Curtin School of Nursing
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The Epidemiology of Ambulance Attended Falls in Western Australia

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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. This thesis includes five original manuscripts, published in Australasian Journal of Paramedicine, Australasian Emergency Care, Injury and Prehospital Emergency Care.

This thesis investigated the epidemiology of ambulance-attended falls in Western Australia. The concept, study design, data collection, data analysis, drafting and writing of manuscripts were my responsibility as the PhD candidate working within the Prehospital, Resuscitation, and Emergency Care Research Unit (PRECRU), under the primary supervision of (Adjunct) Associate Professor Peter Buzzacott and Professor Judith Finn; with the assistance of my other supervisors Professor Anne-Marie Hill, Dr Hideo Tohira and Dr David Majewski. Primary supervision was taken on by Professor Judith Finn following Adj. Associate Professor Peter Buzzacott's retirement, although Adj. A/Prof Buzzacott continued as a co-supervisor. The inclusion of co-authors (and clinical collaborators, Deon Brink and/or Rudi Brits) in each manuscript reflects PRECRU's commitment to the development of collaborative research teams.

Paige Marie Watkins
February 2024

Ethics Approval

The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated 2023. The proposed research study received human research ethics approval from the Curtin University Human Research Ethics Committee (HREC), Approval Number HR 128/2013-85. My name was added to the list of investigators for HR 128/2013: "Western Australian Prehospital Care Record Linkage Project" to enable (de-identified) data access and analysis. Approval to access St John Western Australia electronic patient care records was gained from the St John Western Australia Research Advisory Group (now called the Research Governance Committee). St John Western Australia Research Governance Committee and HREC approval were obtained to interview paramedics for the purpose of this thesis (Approval Number: HRE2021-0100). All ethical approval documents are provided in Appendix E.

Paige Marie Watkins
February 2024

Acknowledgment of Country

We acknowledge that Curtin University works across hundreds of traditional lands and custodial groups in Australia, and with First Nations people around the globe. We wish to pay our deepest respects to their ancestors and members of their communities, past, present, and to their emerging leaders. Our passion and commitment to work with all Australians and peoples from across the world, including our First Nations peoples, are at the core of the work we do, reflective of our institutions' values and commitment to our role as leaders in the Reconciliation space in Australia.

Abstract

Background

Falls are the second leading cause of unintentional injury globally, with more than 37 million falls requiring medical attention annually. Emergency Medical Services (EMS) (commonly referred to as 'ambulance services' in Australia) are usually the first point of medical attention when a fall occurs. Fall-related incidents involving older adults account for an increasing number of non-urgent calls for an ambulance. Alternative referral pathways, as alternatives to transport to emergency departments (ED), are being explored more commonly as the demand to attend low-acuity falls in older adults increases. However, little is known of the prehospital management, provided by EMS staff responding to patients who fall. Further investigation via epidemiological and exploratory qualitative research is needed to address this gap in prehospital literature and provide context to EMS staff management of adults who fall.

Aim

The overall aim of this doctoral thesis was to describe the epidemiology of patients who fell and were attended by EMS personnel, in Western Australia (WA) - examining the patient characteristics and prehospital clinical management of falls and repeat falls. A secondary aim was to explore paramedics' experience, views and attitudes towards the management of falls patients in WA.

Methods

This thesis encompasses four research studies, published in peer-reviewed journals. The first was a scoping review. Following the published protocol, the scoping review aimed to systematically map published literature to identify knowledge gaps in the EMS management of adult patients who had fallen. The second two studies focused on the epidemiology of ambulance-attended adults who fell, describing patient characteristics, predictors of transport urgency and risk of sustaining repeat ambulance-attended falls. The fourth and final study was an exploratory qualitative study of paramedics' experiences attending and managing patients who fell.

Results

Study 1: A Systematic Scoping Review

Watkins PM, Buzzacott P, Brink D, Masters S, Hill A-M. Pre-Hospital Management, Injuries and Disposition of Ambulance Attended Adults who Fall: A Scoping Review Protocol. *Australasian Journal of Paramedicine. 2021*;18:1-5.

Watkins, P. M. Masters, S. Hill, A. M. Tohira, H. Brink, D. Finn, J. Buzzacott, P. The prehospital management of ambulance-attended adults who fell: A scoping review. *Australasian emergency care, 2023, Vol.26*(1), p.45-53.

This scoping review aimed to map and synthesise the evidence for the prehospital management of EMS-attended adult patients who fell. Following the Joanna Briggs Institute (JBI) methods and scoping review protocol, six databases were searched for sources reporting on the population (adults who fell), context (ambulance-attended patients), and concept (injuries, interventions, and disposition data) reported in the scoping review and protocol.

Results: The scoping review identified 115 sources for review that met the inclusion criteria. A gap in research was identified regarding the management of falls in the prehospital setting. Patient characteristics and injuries are well documented, but the type and number of prehospital interventions, decisions around disposition, whether transport occurs, and alternative health care pathway availability are sparsely reported. The literature search was updated on the 22nd of September 2023 using the same inclusion criteria and search strategy, and 16 additional sources that met these criteria were found. The updated search of the literature has identified ambulance-attended patients who fall have a high risk of future health service use. The literature included in the updated search recommended intervention to facilitate EMSs management of patients who fall.

Study 2: Epidemiology of Ambulance-attended Falls

Watkins PM, Hill A-M, Tohira H, Brink D, Finn J, Buzzacott P. Epidemiology of ambulance-attended adults who fell in Western Australia 2015 – 2021: An increasing incidence in an ageing population. *Injury. 2023;54*(12):111035.

This state-wide retrospective cohort study examined all patients attended by St John Western Australia (SJWA) ambulance service, who were aged >=18 years and described as having experienced a fall between 1st January 2015 and 31st December 2021. The aims of the study were to: 1) describe the characteristics of patients attended; 2) estimate the crude, and age-standardised incidence rates; 3) identify the prevalence of injuries sustained; 4) describe prehospital interventions used in the management of patients; 5) summarise the frequency of the disposition of patients attended; and 6) determine patient and fall characteristics associated with low transport urgency. Based on the findings from the previous study, the descriptive epidemiology of these patients, their injuries, prehospital interventions and disposition were reported to add to published literature on the prehospital management of falls. An ordinal logistic regression exploring the odds of low transport urgency was performed.

Results: Between 2015-2021, there were n=188,720 ambulance attendances for fall incidents. The incidence rate of falls requiring ambulance attendance has increased over time, increasing the demand placed on EMS annually. The age-standardised incidence rate of all ambulance-attended adults who fell in WA increased from 1,108 per 100,000 in 2015 to 1,247 per 100,000 in 2021. The crude incidence for all ambulance-attended adults who fell increased from 877 per 100,000 in 2015 to 1,133 per 100,000 in 2021; The crude incidence for those 85 years of age and over increased from 18,826 per 100,000 in 2015 to 21,423 per 100,000 in 2021.

Older, female patients had a higher odds of being transported to hospital via a lower urgency, with 50% of this cohort transported to hospital via urgency three. While 19% of patients were attended via a priority one, only 1% were transported to hospital via urgency one.

Study 3: Epidemiology of Adults Who Experienced Repeated Ambulance-attended Falls

This retrospective cohort study examined all patients aged >=18 years attended by SJWA ambulance service for a fall-related incident, identified in the previous cohort study. The aim of this study was to examine the subset of ambulance-attended adults who sustained repeat falls in WA. A patient's index fall was their first recorded fall in the data set. We defined patients who experienced >=1 subsequent fall, following their index fall, as experiencing repeat falls. The descriptive epidemiology of these patients, the pattern of their repeated ambulance-attendances, their injuries, prehospital interventions and disposition was reported. A multivariable logistic regression exploring the odds of experiencing a repeat ambulance-attendance for a fall within 30 days and 31-365 days, following a patients first ambulance-attended fall was reported. A Kaplan-Meier analysis was used to estimate the time (in days) between consecutive ambulance-attended falls.

Results: A total of 128,588 falls-related incidents occurred involving 77,087 individual patients. 54,554 patients (71%) were attended once for a fall-related incident (n= 30,280 females; mean age 68 years, SD: 21). A total of 22,533 patients (29%) experienced repeat ambulance-attended falls (n= 13,248 females; mean age 80 years, SD: 14, at first call). These 22,533 patients accounted for 58% (n= 74,034 attendances) of all ambulance-attendances to fall-related incidents. Time between ambulance-attended falls decreased significantly the more falls a patient sustained, ($p<0.001$). Among patients who experienced repeat falls, 13,363 (59%) of repeat falls occurred within 12 months: 3,103 (14%) of patients sustained their second fall within 30 days of their index fall, and 10,260 (46%) between 31 days to 12 months. Patients who were transported, via any urgency, at their first ambulance-attended fall, had a reduced odds of sustaining a second ambulance-attended fall within 30 days and 31 days to 12 months, compared to non-transported patients.

Study 4: Paramedics' Experience Attending and Managing Adults Who Fall

Watkins P, Buzzacott P, Tohira H, Finn J, Brink D, Brits R, Hill A-M. "Mind the gap": An exploratory qualitative study of paramedics' experiences attending older adults who fall in Western Australia. Australasian Emergency Care. 2024.

