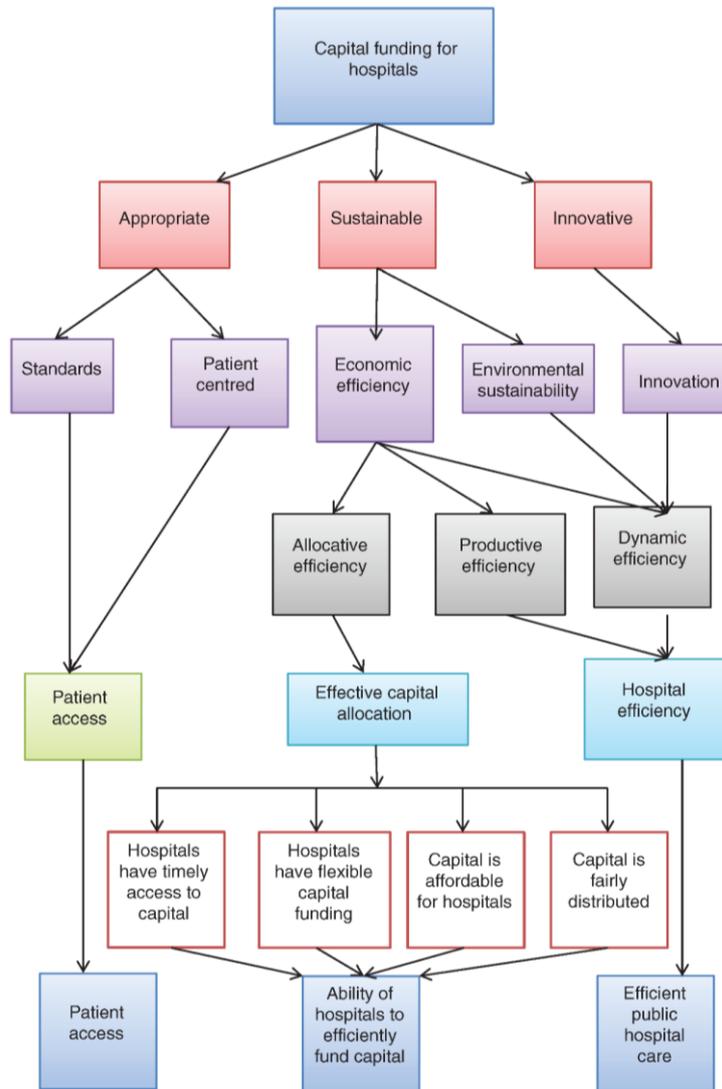


Fig. 1. Funding patient access to efficient hospitals, qualities and measures.

Inclusion criteria for the literature review were articles or reports published after 2000 in the English-language peer-reviewed literature on system-wide approaches to capital funding. Articles were identified using the search terms ‘capital allocat*’ with ‘hospital*’, ‘patient access’ and ‘public hospital investment process’ and variants thereof for OECD countries in the electronic databases Emerald, Informit and Medline. Items were reviewed based on title and abstract and excluded if only one hospital was discussed, references were for social or intellectual capital or the studies were focused on portfolio investment strategies. Well-known comparative health efficiency

studies were excluded because they did not include capital.^{24–28} Three relevant Australian references were identified^{12,13,29} in addition to 58 reports and articles for the international comparisons.^{15,22,30–85}

Searching Australian government and university websites using the same criteria as for the peer-reviewed literature identified 56 relevant documents^{5,86–140} that were used to verify the results of the Australian interviews. International grey literature information sources and websites included the World Health Organization (WHO), relevant European, US and UK official websites, the OECD, the Commonwealth Fund and

university health economic sites (McMaster, University of York, Imperial College London, London School of Economics, London School of Hygiene and Tropical Medicine). The literature review provided sufficient data on national capital allocation systems for the 17 OECD countries. The WHO Health in Transition (HiT) studies^{31–38,40–46,48–50,53,58,59,67,73} for those nations provided a common source.⁵¹ National systems for capital allocation for public hospitals were identified from the HiT studies and categorised into five groups, namely diagnosis-related group (DRG)-type systems, government subsidy, government project grants, mixed government–private–public partnership (PPP) or private funding (Table 1).

Health systems in Australia identify efficiency, sustainability, innovation and patient-centred care as system objectives.^{141–144} Three aspects of economic efficiency were examined: (1) productive efficiency, analysed from econometric reports on efficiency,^{10,12,13,15,22,52,145} (2) allocative efficiency measures, which, in the present study, are based on systems for priority setting for public hospital capital allocation and patient access; and (3) dynamic efficiency, assessed by examining systems for environmental sustainability, responsiveness to innovation and patient-centred care.¹⁷

Productive efficiency was scored from three studies ranking WHO member countries for health service allocative and productive efficiency.^{15,22,52} These three studies ranked 191 countries using frontier production function model and data envelope analysis, and were reviewed by an international scientific committee^{146–148} and by the European Commission study of health system efficiency.¹⁴⁵ Each study had a different emphasis and measures providing different, but comparable, national rankings. Conversion of rankings to graduated scores within the range 0–3 was based on relative rankings between the

17 OECD countries and Australia such that the highest-ranking nation (of the designated group) for each study scored 3, the second scored 2.83 and the lowest-ranked countries scored 0.17 for each study. The scores for each nation across the three studies were then averaged to provide one national score for productive efficiency.

To compare the measures for capital from national and international sources, a common scoring scheme was developed across the measures to be tested: hospital access to capital and patient access to hospital to match the measure for productive efficiency. Together, these measures were used to assess which systems most effectively fund patient access to efficient hospital care (Fig. 1).

‘Patient access to hospital’ and ‘hospital access to capital’ were assessed by three scorers (RK, DVH, Rachel Moorin) using the 0–3 scoring system (with 3 the highest score, 2 indicating satisfactory, 1 indicating poor or inadequate and 0 indicating a very poor standard). Scores were based on extracts from Section 4.1 of each HiT study and other peer-reviewed studies.^{10,12,31–51,53–74,81–85,149–159}

Using the same scoring system, scoring for ‘hospital access to capital’ per country was for each of the four domains (timely access to capital, flexibility of funding, affordable capital and fairness of distribution); these domain scores were averaged to provide a single score for ‘hospital access to capital’ within the 0–3 range for each country. ‘Patient access to hospital’ was scored directly for each country. Then, the scores for each country, as assessed by the three scorers, were averaged to provide a final score in the range 0–3 for ‘patient access to hospital’ and ‘hospital access to capital’.

Scoring was compared between scorers using weighted Cohen’s kappa analysis.¹⁶⁰ Scoring of these measures reflected

Table 1. Source of capital funds for hospitals in Australia and 17 Organisation for Economic Cooperation and Development countries

Data from World Health Organization (WHO) Health Systems in Transition by nation and other peer-reviewed literature. PPP, private–public partnerships; DRG, diagnosis-related group

	DRG-type	Government subsidy	Capital funding Government project grant	Mixed government-PPP	Private funding
Australia ^{10,12,74}			✓	✓	
Austria ^{31,32}	✓	✓			
Belgium ^{33,59}		✓	✓		✓
Canada ^{34,82}			✓		✓
Denmark ^{35,36,66}		✓	✓		
Finland ^{37,83,158}	✓				
France ^{38,40}	✓		✓		
Germany ^{41,61,84}		✓			
Italy ^{42,159}	✓				
Japan ⁴³				✓	✓
Netherlands ^{44,67}	✓				
Norway ⁴⁵	✓		✓		
Portugal ^{46,157}			✓	✓	
Spain ^{58,73}			✓	✓	
Sweden ⁴⁸	✓				
Switzerland ⁵³	✓				
UK ^{49,85}				✓	
USA ^{50,57}	✓				✓
Total	9	4	8	5	4

Table 2. Mean scores for access to capital, patient access to hospital and efficiency in Australia and 17 Organisation for Economic Cooperation and Development nations