The aim of this study was to explore paramedics' experiences and perspectives about attending and managing older adults who had fallen. This exploratory qualitative study focused on a purposive sample of paramedics with at least one years on road experience working in WA. Given the growing frequency and incidence of ambulance-attended falls in WA, identified in the previous cohort studies, one years on road experience from this purposive sample was determined to be adequate to address the research questions. Semi-structured interviews were undertaken, and data were thematically analysed, via an inductive approach. Interviews lasted 64 minutes on average, reaching data saturation at interview 14.

Results: Participants' ages ranged from 29 – 49 years, including nine males and four participants with rural experience. The main theme identified that experiences were positive when attending older adults with high-acuity medical problems or injuries following falls because binary decision-making (transport vs non-transport) was appropriate. However, participants described stressful and frustrating experiences when attending low-acuity falls call-outs. Themes highlighted that decision-making for low-acuity falls attendances was a complex balance between 1) patient context, 2) risk management, 3) paramedic reactions, and 4) the lack of alternate referral pathways available. If transport to hospital was not required there were no available, alternative pathways to refer onwards for appropriate health or social care.

Conclusion

My research demonstrated that the frequency and incidence of ambulance attendances to adults who fall increased across WA between 2015 and 2021. During this period, nearly 30% of all patients attended by an ambulance for a fall, sustained one or more repeat falls, collectively accounting for nearly 60% of all ambulance-attendances to fall incidents. The two epidemiology studies found that 88% of patients were

transported to hospital at their only fall, and 80% were transported to hospital at their first fall of multiple falls. Ultimately there were 147,282 (78%) transports to hospital following 188,720 ambulance-attendances to fall-incidents, between 2015-2021. As most ambulance-attended falls call-outs were identified as being for older adults and classed as low-acuity events, the findings of this thesis suggest that efforts in WA could aim to create and strengthen alternative referral pathways available to EMS staff in the prehospital setting, to manage fall-related call-outs. These findings are supported by paramedics' experiences that, having no alternatives to the transport/non-transport binary decision pathway, leads to complex decision-making while attending and managing patients who have fallen, if they are low-acuity presentations. The development of prehospital clinical practice guidelines (CPG) specifically identifying criteria for when it is safe to leave a patient at home, could support paramedics in their decision-making role when attending patients who fall.

The frequency and incidence of ambulance-attended falls are increasing, and no alternative referral pathways were available, during these studies, to support this growing demand placed on the WA prehospital system. New CPGs and hospital ED based trials are currently being implemented in WA to improve emergency access for adults who have fallen and require an ambulance. While these processes are being implemented, continuous progress to focus on high-risk groups, such as repeatedly attended patients, in the prehospital setting is needed.

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List of Abbreviations

CAD	Computer Aided Dispatch
CPG	Clinical Practice Guidelines
DOH	Department of Health
ED	Emergency Department
EMS	Emergency Medical Service
ePCR	Electronic Patient Care Record
GEMS	Ground Emergency Medical Services
HEMS	Helicopter Emergency Medical Service
JBI	Joanna Briggs Institute
MPDS	Medical Priority Dispatch System
MTC	Major Trauma Centre
PRECRU	The Prehospital, Resuscitation, and Emergency Care Research Unit
SJWA	St John Western Australia
USA	United States of America
WA	Western Australia, Australia

Publications

Article 1 (Chapter 3) – Published [1]

Watkins PM, Buzzacott P, Brink D, Masters S, Hill A-M.

Pre-hospital management, injuries and disposition of ambulance attended adults who fall: A scoping review protocol.
Australasian Journal of Paramedicine. 2021;18.

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Article 2 (Chapter 4) – Published [1]

Watkins PM, Masters S, Hill A-M, Tohira H, Brink D, Finn J, Buzzacott P.

The prehospital management of ambulance-attended adults who fell:
A scoping review.
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Available from: https://doi.org/10.1016/j.auec.2022.07.006

Article 3 (Chapter 5) – Published [1]

Watkins PM, Hill A-M, Tohira H, Brink D, Finn J, Buzzacott P.

Epidemiology of ambulance-attended adults who fell in Western Australia 2015 – 2021: An increasing incidence in an ageing population.
Injury. 2023;54(12).

Available from: https://doi.org/10.1016/j.injury.2023.111035

Article 4 (Chapter 6) – Submitted for publication and under peer review

Watkins P, Buzzacott P, Tohira H, Majewski D, Hill A-M, Brink D, Brits R, Finn J.

Emergency Medical Service attendances for adults with repeat falls in Western Australia: A state-wide retrospective cohort study.

Submitted to the journal Prehospital Emergency Care.

Article 5 (Chapter 7) – Published [1]

Watkins P, Buzzacott P, Tohira H, Finn J, Brink D, Brits R, Hill A-M.
"Mind the gap": An exploratory qualitative study of paramedics' experiences attending older adults who fall in Western Australia.
Australasian Emergency Care. 2024.

Available from: https://doi.org/10.1016/j.auec.2024.01.004

[1] Approval has been granted by the relevant publishers to reproduce these articles in the thesis (Appendix F).

Abstract Publications and Contributions to Reports

1. Acknowledgement of contribution to the development of this report:

   Paige Watkins, Curtin University. Injury Matters: Sweeney, R. and Meade, R. (2021). **2021 Western Australian Falls Report**. Perth, Western Australia: Injury Matters.

   Available from: https://www.injurymatters.org.au/wp-content/uploads/2021/08/2021WAFallsReport.pdf

2. Acknowledgement of contribution to the development of this report:

   Paige Watkins, Curtin University. Injury Matters: Sweeney, R. and Menezes, S. (2022). **2022 Western Australian Falls Report**. Perth, Western Australia: Injury Matters.

   Available from: https://www.injurymatters.org.au/wp-content/uploads/2022/09/2022WAFallsReport.pdf

3. EUSEM, 2022. Session title: Pre-hospital / EMS / Out of Hospital. Session type: Oral Abstract Session. Catalogue number: 66. Presentation number: OA066.

   Paige WATKINS, Stephen BALL, Paul BRAYBROOK, Anne-Marie HILL, Hideo TOHIRA, Deon BRINK, Peter BUZZACOTT. **Epidemiology of ambulance attended adults who fall in Western Australia 2015-2021: A retrospective cohort study.**

   Online abstract available from European Society for Emergency Medicine (EUSEM) 2022: https://eusem.org/events/799-eusem-2022-abstracts-are-online.

4. EUSEM, 2022. Session title: Coffee Break 5 - EPoster session - Screen 5. Session type: EPosters. Catalogue number: 220. Presentation number: EPOS098.

   Paul BRAYBROOK, **Paige WATKINS**, Hideo TOHIRA, Deon BRINK, Stephen BALL, Peter BUZZACOTT. **The epidemiology and severity of medical events sustained by ambulance-attended mountain bikers and hikers in Western Australia from 2015-2020: a retrospective cohort study**.

   Online e-poster available from European Society for Emergency Medicine (EUSEM) 2022: https://eusem.org/events/799-eusem-2022-abstracts-are-online.

5. Safety 2022 14th World Conference on Injury Prevention and Safety Promotion. Session type: Long oral (Rapid fire), face to face; 3G – falls prevention.

   Watkins P, Buzzacott P, Tohira H, Brink D, Finn J, Hill A. 178, **Paramedics' experiences attending and managing patients who fall**. Injury Prevention 2022 11;28: A27.

   Online abstract available from Safety 2022.

6. Safety 2022 14th World Conference on Injury Prevention and Safety Promotion. Session type: Long oral (Conversation starter), face to face; 3G – falls prevention.

   Watkins P, Finn J, Hill A, Brink D, Tohira H, Buzzacott P. 181, **Epidemiology of ambulance attended falls in adults in WA 2015–2020**. Injury Prevention 2022 11;28: A28.

   Online abstract available from Safety 2022.

Statement of Author Contributions to Publications

Article 1 (Chapter 3) - Published

Watkins PM, Buzzacott P, Brink D, Masters S, Hill A-M.

Pre-hospital management, injuries and disposition of ambulance attended adults who fall: A scoping review protocol.
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I, Paige Marie Watkins, was the primary author of this published paper, contributing 70%. I prepared the manuscript, which was reviewed by all the authors. All the authors were involved in the subsequent revision of the article and final approval of the submitted version.

Article 2 (Chapter 4) - Published

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The prehospital management of ambulance-attended adults who fell: A scoping review.

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I, Paige Marie Watkins, was the primary author of this published paper. The extent of my contributions was 60%. I completed the literature search and selection of relevant papers. Dr Stacy Masters and I independently screened these papers to identify relevant articles for inclusion. I prepared the manuscript, which was reviewed by all the authors. All the authors were involved in the subsequent revision of the article and final approval of the submitted version.

Article 3 (Chapter 5) - Published

Watkins PM, Hill A-M, Tohira H, Brink D, Finn J, Buzzacott P.

Epidemiology of ambulance-attended adults who fell in Western Australia 2015 – 2021: An increasing incidence in an ageing population.
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Article 4 (Chapter 6) – Submitted for publication and under peer review

Watkins P, Buzzacott P, Tohira H, Majewski D, Hill A-M, Brink D, Brits R, Finn J.

Emergency Medical Service attendances for adults with repeat falls in Western Australia: A state-wide retrospective cohort study.

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Article 5 (Chapter 7) - Published

Watkins P, Buzzacott P, Tohira H, Finn J, Brink D, Brits R, Hill A-M. "Mind the gap": An exploratory qualitative study of paramedics' experiences attending older adults who fall in Western Australia. *Australasian Emergency Care. 2024*.

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Other Research Outputs

Presentations

Conference Presentations

1. Oral Presentation at the **Emerging Researchers in Ageing 2021, Perth**. Abstract "Ambulance-attended adult falls patients in Western Australia, 2019/20". 'Strive and Survive' National Conference, 2021.

2. Oral Presentation at **EUSEM 2022, Berlin.** The European Emergency Medicine Congress. "Epidemiology of ambulance attended adults who fall in Western Australia 2015-2021: a retrospective cohort study".

3. Oral Presentation over an E-poster at **EUSEM 2022, Berlin**. The European Emergency Medicine Congress. "The epidemiology and severity of medical events sustained by ambulance-attended mountain bikers and hikers in Western Australia from 2015-2020: a retrospective cohort study".

4. Oral Presentation at the **WA State Trauma Conference 2022, Perth**. Prevent-Provide-Progress. "Ambulance-attended adult falls patients in Western Australia, 2019/20". Updated: "Ambulance-attended adult falls patients in Western Australia, 2015/21".

5. Oral Presentation at the **Safety 2022 14th World Conference on Injury Prevention & Safety Promotion, Adelaide**. "Paramedics' experiences attending and managing patients who fall".

6. Oral Presentation at the **Safety 2022 14th World Conference on Injury Prevention & Safety Promotion, Adelaide**. "Epidemiology of ambulance attended falls in adults in WA 2015-2020".

7. Oral Presentation at the **Australia and New Zealand Falls Prevention Society & World Falls Congress, 2023**. "Epidemiology of repeated falls and ambulance attendances in WA adults".

8. Oral Presentation at the **Australia and New Zealand Falls Prevention Society & World Falls Congress, 2023**. "Mind the gap": Paramedics' experiences attending and managing patients who fall".

9. Oral Presentation over an E-poster at the **Australia and New Zealand Falls Prevention Society & World Falls Congress, 2023**. "Epidemiology of ambulance attended adults who fell in WA: 2015-2021".

10. Oral Presentation over an E-poster at the **Australia and New Zealand Falls Prevention Society & World Falls Congress, 2023**. "Ambulance attended adults who fall: a scoping review".

Other Oral Presentations

1. **Injury Matter Community Falls Network** meeting, Perth, Western Australia, 2021.

2. **Mark Liveris Seminar**, Faculty of Health Science, Curtin University, Perth, Western Australia, 2021 (Peoples' choice award for school of Nursing)

3. **Mark Liveris Seminar**, Faculty of Health Science, Curtin University, Perth, Western Australia, 2022 (Peoples' choice award for school of Nursing)

4. The 2022-23 Industry Mentoring Network in STEM (IMNIS) Engage Program, **STEM Careers in Industry event Panellist**, April, 2023

5. **Injury Matter Community Falls Network** meeting, Perth, Western Australia, 2023.

Conference Posters

1. Oral Presentation over an E-poster at **EUSEM 2022, Berlin**. The European Emergency Medicine Congress. "The epidemiology and severity of medical events sustained by ambulance-attended mountain bikers and hikers in Western Australia from 2015-2020: a retrospective cohort study".

2. **Australia and New Zealand Falls Prevention Society & World Falls Congress**. "Ambulance attended adults who fall: a scoping review", (see Appendix A).

3. **Australia and New Zealand Falls Prevention Society & World Falls Congress**. "Epidemiology of ambulance attended adults who fell in WA: 2015-2021", (see Appendix B).

Mentoring Programs

Programs

1. The **2022 L'Oréal-UNESCO For Women in Science Mentoring Program**. Selected as the Western Australian Mentee, and one of five women selected from across Australia & New Zealand. Included monthly: 1) Workshops with L'Oréal Australia and 2) Monthly one-on-one meetings with Dr Kirsty Nash [https://www.linkedin.com/in/kirsty-l-nash/].

   Available from: https://www.forwomeninscience.com.au/about

2. The **2022-23 Industry Mentoring Network in STEM (IMNIS) Engage Program**, by the Australian Academy of Technology & Engineering (ATSE). Included: 1) Workshops with ROC Excellence Curtin university and the IMNIS engage program and 2) Monthly one-on-one meetings with Celine Royet.

   Available from : https://www.linkedin.com/in/celine-royet-6986a73/

Awards Ceremony

1. The **2022 L'Oréal-UNESCO For Women in Science awards ceremony, Melbourne**. Hosted and invited by Rodrigo Pizarro, CEO L'Oréal Australia & New Zealand.

Social Media Acknowledgements

1. **Instagram**: L'oreal Australia ✅ announcing the 2022 L'Oréal-UNESCO For Women in Science Mentees.

   Available from: https://www.instagram.com/lorealaustralia/?hl=en

Scholarships and Awards

Living Expenses

1. **HDR scholarship**: $28,000 p.a. for three and a half years [Feb 2020 – Aug 2023].

2. **PRECRU** 'top-up' scholarship to $30,000 total: $2,000 p.a. for three years [Aug 2020 – Aug 2023]; PRECRU completion scholarship of $14,837.04 for six months [Aug 2023 – Jan 2024].

Research Scholarships

1. The **RTP 2020 Faculty Strategic Scholarship** for Domestic students. Awarded by Garry Allison Associate Deputy Vice Chancellor – Research Excellence, one-off payment.

   Project linked domestic student's mobility allowance: $5,000.

2. The **RTP 2020 Faculty Strategic Scholarship** for Domestic students. Awarded by Garry Allison Associate Deputy Vice Chancellor – Research Excellence, one-off payment.

   Project linked domestic student's digital support: $2,000.

Awards

1. **Mark Liveris Seminar**, Faculty of Health Science, Curtin University, Perth, Western Australia, 2021: **Peoples' choice award**, prize: $250.

2. **Mark Liveris Seminar**, Faculty of Health Science, Curtin University, Perth, Western Australia, 2022: **Peoples' choice award**, prize: $300.

3. Safety 2022 14th World Conference on Injury Prevention & Safety Promotion, Adelaide, Australia 2022: Riskware Warning Challenge, prize: iPad 10.2-inch (9th generation).

4. Oral Presentation over an E-poster at the **Australia and New Zealand Falls Prevention Society & World Falls Congress**, 2023. "Epidemiology of ambulance attended adults who fell in WA: 2015-2021", **'Best Poster Presentation'**, prize: $250.

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In loving memory of

David Ian Williamson

Chapter 1

Introduction

1.1 Introduction

This chapter aims to provide the background and rationale of this thesis exploring ambulance-attended adults who fell in Western Australia (WA). This chapter also includes the specific research aim and objectives, the thesis approach and an overview of the thesis chapters.

1.2 Background and Rationale

Millions of people fall every year, and as the population increases and ages concurrently, the frequency and incidence of falls are increasing globally.(1-5) Ambulance services or Emergency Medical Services (EMS) are responding to an increasing number of adults, >=65 years of age (older adults), who fall.(4, 6-8) Approximately 37 million falls require medical attention annually, and falls are the second leading cause of unintentional injury deaths globally.(2) Given that the high demand for medical attention in older adults following falls is well established in the research literature,(1-8) further investigation into the prehospital management of falls is relevant.

When responding to a person who has fallen, the objective for prehospital staff is to alleviate symptoms and/or prevent further deterioration by providing interventions, and where necessary, transport the patient to a hospital. Injuries resulting from fall-related incidents can vary from none to life-threatening, and tend to increase in severity with age.(2, 6, 8-10) Falls have the potential to result in major, life-threatening injury, so it is crucial that ambulance services accurately ascertain when it is appropriate, and how urgently to transport patients to hospital.(11)

Whether ambulance-attended patients are urgently transported or not, relies on the patients' clinical condition, the context of the fall, and paramedics' clinical assessment at the time of attendance. Patient management is mostly based on the underlying cause of the fall and/or the injuries sustained,(9) and is guided by ambulance services specific clinical practice guidelines (CPG). In WA, at the time of the studies, prehospital staff had two destination options for patients who fall,

transport to hospital, or leave the patient at the scene. Alternative referral pathway options for the management of people who fall and require an ambulance are sparsely reported in prehospital literature and were not available to prehospital staff in WA during the completion of the studies within this thesis.(12-14) Further research regarding the accurate identification of high-risk groups, such as people attended repeatedly by ambulances for fall-related events, could benefit the health sector as a whole. This would potentially allow for new referral pathways and falls services to be developed specifically to target known high risk groups.

1.3 Specific Research Aim and Objectives

1.3.1 Research Aim

The overall aim of this thesis was to investigate adults (>=18 years) who experienced a fall, were attended by an EMS ambulance, and the health services perspectives, in WA – epidemiologically and qualitatively – with a view to better inform the prehospital management of patients who fall.

1.3.2 Research Objectives

To achieve this aim, the following research objectives were addressed.

1. To undertake a systematic scoping review of literature describing adults who have fallen and were attended by EMS.

    a) To produce a systematic scoping review protocol to solidify a rigorous methodology prior to conducting the systematic scoping review.
    b) To map and synthesise the evidence for the prehospital management of EMS-attended adult patients who fall, identify knowledge gaps and propose recommendations for further research of EMS management of falls in the prehospital setting.

2. To conduct a retrospective cohort study to describe the incidence rate and characteristics of ambulance-attended falls in WA, including fall-related injuries, prehospital interventions delivered, and disposition (including transport to a hospital or otherwise) using St. John Western Australia (SJWA) ambulance data.

a) To describe the characteristics of patients attended.
b) To estimate the crude, and age-standardised incidence rates.
c) To identify the prevalence of injuries sustained.
d) To describe prehospital interventions used in the management of patients.
e) To summarise the frequency of the disposition of patients.
f) To determine patient and fall characteristics associated with low transport urgency.