Data from World Health Organization (WHO) Health in Transition reviews, other peer-reviewed literature and the scoring of Evans¹⁵, Murray²² and Tandon⁵²

Country	Hospital access to capital	Patient access to hospital	Economic efficiency	Total
France ^{38,40}	2.8	3	3	8.8
Netherlands ^{44,67}	2.8	3	3	8.8
Switzerland ⁵³	2.7	3	3	8.7
Austria ^{31,32}	2.7	2.3	3	8
Germany ^{41,61,84}	2.3	3	2.3	7.6
Norway ⁴⁵	2.8	1.7	2.7	7.2
Japan ⁴³	0.8	3	3	6.8
Average	1.64	1.8	2.7	6.14
Australia ^{10,12,74}	1.75	2	2.3	6.05
Finland ^{37,83,158}	2.2	1.3	2.3	5.8
Belgium ^{33,59}	1.6	1.3	2.7	5.6
Italy ^{42,159}	1.3	1.3	3	5.6
Sweden ⁴⁸	1.1	1.3	3	5.4
UK ^{49,85}	0.5	1.7	3	5.2
Portugal ^{46,157}	0.8	1.3	3	5.1
Denmark ^{35,36,66}	1.3	1.3	2	4.6
Spain ^{58,73}	0.8	1	2.7	4.5
Canada ^{34,82}	0.9	1	2.3	4.2
USA ^{50,57}	0.6	0.3	2	2.9

Table 3. Mean scores for access to capital, patient access to hospital and efficiency by capital allocation systems
CaDRG, capital aligned to the diagnosis-related group

System	Access to capital	Patient access	Efficiency	Total
CaDRG minus US	2.1	2.1	2.0	6.2
CaDRG including US	2.3	1.9	1.8	6.0
Government subsidy	2.0	2.0	1.2	5.1
Government project grants	1.6	1.6	1.5	4.7
Private-public partnerships	0.7	1.8	1.9	4.4
Predominantly private	1.0	1.4	1.4	3.8

fair to moderate agreement or better, with no levels of poor agreement.

Scores for hospital access to capital, patient access to hospital and efficiency were summed (Table 2) to assess how effectively hospitals fund patient access to efficient hospitals for each country. Finally, in Table 3, countries were grouped by their system of capital allocation (Table 1) for the qualities of hospital access to capital, patient access to hospital and efficiency (Table 2) to assess which funding system most effectively funds patient access to efficient care. Because the US scored considerably lower than most other countries, the funding categories were expanded to include DRGs without the US to aid comparison.

Results and discussion

Capital allocation systems in Australia

Interviews with senior officials identified that all Australian states have similar systems for annual capital allocations for

public hospitals. Regional health authorities compile prioritised project investment lists that are amalgamated and prioritised centrally for funding. Decision making on capital for public hospitals was identified by 43% of senior officials to take place in the state departments of health, whereas 29% indicated that decision making was at ministerial level and 29% identified cabinet or treasury level. The amount allocated for public hospital facilities and medical equipment was recognised as part of a planned replacement process or a similar amount annually by 50% of officials, and was stated to be dependent on the state budget by 20% of officials.

Clinical alignment

In the process for capital allocation, clinical views were universally sought in the planning process at the beginning of the capital allocation process, but were half as likely to be included at each further step in the planning process. Only 50% of officials used evidence-based clinical standards or clinical guidelines. This result aligns with the findings of system-wide reviews and commentators.^{86–88,141,161–165} Clinical pathways were always referenced in planning, but not used in the capital allocation process.

Clinical service planning at the beginning of the capital allocation process was found to be hospital and region based in 80% of cases, with only one state using patient-centred planning as the foundation of capital allocation.