3. To examine EMS-attended adults who sustained repeat falls in WA, in the study cohort described above.

a) To compare the characteristics of patients who sustained one fall compared to those who sustained repeat falls.
b) To describe the characteristics of patients attended in response to repeat falls within 30 days and 31 days to 12 months of their first EMS-attended fall.
c) To explore the number of days between the index fall and the subsequent fall(s).
d) To compare the mortality in patients who sustained one fall compared to those who sustained repeat falls.

4. To conduct an exploratory qualitative study to ascertain paramedics' views and attitudes towards attending patients who fall, including repeat fallers, and the management of falls in WA (e.g., to transport or not transport).

a) To explore and describe paramedics' perceptions of the interventions they provide and alternative pathways regarding patients who fall.
b) To explore and describe paramedics' perceptions of patients who fall, attending falls and the management of falls in WA.

1.4 Thesis Approach

This thesis is based on a 'hybrid model' which incorporates both published research papers together with a written description of the work undertaken. Chapter 1 provides an overview of the thesis aim and objectives. Chapter 2 provides a contextual overview of falls and the prehospital setting, particularly in the context of WA. Chapter 3

presents a scoping review protocol, published in a peer-reviewed journal. Chapters 4-7 comprise four individual studies, published or under review in peer-reviewed journals. Chapter 8 provides a discussion of the findings of my doctoral research, potential limitations, and my recommendations for future research, policy, and practice. The thesis approach is presented in Figure 1.1, and an overview of each chapter is provided in Table 1.1.

Figure 1.1
Model of thesis approach

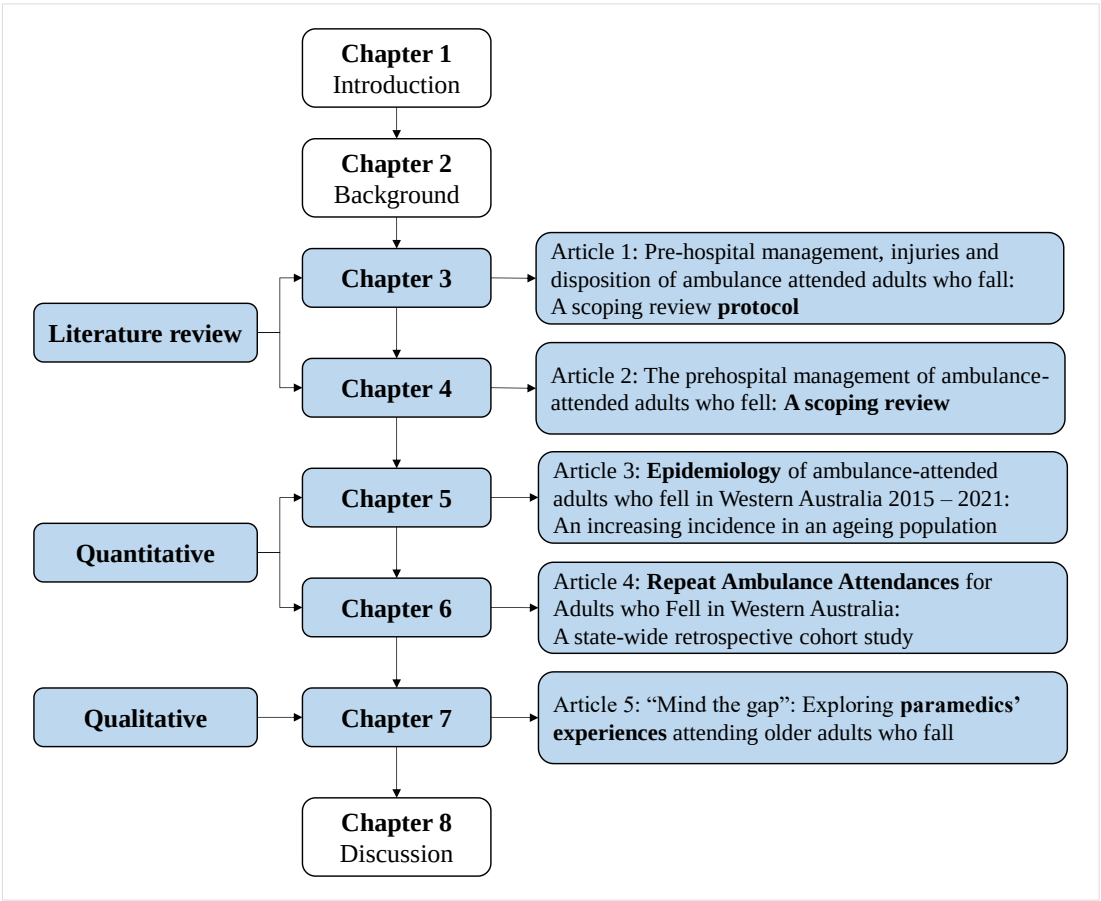


Table 1.1
Overview of thesis chapters

Chapter	Title and Description	Research objectives
1	**Introduction**	
2	**Background** This chapter presents background information of adults who have fallen, the WA EMS system, and the context and significance of the research presented in this doctoral thesis.	
3	**Systematic Scoping Review Methodology** *Article 1: Published paper* **Watkins PM**, Buzzacott P, Brink D, Masters S, Hill A-M. Pre-hospital management, injuries and disposition of ambulance attended adults who fall: A scoping review protocol. *Australasian Journal of Paramedicine. 2021;18*. https://ajp.paramedics.org/index.php/ajp/article/view/876	(1) a
4	**Systematic Scoping Review** *Article 2: Published paper* **Watkins PM**, Masters S, Hill A-M, Tohira H, Brink D, Finn J, Buzzacott P. The prehospital management of ambulance-attended adults who fell: A scoping review. *Australasian Emergency Care. 2023;26*(1):45-53. https://doi.org/10.1016/j.auec.2022.07.006	(1) b
5	**Epidemiology of Falls** *Article 3: Published paper* **Watkins PM**, Hill A-M, Tohira H, Brink D, Finn J, Buzzacott P. Epidemiology of ambulance-attended adults who fell in Western Australia 2015 – 2021: An increasing incidence in an ageing population. *Injury. 2023;54*(12) https://doi.org/10.1016/j.injury.2023.111035	(2) a – f
6	**Epidemiology of Repeat Falls** *Article 4: Submitted paper under peer review* Watkins P, Buzzacott P, Tohira H, Majewski D, Hill A-M, Brink D, Brits R, Finn J. Emergency Medical Service attendances for adults with repeat falls in Western Australia: A state-wide retrospective cohort study.	(3) a – d
7	**Paramedic Perspectives** *Article 5: Published paper* Watkins P, Buzzacott P, Tohira H, Finn J, Brink D, Brits R, Hill A-M. "Mind the gap": An exploratory qualitative study of paramedics' experiences attending older adults who fall in Western Australia. *Australasian Emergency Care. 2024*. https://doi.org/10.1016/j.auec.2024.01.004	(4) a, b
8	**Thesis Discussion** This chapter presents a summary of key findings, synthesise these findings in the context of research literature and of local and global guidelines	

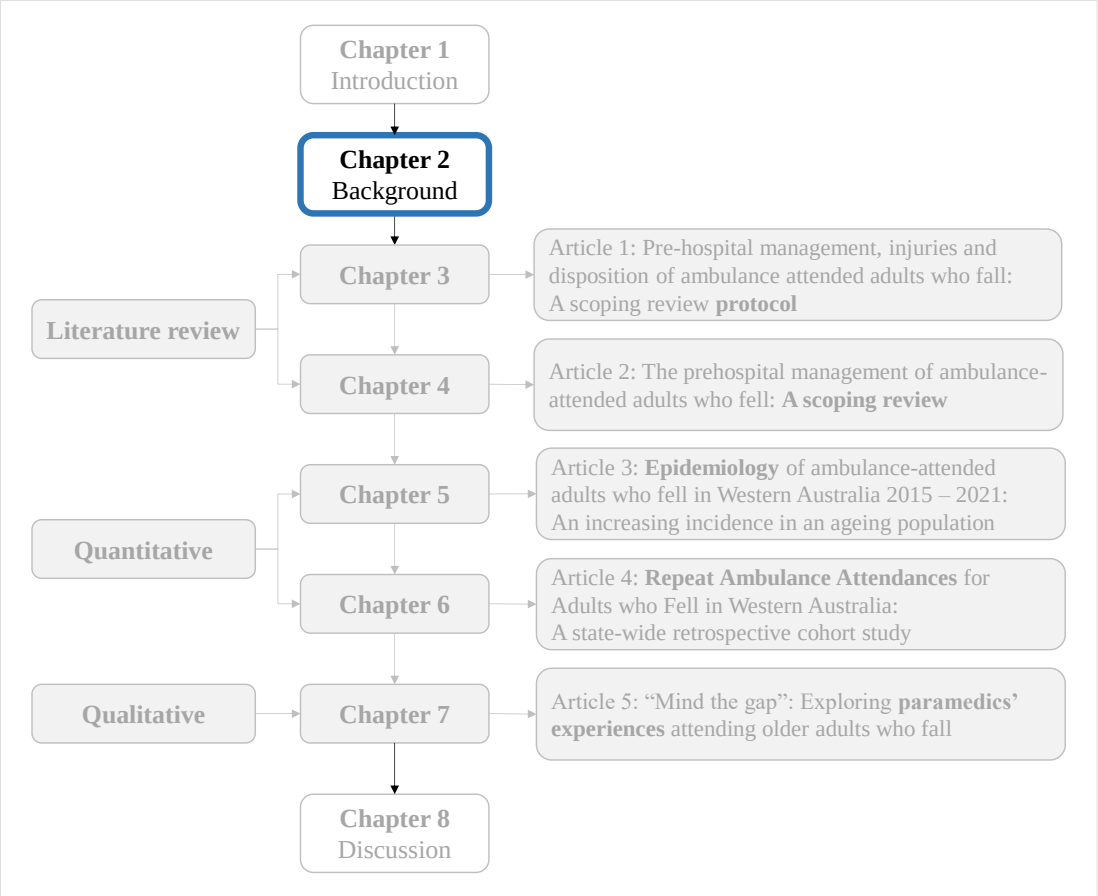
Chapter 2

Background

2.1 Overview

This chapter aims to provide background information relating to falls, the prehospital management of falls, and the prehospital setting specific to the studies within this thesis.

Thesis Context



2.2 Introduction

2.2.1 Falls

Definition

A fall can be described as a slip, trip, or stumble at ground level, or from height, where a person comes to rest unintentionally at ground level.(2) Having a fall can suggest a more significant, substantial, or potentially consequential event. While anyone of any age can sustain fall-related injuries, this is often associated with an increased risk of injury in older adults.

Injuries

Injuries resulting from fall-related events can vary from none/minor to life threatening including lacerations, fractures, abrasions and pain, and tend to increase in severity with increasing age.(2, 6, 8-10) Falls can result in injuries and be the presenting symptom of an acute medical event, highlighting how complex falls and fall-related injuries can be. Falls also have the potential to contribute to an increase in disability or poor health outcomes. Injuries sustained from falls can also contribute to a loss of confidence, independence, physical activity and ultimately a reduction in self-efficacy.(15)

Mechanism

Falls can be caused by intrinsic factors such as poor balance, immobility and frailty, acute medical conditions like a stroke, or unmanaged chronic illness, e.g., syncope caused by unmanaged diabetes.(2, 16) Cognitive decline is also associated with an increased risk of falls, largely in populations of cognitively impaired (i.e., people living with dementia). The combination of physical and cognitive decline with age creates a compounding effect, whereby the risk of falls increases significantly with age.(17)

External factors including environmental conditions commonly cause falls, although falls on the same level from slipping, tripping, and stumbling are shown to be the most common cause of hospitalised falls for older adults.(6, 18, 19) Intrinsic and extrinsic factors are important when considering older adults, as they have the highest incidence of falls globally.(5, 20, 21)

Incidence

The incidence of falls is increasing globally, with one in three older adults experiencing a fall annually.(2, 5, 14) The incidence of fall-related injury requiring health care interventions is increasing with age, particularly in those >=70 years of age and females.(5, 21, 22) Across Western Europe, 8.4 million older adults, >=70 years of age, sought medical attention due to fall-related injuries in 2017.(5) The United States of America (USA), observed a 4.4% overall increase (1.5% annual growth) in the age and sex adjusted national quarterly fall injury rates, between 2016-2019.(23)

The incidence of falls is increasing across Australia,(6, 18, 19) and the state of WA.(3, 24) Falls are the most common cause of hospitalisations and deaths from injuries in Australia.(22) In WA, falls are the fourth most common cause of injury deaths and second most common cause of injury hospitalisations.(16) The rates of hospitalisations for falls-related events are increasing, with 2,600 hospitalisations in males >=65 years of age, and 3,800 hospitalisations in females >=65 years of age, per 100,000 population, across Australia in 2021-22.(18)

Mortality

Globally, falls are the second leading cause of injury deaths, accounting for approximately 684,000 fatalities annually.(2) In Western Europe alone, 54,504 older adults died due to falls in 2017,(5) although over 80% of fall related deaths globally are estimated to occur in low- and middle-income countries.(2) In Australia in 2021, the crude rate of injury deaths due to falls was 131.5 per 100,000 population, in adults >=65 years of age.(18) The age standardised rate of deaths due to falls in Australia has been steadily increasing from 14 per 100,000 persons in 2011 to 16 per 100,000 persons in 2020.(18)

2.2.2 Prehospital management

As the first stage in trauma system care, the objective of EMS is to provide clinical interventions and care to alleviate symptoms and/or prevent further deterioration, or death, and where appropriate, transporting patients to the hospital. Prehospital staff provide emergency care on scene and emergency transport to the appropriate hospital for further treatment.

2.3 Context

2.3.1 Setting

The Australian state of WA covers 2,529,875km^2 with a population of 2.7 million people, 2.1 million residing in the state capital, the Greater Perth Metropolitan area.(25) The Australian Bureau of Statistics (ABS) reported that the median age of WA residents was 38 years of age in 2021, increasing from 36 years in 2016.(25) In 2021, the ABS reported that 29% of the WA population were >=55 years of age, which is projected to continue growing.(25)

2.3.2 St John Western Australian Ambulance Service (SJWA)

Coverage

Western Australia's Ambulance Service, St John WA, is the sole provider of road-based emergency ambulance service in WA, contracted by the WA Department of Health. SJWA covers the largest area of any single ambulance provider globally, employing approximately 770 paramedics in the Perth metropolitan area, and 3,200 volunteer ambulance officers and 90 paramedics in country WA.(26, 27)

Prehospital management

When an emergency ('000') call is made, the goal for emergency call dispatchers is to categorise the severity of the patient's condition. The Medical Priority Dispatch System (MPDS) is used by SJWA emergency call dispatchers, to categorise and prioritise emergency calls.(28) This allows for the dispatch of the appropriately allocated resources to attend to the patient in a timely manner. When prehospital staff arrive on scene, they assess the patient/s, and determine the most appropriate care for the patient, guided by the relevant CPGs. Finally, prehospital staff will determine if the patient requires transport to the hospital, if so, to what destination, mode of transport (i.e., road or air), and transport urgency level (i.e., lights and siren).

Dispatch

The accurate identification of patients with time-critical conditions, during emergency calls, is crucial for accurate and effective prioritisation of ambulance dispatch. Using the MPDS, call dispatchers allocate each call to one of the 32 chief complaints, one of which is 'Falls'.(28) The call dispatcher collects and uses caller feedback from a set of scripted questions.(28) The information collected during the

emergency call informs the priority (priority 1 lights and siren, priority 2 emergency, or priority 3 urgent) that the ambulance is dispatched to the patient.(28) Road ambulances or emergency medical helicopters may be dispatched depending on the allocated dispatch priority, the clinical skills of the staff required and/or the location of the incident.(29)

Staff

Road ambulances in WA are staffed by a team of two, a paramedic team or a paramedic/ ambulance officer team in metropolitan areas. Ambulance officers are currently training to become fully qualified paramedics, working on road for SJWA, while under the mentorship of a qualified paramedic. The clinical skills that can be performed by ambulance officers and paramedics is defined by their employing service.(26, 27, 30) Clinical support paramedics (and area managers) also work in the Perth Metropolitan area providing support to ambulance crews.(27) In rural areas ambulance crews can be composed of two paramedics (in larger centres), a paramedic and volunteer ambulance officer or two volunteer ambulance officers.(26)

Clinical practice guidelines (CPG)

The standards and clinical scope of practice delivered by prehospital staff in WA are specifically defined in SJWA's CPGs. The CPGs for managing falls include two guidelines based on the level of trauma sustained. Falls from >3 meters high in adult patients, prompt prehospital staff to follow the Major Trauma Guidelines CPGs, directing them to identify people who would benefit from primary transport to a MTC.(31) The second CPG, introduced in 2022, guides prehospital staff to use a Falls Risk Assessment Tool (FRAT) to deliver a FRAT score to the receiving clinical staff in the ED.(32) This assessment provides intrinsic (i.e., previous fall, postural instability, aged >80 years) and extrinsic factors (i.e., environmental risk factors, unsafe walking aids, loose-fitting footwear) to help identify patients who are potentially considered as 'high falls risk'.

Interventions

Prehospital staff provide different interventions based on their levels of training.(30) Cardiopulmonary resuscitation (CPR), splinting, or administration of paracetamol can be provided by prehospital volunteers, and ambulance officers. Advanced life support requires a higher level of training, i.e., intubation, 12-lead Electrocardiogram (ECG), and manual defibrillation, are provided by paramedics.(30)

Transport

Patient disposition, or their destination at the end of their prehospital interaction, is based on the clinical decision making and available options to prehospital staff. Effective and efficient triage ensures that patients are sent to the most appropriate destination in a timely manner. Following clinical assessment by the ambulance personnel, those patients who meet the requirements for transport to hospital, are transported to the hospital ED. Based on their clinical condition the ambulance personnel determine the urgency that the patient needs to be transported to the hospital. Prehospital triage criteria and CPGs are required to demonstrate sensitivity (accurately identify severely injured and/or ill patients) and specificity (accurately identify minor injuries or the absence of injury and illness), to support paramedics in identifying severely injured patients in need of urgent care, or patients with minor injuries. Transport destination can also be influenced by the type of care the patient requires, particularly in regional settings where local hospitals may not have the equipment or staff to manage trauma.

2.3.3 Hospitals

Western Australia Health (WA Health) has more than 80 hospitals across the state, with three under private-public partnership, providing free public health care.(33) The state trauma service includes: major trauma services (Royal Perth Hospital and Perth Children's Hospital), metropolitan and urban trauma services, regional, rural and remote trauma services. The state organisational structure (Appendix C) and role delineation of hospitals in WA (Appendix D) are shown in the Appendices.