Allocative efficiency

Allocative efficiency is promoted under activity-based funding because all patients treated within the same DRG are funded to have access to comparable recurrent resources.¹⁶⁶ Similarly, an effective system of capital allocation would promote allocative efficiency when capital for hospitals was sufficient to fund equitable patient access to appropriate quality care that is efficient.²⁰

However, all Australian jurisdictions use a similar system that compares and prioritises capital allocation options within the health system. Prioritisations draw from asset-replacement strategies based on lifespans for buildings of up to 50 years, and up to 20 years for some technologies.^{29,167} Twenty per cent of officials saw capital as an asset with a 20- or 50-year lifespan, with another 20% of officials, from different states, identifying elections as significant in setting priorities for capital allocation. Fifty per cent of officials reported working from a defined plan for allocations or used asset-specific replacement as a determinant of capital allocations. Prioritised systems are also used for medical equipment investment, with new builds and redevelopments receiving the majority of funds for medical equipment, and the replacement and improvement of older medical equipment receiving a lower priority. Similarly, investment in information and communications technology (ICT) was recognised as associated with major hospital developments by 92% of officials.

Productive efficiency

Productive efficiency in public hospitals is dependent on optimal combinations of skilled labour and capital so desired outputs are achieved within resources.^{10,168} Australian public

hospitals were found to be operating at an estimated 90% efficiency in the most detailed study of hospitals, but the value of capital cost per patient could only be estimated.^{6,12}

Dynamic efficiency

Innovations in clinical services are less clearly supported in the capital funding system, with no national or state-wide systems to support capital for evidence-based clinical innovation; commonly, funding to facilitate innovation was sought at the project or hospital level (60%).

Sustainability is a significant issue for acute health care, with high energy costs and carbon emission particularly in ward areas and surgical services.¹⁶⁹ Up to 60% of public sector energy costs in Victoria were estimated to have been generated by hospitals.¹⁷⁰ Several states have trialled projects to monitor the use of energy in existing hospitals, but officials could not reference a state-wide system of energy or carbon management. The prevailing approach to improving energy consumption was redevelopment of the hospital (60%) or was a matter for individual hospitals (40%).

Patient access to appropriate hospital care is a national measure of equity.¹⁷¹ Patient-centred care is an aspiration of most health systems, but only 20% of officials reported patient-centred, rather than hospital-based, clinical service planning within the capital allocation system.

Funding patient access to efficient hospital care: the international experience

Hospital investment systems of 17 countries were examined to assess which systems most effectively fund patient access to efficient public hospital care. Examining the system of capital funding (Table 1) found that although many countries have mixed systems, most countries reviewed have transitioned to capital aligned with the DRG-type payment (CaDRG). Fewer nations use traditional government project grants (Table 1). Centralised government funding was less common than funding closer to the clinical level (CaDRG, mixed government–PPP and private funding).

Table 2 provides results for the three elements of the research question: capital funding for hospitals, patient access to hospitals and economic efficiency.

Access to capital for hospitals identified the UK and the US to have the lowest scores (Table 2). Australia ranked eighth for access to capital, whereas the best-performing national systems were France, the Netherlands and Norway.^{12,27,30,33,34,37,46,47,49,50,59,70,73,151,158,172–176}

Considering patient access to hospitals, the US again scored lowest, with the best patient access in Germany, the Netherlands, Switzerland, France and Japan.^{25,31,35–38,45,48,50,57,64,67,151,158,175,177–180}

Evaluating the relative economic efficiency of health systems found that the US and Denmark ranked lower than the average efficiency figure for the 18 countries studied.^{15,22,52}

Bringing the three measures of access to capital, patient access and economic efficiency together (Table 2), France and the Netherlands funded the best access to efficient hospital care for patients, followed by Switzerland, Austria, Germany and Norway. The international comparative studies echo Productivity Commission reports that Australia ranked below the

18-nation average for patient access to efficient care.^{10,12,74,181} The US scored lowest at funding patient access to efficient care, with a score equivalent to 33% of the top scoring nations.

Does the capital funding system influence how well nations fund patient access to efficient hospital services? Table 3 aggregates nations by capital funding system (from Table 1), for hospital access to capital, patient access and efficiency (Table 2). CaDRG systems gained the highest scores for (timely, flexible, affordable and fairly distributed) capital allocations for hospitals. Government subsidies were ranked as the next most appropriate capital funding method. Private funding scored below average. The least effective system for funding patient access to efficient hospital care was mixed government–PPP funding.

Patient access to public hospitals was best provided by CaDRG (when the US was excluded) and government subsidy systems, narrowly ahead of CaDRG capital allocation systems that included the US. Private and mixed government–PPP funding again scored below average (Table 3).

For efficiency, countries using DRG-type funding were 70% of the top 10 rated countries.^{15,22,25,52} So when nations were aggregated by funding system for efficiency, DRG-based funding ranked highest regardless of inclusion of the US (Table 3).

Overall, DRG-based capital funding systems (with or without the US) scored highest for funding patient access to efficient hospital care. Government subsidies ranked above average. Market-based funding systems did not provide better access to capital for hospitals than government-funded systems. Predominantly private capital funding and mixed government–PPP systems provided one-third or less access to capital afforded by the CaDRG and government subsidy systems, scoring lowest for funding patient access to efficient care (Table 3).

Conclusions

Australian capital allocation systems are generally not patient centred or focused on clinical standards. Instead, Australia has a prioritised hospital investment system based on hospital asset replacement, institutionally based capital planning, budgetary and political priorities.

Because Australian systems for capital allocation for acute care were also found not to demonstrate allocative, productive or dynamic efficiency, the fundamental question was asked, which capital allocation method most effectively funds patient access to efficient hospitals?

The present study identified that the OECD countries most effectively funding acute care have transitioned to DRG alignment for capital funding for hospitals. Measures of effective capital allocation for hospitals, patient access and efficiency found DRG-based capital allocation superior to government subsidies, with the worst performing systems based on private finance. Of the 18 health systems assessed, France, the Netherlands and Norway provided the best access to effective capital funding for hospitals.

Numerous reviews of health service delivery across Australia have found that a prioritised capital allocation system does not comprehensively provide appropriate access to capital resources for all patients and clinicians.^{29,86–88,141,161–163,182,183} Australian systems of capital allocation for public hospitals were not found

to match health system objectives for promoting allocative, productive¹⁰ or dynamic efficiency within the national study or in comparison with 17 OECD nations.

The present study is the first to review capital allocation systems for Australian hospitals, to evaluate those systems against the contemporary objectives of the health systems, and to assess whether prevailing Australian allocation systems deliver funds to facilitate patient access to efficient hospitals. Commonly, hospital efficiency and access are considered by type of ownership or bed numbers rather than system of funding. The present study is the first to evaluate hospital capital allocation and efficiency. It is also the first to analyse the effectiveness of a range of capital funding systems to facilitate access for patients to efficient hospital care across a range of OECD countries. Similarly, it is the first time capital allocation for Australian hospitals has been included in an international review.

Although the measures used to quantify capital allocation, patient access and efficiency have been used with care, all measures have their limitations. Information has been drawn from various sources, themselves containing limitations. A wider search over 12 additional languages may have found further information on patient access, innovation, clinical standards and access to capital. Patient access to hospital services relies on a wide range of factors, including recurrent funding of hospitals, staffing and access to primary care. The efficiency measure is a generalised measure because comparative efficiency studies are challenged by method,¹⁴⁸ data and specificity,¹⁸⁴ defining outputs or outcomes¹⁸⁵ and because inputs rarely include measures of capital investment other than hospital beds.^{13,25} The studies scored for efficiency date from the turn of the century and do not include later changes made in health systems.

Allocative efficiency for capital in Australia, in an activity-based funding context, invites capital to be linked to patient care, clinical standards and efficiency, and to be equitably distributed between hospitals for patients in similar DRGs. The international evidence identified that an allocation system that provides hospitals with access to capital that is timely, flexible in use, affordable and fairly distributed improves efficiency. The evidence indicates that DRG-aligned capital allocation in Australia can provide the equitable, patient-centred distribution required for allocative, productive and dynamic efficiency in acute care.

Competing interests

The authors declare no conflicts of interest.