2.4 SJWA Data

2.4.1 Data sources

The SJWA data base managed by the Prehospital, Resuscitation and Emergency Care Research Unit (PRECRU) contains information from the electronic patient care record (ePCR) and the Computer-Aided Dispatch (CAD) system database, forming a single record for each unique 'case number'. Each 'case number' is equivalent to a single ambulance attendance. The information collected with each 'case number' includes patient data, incident location, interventions (i.e., medication), relevant times (i.e., ambulance arrival on scene, time of observation or arrival at hospital) and transport data. The ePCR includes each patient's presentation and clinical management, including medications administered.

2.4.2 Case identification and data extraction

Falls were identified by PRECRU researchers using data from the SJWA database, by searching free-text fields, using manual screening, machine learning and natural language processing.(34) These processes were used to identify SJWA ambulance records of patients categorised as 1) having sustained a fall by the MPDS codes, 2) coded as sustaining a fall via ePCR problem codes or, 3) having examination text written by the attending paramedics describing a fall. This rigorous process was used for the identification of falls cases to form the datasets used to explore the epidemiology of patients who experience falls and repeat falls, within this thesis.(34)

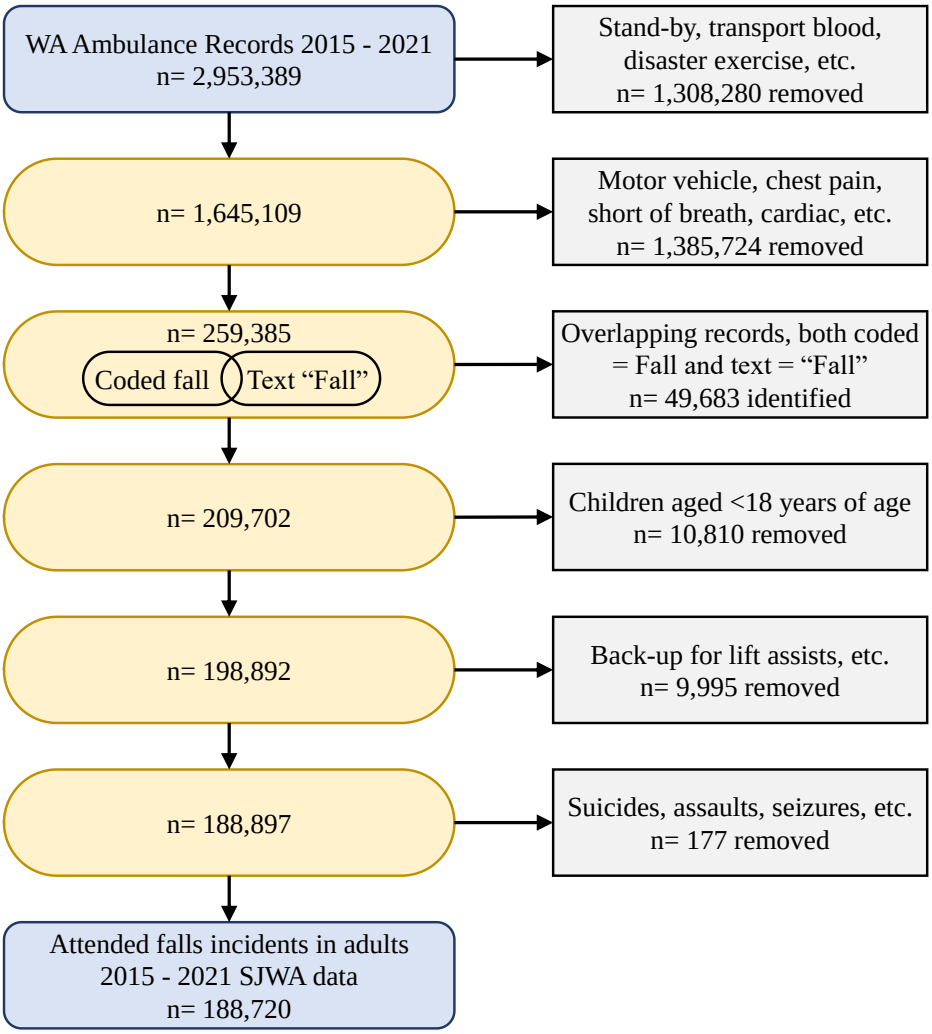
Machine learning modules using features generated by natural language processing were used to identify falls in free text data.(34) This was validated prior to the extraction of data for this thesis, and described in a recently published study.(34) Given that the machine learning model was not able to identify all falls cases in the ambulance free text, we determined that a combination of machine learning, manual screening and coding, followed by the identification of duplicate records would provide us with the ability to identify all falls cases with high sensitivity and specificity.(35) A flow chart, graphically presenting the method of data cleaning and case identification, showing the process of inclusion and exclusion based on the operational definition of a fall, is shown in Figure 2.1. The operational definition of a fall was created by Dr Hideo Tohira and Professor Peter Buzzacott and used in the identification of falls from the SJWA records.

The SJWA records from 2015 – 2021 were de-identified by the supervisory team, removing non-incidents (i.e., stand-by), unrelated incidents (i.e., motor vehicle), overlapping records, and children <18 years of age. The data extracted between 2015 - 2021 was selected by the supervisory team and provided to the me as the PhD candidate, based on it being the most available data at the time the studies were conducted. I as the PhD candidate, conducted manual screening for the removal of unidentified or unrelated incidents, children, back-up ambulances, and the removal of falls that did not meet the operational definition of a fall. The operational definition of a fall, used throughout this thesis is shown in Table 2.1. Date of birth (DOB) was subtracted from the incident date to derive a value for patient age. Once age was identified, I manually reviewed the examination text and dispatch notes for missing patient information (i.e., age and sex). Where multiple ambulance crews attended a single fall-related incident, only the case records of the primary attending crew were extracted with all related patient data to prevent the duplication of individual patients.

Table 2.1
Operational definition of a fall

Inclusion: Falls from …	Exclusion: Falls from …
Balconies + bridges	Suicides
Horses	Kicked by horses
E-bikes	Petrol powered motorbikes
Stationary vehicles	Moving vehicles
Mobility scooters	Golf karts
Intoxicated/drug-affected	Assaults
Fall followed by syncope	Syncope followed by fall
Slipping off chairs	Lowering self to ground
Attempting somersault/backflip	Sports

Figure 2.1
Case identification and data cleaning



2.5 Summary

This chapter provided background information regarding falls, trauma systems, the WA prehospital system and the prehospital management of adult patients who experience falls in WA. The local context of people who fall, the WA prehospital setting and WA ambulance service has been provided to inform the subsequent description of the epidemiology and paramedics' perspectives of ambulance-attended falls. Further detail of the specific methods for each study are provided within their respective chapters. The next chapter presents the systematic scoping review protocol.

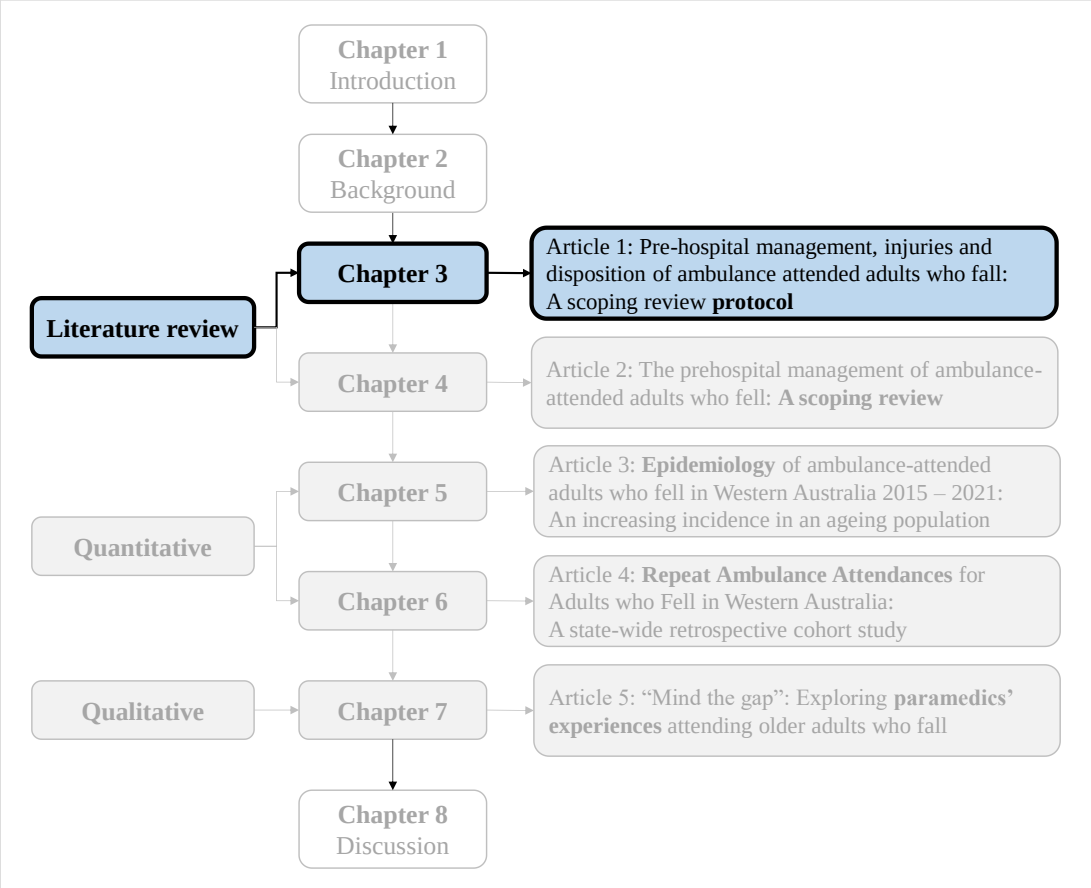
Chapter 3

Systematic Scoping Review Methodology

3.1 Overview

This chapter describes the methods and approach taken to conduct the first study of this PhD thesis. The aim was to produce a systematic scoping review protocol to solidify a rigorous methodology prior to conducting the systematic scoping review. The Joanna Briggs Institute (JBI) guidelines and PRISMA-ScR statement were followed to complete a scoping review protocol to pre-define the objectives, methods to allow for transparency of the process and to limit the occurrence of reporting bias.(36, 37)