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COST ASSESSMENT FOR NEW PUBLIC HOSPITAL SERVICES

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AUSTRALIANS VALUE OUR PUBLIC HOSPITALS HIGHLY BUT, QUANTITY SURVEYORS WILL BE SURPRISED TO KNOW THAT, THE VALUATION OF THE BUILDINGS AND MEDICAL EQUIPMENT, REQUIRED TO SUPPORT HOSPITALS, IS POOR

Over many years national reports on public hospitals have lamented the quality of data on hospital assets (SCRGSP 2017; SCRGSP 2018, 2007, 2008, 2009) and the Productivity Commission, when directed to value public hospital capital, acknowledged that “nobody knows exactly how much capital is currently used by public hospitals” (Productivity Commission 2009 p. 303). Consequently the value of public hospital capital assets required for patient diagnosis and treatment are estimated from asset depreciation plus the user cost of capital (Productivity Commission 2009; SCRGSP 2019).

However, public hospitals in Australia are now costed and funded for the specific resources required for individual patient care. Impending clinical improvements including Personalised Medicine, Genomics and Precision Medicine require precision costing for public hospital capital costs.

This article outlines trends in capital funding for public hospitals in Australia, the key factors influencing investment and building and the opportunities and challenges facing public hospital infrastructure posed by technological change. It concludes with identification of the role Quantity Surveyors can take in developing the tools for activity-based capital funding for public hospitals.

BACKGROUND

Australians value access to high quality public hospital services when they need them. Consequently, between \$2 billion and \$2.3 billion has been invested annually in public hospital projects over the last three years but this is down from peaks of \$4.3 to \$5.3 billion annually between 2010-11 and 2012-13.

Public hospitals are focussed on activity. Once beds were the measure of hospital size and technical capacity. But now beds are only a portion of hospital activity with 6.6 million patients of whom 53% do not have an overnight stay (AIHW, 2018 - page 15), 3 million procedures in outpatient clinics, 16 million allied health treatments and 12 million outpatient medical consultations. Hospital-in-the-home meant 1,500 fewer beds were required in 2016-17 (AIHW 2018 - Table 5.49). Across the nation the number of patients increases by 4% per year each year (since 2012-13) although fewer than 15% of public hospitals have had building projects over the past three financial years (State and Territory Budget Papers 2015-16, 2016-17, 2017-18).

However, waiting lists for surgical care are increasing annually with 3% of Australians waiting for surgical treatments, some for over a year (Table 4.5 (AIHW 2017; Australian Medical Association 2019). Access to emergency departments is deteriorating with some waiting times defined as clinically dangerous (Whitson 2018; Australian Medical Association 2019). Emergency department waiting times are constrained by access to hospital beds (Australasian College for Emergency Medicine 2018;

Australian Medical Association 2019). Mounting evidence suggests that current clinical requirements for patients are not being met by traditional approaches to capital funding (Kerr 2014; Kerr 2018).

FUNDING FOR HOSPITALS

Contemporary public hospitals in Australia are focussed on the quality of care delivered at an efficient cost. Funding for most hospital costs is per patient based on their diagnosis group (DRG) and is called activity-based funding (ABF). Since ABF funding was introduced in 2012-13, the annual cost for operating public hospitals has only increase by an average 1% per year (Biggs 2018).

However, capital funding for public hospitals is prioritised by State and Territory (called states in this paper) Governments based on health service, budgetary and political priorities (Kerr 2018). At the beginning of this century, the value of capital required to support clinical care was estimated to be 8% of recurrent costs (Deeble 2002). By 2016-17, the Productivity Commission depreciation-based estimate for the capital cost per patient had risen to 19% of recurrent costs for public hospitals (SCRGSP 2018). However, State Budget papers showed over the three years, 2015-16, 2016-17 and 2017-18, across all states, investment in hospitals averaged 44%, 40% and 36% of the cost of capital consumed in providing care (Table 1).