Thesis Context



Article 1 Pre-hospital Management, Injuries and Disposition of Ambulance Attended Adults Who Fall: A Scoping Review Protocol

Australasian Journal of Paramedicine

Review

Pre-hospital management, injuries and disposition of ambulance attended adults who fall: A scoping review protocol

Paige Marie Watkins, BSc(Hons) is a PhD student[1]; Peter Buzzacott MPH, PhD, FUHM is a Senior Research Fellow[1]; Deon Brink is the Executive Director of Ambulance Operations[2]; Stacey Masters PhD, MSc(PHC), BN, DipNurs is a Research Fellow[1]; Anne-Marie Hill PhD, GradCertUniTeach, MSc, PostGradDip (Physio), BAppSc(Physio)[3]

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https://doi.org/10.33151/ajp.18.876

Abstract

Introduction
Falls are a globally prevalent health issue, with 37.3 million falls severe enough to require medical attention each year. Falls can result in major trauma and are the second leading cause of unintentional injury deaths worldwide. The role of emergency medical services (EMS) in the pre-hospital emergency treatment of falls is critical, however the sources describing this phase of care has not previously been synthesised. The aim of this scoping review is to identify and map the published literature on the characteristics and injuries of adults who fall, are attended by EMS, EMS interventions and patient disposition.

Methods
The methods for scoping reviews outlined by the JBI Manual for Evidence Synthesis will be used. Databases including Medline, Scopus, CINAHL Plus, Cochrane, EMBASE and ProQuest will be searched from inception. Reference lists of included sources will also be searched. Two reviewers will independently complete title, abstract and full text screening. Included sources will be summarised using narrative synthesis and conceptual categories including patient characteristics, injuries, EMS intervention and patient disposition will be mapped.

Discussion
This protocol describes the framework to identify the scope, comprehensiveness and concepts surrounding pre-hospital falls to identify gaps in knowledge regarding the role of EMS in attending patients who sustain a fall.

Keywords:
emergency medical services; emergency medical technicians; Joanna Briggs Institute; patient; transportation; accidental falls

Corresponding Author: Paige Watkins, paige.watkins@student.curtin.edu.au

Watkins: Pre-hospital management of falls injuries: A scoping review protocol
Australasian Journal of Paramedicine: 2021;18

Introduction

Falls are the second leading cause of unintentional injury globally, after road traffic collisions, accounting for 646,000 fatalities annually (1). Risk of a fall increases with age, immobility and fragility, and is associated with high morbidity and mortality (1-3). Adults aged 65 years and more account for the greatest number of fatal falls globally (1), and emergency medical services (EMS) are responding to an increasing number of older adults who sustain a fall, at least in part due to the ageing population (4-7).

Fall related injuries can vary, from none to life threatening, and can include lacerations, fractures and pain; with injuries tending to increase in severity with age (1,4,7-9). In New South Wales (Australia), adults 25 to 34 years of age have the lowest rates of EMS call outs for falls of all age groups, with a crude rate of 239 per 100,000 EMS-attended falls (9). These rates increase significantly for older adults across Australia: from 585 per 100,000 in those 50 years of age to 11,551 per 100,000 in those 85 years of age in New South Wales (9); and from 6000 to 10,000 per 100,000 in adults 65 years of age and more in Victoria (7). A 2019 government report shows the prevalence of fall-related injuries increases with age in Australian older adults: from 3754 to 17,200 per 100,000 in women 65+ to 95+ years of age respectively; and from 2629 to 15,000 in men 65+ to 95+ years of age respectively.(4)

EMS-attended falls review

Emergency medical services are often the first point of medical attention for individuals who sustain a fall. EMS staffing structures differ worldwide, and can include extended care paramedics (ECP), emergency medical technicians (EMT), paramedics and ambulance officers (5,10). On responding to an individual who has fallen, the objective of EMS is to provide interventions to alleviate symptoms and prevent further deterioration, and to provide appropriate treatment based on clinical practice guidelines (CPGs) or protocols. Patient management is based on the underlying cause of the fall (eg. syncope), or injuries sustained from the fall. Falls can result in major injury, so it is crucial that EMS ascertain when it is appropriate to urgently transport the patient to hospital (11). In the absence of injury, patients may not require transport to an emergency department (ED) (6), or they may refuse transport. Depending on the health services available, there may be other options that EMS can employ for patients who sustain a fall, other than transport to hospital (12), such as lift assistance. Lift assistance is provided when a person falls, is unable to move and requires physical help to return to a preferred position (13), such as rise from the floor to stand or sit. Alternatively, the patient may be referred to their general practitioner or an allied health service such as a falls clinic (7,11).

Decision-making and CPGs

Decisions regarding the management of patients who sustain a fall depend on EMS decision-making and CPGs. In the United Kingdom, CPGs determine that a patient can be left at home and referred to a fall service, transported to ED on request, or sign a 'refuse to travel' document and be left at home without a referral (14). CPGs differ across Australia (15): in Victoria, CPGs for 'elderly/frail non-injury fall' determine that low risk patients who fall should be referred to their general practitioner for a falls assessment. High risk (risk of subsequent fall) patients should be transported to hospital via non-emergency ambulance or, if they refuse transport, follow guidelines for low risk fallers (16). In Western Australia, patients who sustain a fall are treated based on the underlying cause of the fall (eg. syncope) and resultant injuries (eg. factures).

Patient disposition

As new care pathways emerge as alternatives to default transport to an ED, a challenge for EMS is to ascertain if it is both safe and appropriate to not transport patients who sustain a fall, and which alternative pathway to choose (12,17). The disposition of patients who sustain a fall varies depending on age, comorbidities, mechanism of injury and availability of health services (17). Non-transport rates of patients who have sustained a fall vary from 11% to 56% between the United Kingdom, United States and Australia for adults more than 60 years of age (17). Potential risks associated with non-transport include a subsequent increase in unplanned healthcare use such as EMS re-attendance, self-presentation to an ED and hospitalisations (17-19). A meta-analysis of 13 studies reviewing how ECP influence transport to the ED found a reduced likelihood of patient transportation compared with conventional EMS (10). Patients were more likely to be discharged at the scene when treated by an ECP, however two studies found an increase in subsequent ED attendances of 26% (20), and 41% (21) after being seen by an ECP compared with conventional EMS (10). The disposition of patients who sustain a fall varies greatly, though data on non-transported patients is equivocal (10,11,17). There is strong evidence regarding the incidence, prevention and consequences of falls (22,23). However, there is limited evidence regarding pre-hospital interventions delivered by EMS for patients who sustain a fall, and evidence describing their management is scarce.

Causes of falls and EMS care

Falls can be caused by intrinsic factors (ie. muscle weakness, poor balance, impaired sensory function) or by extrinsic factors (ie. environment) which can influence how a patient who sustains a fall is managed (24,25). A systematic review of EMS-attended adults aged 65 years and more who experienced a fall highlighted there is sparse evidence about the use of alternative interventions to safely manage older people who fall and do not require conveyance to hospital (24). Rates of conveyance via EMS have been found to vary among patients who fall (17). Referral to primary care or falls prevention services and alternative models of EMS response have been trialled and are shown to vary (17,18,24).

This scoping review aims to systematically map the range,

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comprehensiveness and key concepts in the published literature to identify knowledge gaps in EMS management of adult patients who fall, including patient characteristics and injuries, and EMS interventions and disposition. The review questions are: i) Which adults attended by EMS sustain what injuries after falling? ii) How do EMS manage the care (ie. interventions) of adults who have fallen? iii) What pathways (ie. disposition) are used by EMS when attending adults who have fallen?

Methods

This scoping review will 'map' the topic of EMS-attended falls to compose an overview and identify the extent of the current literature describing research conducted on the pre-hospital management of patients who sustained a fall. A scoping review is an appropriate methodological choice to explore the breadth of the literature, map and summarise the available evidence and to inform future research (26) by comprehensively reviewing the previously unreviewed topic of EMS management of adults who sustained a fall.

The review will follow the JBI methodological guidelines for scoping reviews and will be reported according to PRISMA-ScR reporting guidelines (26-28). A preliminary search of Medline, Scopus, CINAHL Plus, Cochrane, EMBASE, ProQuest and PROSPERO was conducted to ensure no similar scoping reviews are underway or address this review's objective, before designing this scoping review protocol.