HOSPITALS



Table 1 Capital expenditure for hospitals as a percentage of capital costs consumed, 2015-16, 2016-17 and 2017-18

	Total Estimated Cost of Capital \$'000	Hospital Capital Expenditure			Total investment as a percentage of capital cost		
		2015-16	2016-17	2017-18	2015-16	2016-17	2017-18
		\$'000	\$'000	\$'000	%	%	%
NSW	1,762,521	699,172	718,406	611,845	40	41	35
Victoria	1,738,014	247,106	261,598	446,470	14	15	26
Queensland	959,499	752,928	694,196	431,716	78	72	45
S.A.	454,629	92,569	169,997	71,489	20	37	16
WA	542,436	155,113	133,664	219,897	29	25	41
Tasmania	88,643	84,826	113,297	185,410	96	128	209
ACT	124,811	11,704	139,416	88,976	9	112	71
NT	164,000	102,750	121,427	42,701	63	74	26
Australia	5,834,552	2,146,168	2,352,001	2,098,504	44	40	36

Source: Annual Report on Government Services 2018 (SCRGSP 2018) State Budget Papers, (AIHW, 2018)

CLINICAL CHANGE AND TECHNOLOGY POSE RISKS AND OPPORTUNITIES

The progression from funding hospitals per bed day to funding per patient by diagnosis group has changed the focus of clinical service costing. The capacity to cost the treatment of similar patients across all hospitals in Australia has increased transparency and efficiency, reducing waste and minimising risk. The success of this micro-economic costing approach has not been extended to capital valuation as yet.

Clinical change has resulted in improvements for patients and hospitals with implications for hospital buildings. Hospital-in-the-home, telemedicine, robotics, medical imaging advances

are examples of improved clinical effectiveness resulting in efficiency dividends.

Further changes in clinical care are expected from new types of medicine and new diagnosis and delivery systems (Williamson 2018) from point-of-care testing for genome sequencing, gene editing, microbiomics and epigenetics to hybrid robotic surgery and imaging (Williamson 2018; CSIRO 2018).

Platforms in hospitals will be required for information and clinical communications systems to supporting electronic medical records, artificial intelligence as a clinical aid (Sampler 2018; Dewey 2018), automatic dispensing, big data (Productivity Commission 2017a; CSIRO 2018), real-time patient monitoring

equipment and apps (Productivity Commission 2017b; Phillips 2018; CSIRO 2018), and patient monitoring systems.

Traditionally, adoption of new technologies has been seen as a cost. By analysing costs in terms of the patient and treatment efficiency, cost-benefit relationships can be established to determine cost-effectiveness. Critical to this process is effective and accurate capital cost estimation.

VALUING CAPITAL FOR PATIENT CARE: THE TOOLS REQUIRED FOR FUTURE VALUATION

European research has provided some frameworks to enhance capital cost



estimation in hospitals to the patient and diagnosis level. The Dutch Layers Approach to hospital building costs hospital functional areas into four areas - hotel, 'hot floor', office and industry. They used a property approach to determine the lifespan, technical specificity, flexibility and ultimate marketability or disposal value of hospital components (Netherlands Board for Healthcare Institutions 2007a). Based on depreciation of assets, Germany subsequently developed diagnosis-based estimation for capital costs linked to facilities management systems (Vogl 2014; Lennarts 2009). The adoption of diagnosis-based capital funding in Germany improved the cost effectiveness of hospitals. Detailed hospital information on capital costs have enabled thorough evaluations of individual hospitals, technological progress and regional efficiency (Karmann 2017).

Green costing for sustainability is becoming more significant in the UK, Europe, Australia and America to manage to costs associated with climate change for hospitals to reduce their carbon footprint, water and energy consumption and optimise waste management (OECD Health Ministerial Meeting 2017; WHO Regional Office for Europe 2017; Watts N 2017; Zhang 2018; CSIRO 2018; Hanna 2018; UK National Audit Office 2015). Australian healthcare is estimated to generate 7% of national carbon emission with 34% of that from public hospitals. Expenditure on health buildings has been estimated to generate an additional 8% of total health emissions (Malik 2018).

These dynamics suggest faster rates of redundancy and replacement of hospital assets with greater emphasis on life-cycle costing.

CONCLUSIONS

In Australia, the pursuit of hospital efficiency at the patient level has overlooked the value of effective capital costing. The traditional prioritised, project-based system of funding hospital projects is not delivering clinically-appropriate access to hospital beds, emergency departments or surgical care for all Australian patients. More patients require care each year but only a small percentage of hospitals are funded through existing processes. Emerging technologies are changing hospitals and the types of services they offer. Technological innovations in healthcare require effective capital valuations to determine both the costs and the benefits accurately. Costing capital to the patient level permits appropriate and sustainable capital funding for the expanding range of clinical services in hospitals.

Evidence suggests that public hospitals require larger and more frequent investment to meet clinical and technological developments. Maintaining Australian standards for quality hospital care will require the development of accurate valuations for the capital required to deliver effective patient care, and a more patient-focussed funding mechanism. If the system of capital allocation is linked to the patient diagnosis through activity-based funding, and the Commonwealth cost-shares, a significant number of hospitals will require professional Quantity Surveying services to improve facilities and assets.

Hospitals are changing from measuring the number of beds to measuring the resources required by patient diagnosis. Rather than hospitals being defined by the number of beds, they will be defined by the number of inpatients, outpatients

and day-patients seen. Quantity Surveyors can expect to be instrumental in delivering detailed costings for hospital services as they adapt to frequent clinical and technological change. Assessments of capital costs in a technologically dynamic time would benefit from data collection specific to the different costs for functional areas of a hospital (operating theatres, ICUs, procedure rooms, delivery suites, wards, day-only areas, hotel spaces, outpatient functional areas, imaging etc.) expanding on the Dutch Layers Approach (Netherlands Board for Healthcare Institutions 2007b) and the German Facilities Management costings (Lennarts 2010). Appropriate costing for buildings and systems responding to energy, water and waste costs increases and the impacts of climate change will also be valuable (UK National Audit Office 2015).

Quantity Surveyors will be instrumental in bringing the next generation of clinical care to Australians through progressively improved hospitals across Australia. Developing detailed costing data that can be linked to the various elements of patient care is the key. The challenge for Quantity Surveyors is to develop databanks of sufficient integrity to support the inclusion of capital costs in activity-based funding.



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Appendix L Permission Letter

From: Angelkoska, Svetlana <Svetlana.Angelkoska@nhfb.gov.au>
Sent: Wednesday, 2 October 2019 7:49 AM
To: 'Rhonda Kerr' <rhonda.kerr@postgrad.curtin.edu.au>
Cc: Rhonda Kerr <kerr005@bigpond.com>; Delia Hendrie <D.V.Hendrie@curtin.edu.au>
Subject: RE: Seeking Permission to use a Diagram from the National Health Funding Body [SEC=OFFICIAL]

Hi Rhonda

The NHFB approves the use of the diagram in your thesis.

Regards
Svetlana

Svetlana Angelkoska
Director, Data Modelling and Analysis



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From: Rhonda Kerr <rhonda.kerr@postgrad.curtin.edu.au>
Sent: Thursday, 26 September 2019 5:08 PM
To: Angelkoska, Svetlana <Svetlana.Angelkoska@nhfb.gov.au>
Cc: Rhonda Kerr <kerr005@bigpond.com>; Delia Hendrie <D.V.Hendrie@curtin.edu.au>
Subject: Seeking Permission to use a Diagram from the National Health Funding Body [SEC=No Protective Marking]

Dear Svetlana,

I am in the final stages before submitting my Ph.D. thesis for examination. I seek permission to include "the National public hospital recurrent funding and payment framework 2018" in my thesis. It neatly describes the flows of funding for recurrent costs.

My research has examined diagnosis-based capital funding for acute care and the Framework describes the funding relationships I seek to emulate very effectively. My research found recurrent cost savings were achieved through Activity Based Funding for capital based on DRG's.

Please advise me if the use of the diagram in a thesis is permitted by the National Health Funding Body.

Kind regards
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