Inclusion criteria

Population

This scoping review will collate peer-reviewed sources focussing on the management of adults who sustained a fall and were subsequently attended to by EMS, and will not be limited by ethnicity, location, gender or comorbidities. The review will include sources that report any population of adult patients who had fallen, as defined by each individual study, to explore all aspects of EMS management of falls.

Concept

Sources of evidence that report on patient characteristics, patient injuries, EMS interventions and/or patient disposition (including transported to ED or otherwise) after a fall will be included in this review. This may be broadly described as patient management and may include: patient assessment, referral to alternative health services and/or disposition decisions. Sources will need to include patient characteristics (eg. age, gender), details of injury, interventions (eg. lift assistance) or disposition (eg. transported, referred or treated at scene).

Context

The context of this scoping review will be EMS attendances, otherwise referred to in Australasia as ambulance or paramedic services. This review will include sources that describe adult patients who have sustained a fall and are then attended by EMS, including paramedics, EMT and various levels of ambulance officers delivering patient care. Sources that report on hospitalised patients, in-hospital falls, inter-hospital transfer of patients or sources exclusively reporting on residential aged care facilities (RACF) will be excluded from this review.

Types of evidence sources

Sources that are peer-reviewed and written in English are likely to contribute the clinical information required to answer the objectives for this review and are a primary source that will include information on the attendance, treatment or management of patients who have sustained a fall.

Potential grey literature identified in the search strategy will be considered for inclusion if they contribute to the study objectives. Newspaper articles and blogs will not be included in this review. This review will include sources that contain data on both out-of-hospital and RACF attendance by EMS. Sources that have only data on RACF attendances will be excluded as RACF have policies and procedures that influence patient disposition of adults who sustain a fall. Sources containing data on adults and children who sustain a fall and are subsequently attended to by EMS will be included; sources with only children will be excluded.

Search strategy

The search strategy will follow the three steps outlined in the JBI methodological framework (26,27). First, Medline, Scopus, CINAHL Plus (EBSCO), Cochrane, EMBASE and ProQuest databases will be searched for relevant text words and indexing terms, through analysis of titles and abstracts for relevant sources. Second, researchers will complete a full-text search of potentially relevant sources. Third, a snowball search of the reference lists of included sources of evidence will be made for additional potential sources of evidence, and each will be assessed to identify if they also met the inclusion criteria. The search strategy will purposefully be broad to capture as many relevant sources as possible and relevant measures will be taken to account for plurals, suffixes and variations to broaden the search.

Searches will not be restricted by date, although sources over 10 years old are less likely to be relevant than more recent research. A research librarian was consulted for the development of initial search terms and will supervise the searches, as their expertise in systematic searches has been found to increase the sensitivity and specificity of search strategies (27,29). The PRESS Guideline Evidence-Based Checklist was used to check the search strategy and assistance was received from a research librarian (25,29). A draft search strategy using medical sub-headings (MeSH) and indexed keywords and terms is presented in Table 1. Further refinements may occur during the search and these will be listed in the final scoping review.

Source of evidence selection

All identified sources will be searched and screened for

duplicates and two researchers will independently conduct title and abstract examinations according to the inclusion criteria, based on JBI methodology: population, concept, context and source type. Any study recommended to pass the initial filtering of titles and abstracts, by either reviewer, will progress to the next stage. Sources remaining at this stage will have the full text versions obtained and examined for eligibility. Additional records identified through hand searches of relevant journals will also be reviewed. Both researchers will use the PRISMA checklist for scoping reviews as a guide (23), following the inclusion criteria. One reviewer will extract all of the sources and all search results will be reviewed by at least one other reviewer.

Table 1. Search strategy for Medline (Ovid interface) with MeSH headings and search terms

Step	Medline (Ovid) search strategy
1	Exp Ambulances/
2	Exp Air Ambulances/
3	Ambulances.mp.
4	(Ambulance* or EMS or "emergency* medic* service*").mp.
5	Exp Emergency Medical Services/
6	1 or 2 or 3 or 4 or 5
7	Exp Accidental falls/
8	(Fall* or fell*).mp.
9	7 or 8
10	6 and 9
11	Emergency Medical Technicians/
12	("emergency medic* tech*" or EMT or paramedic*).mp.
13	Exp "Transportation of Patients"/
14	11 or 12 or 13
15	10 and 14

Presenting the results

Content analysis will enable the formation of a descriptive summary of data to provide a clear explanation of how the results relate to the review question (26). This will not include a thematic analysis or synthesis as this would be beyond the scope of a scoping review (26). Quality appraisal of included sources will also not be conducted as this does not form part of a scoping review (28,30). Substantial variation is anticipated in the granularity of the data throughout included sources. Sources of evidence and data will be described, with results classified under the following conceptual categories: population, injuries/observations, interventions, and/or disposition.

Discussion

This scoping review will systematically map sources on the pre-hospital management of EMS-attended adult patients who sustain a fall in the out-of-hospital setting. The final review will present what is currently known about patients, their injuries and observations, interventions and/or eventual disposition (and overall EMS management). Gaps in the available evidence that require further research will be highlighted by the results.

Competing interests

The authors declare no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement.

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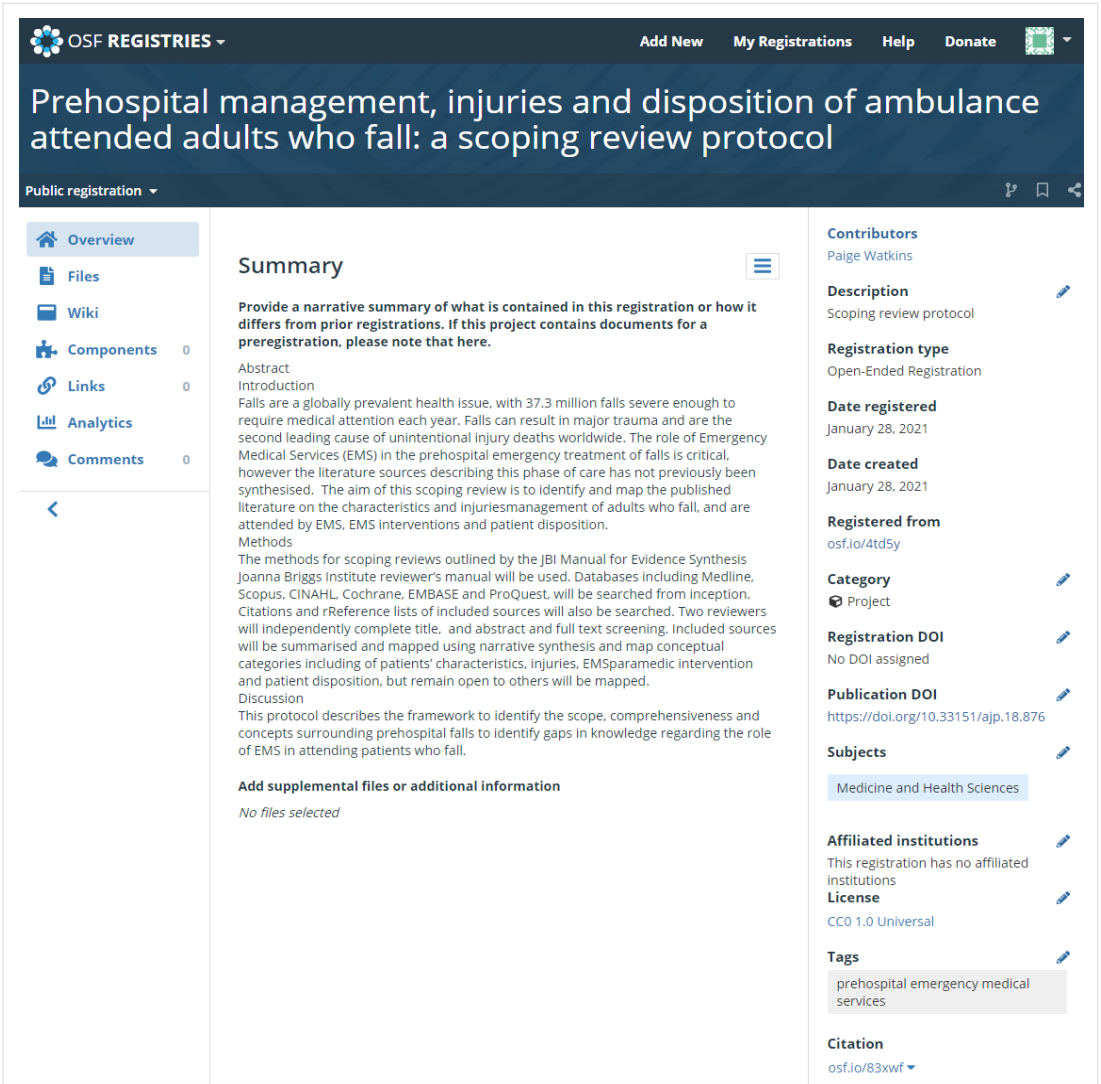
End of Manuscript

3.2 Supplementary Material

Supp Figure 3.1 presents the registration of the scoping review protocol. This registration was completed prior to the publication of the scoping review protocol manuscript and updated on its publication.

Supp Figure 3.1
Open Science Framework Registration of Scoping Review Protocol



3.3 Summary of Chapter Findings

This chapter consisted of the published scoping review protocol, which described the methods by which the scoping review was conducted. Given the heterogeneity of falls research, a scoping review was determined to be the most appropriate method to examine the extent, range and nature of prehospital falls literature published.(36, 37) The next chapter presents the systematic scoping review.

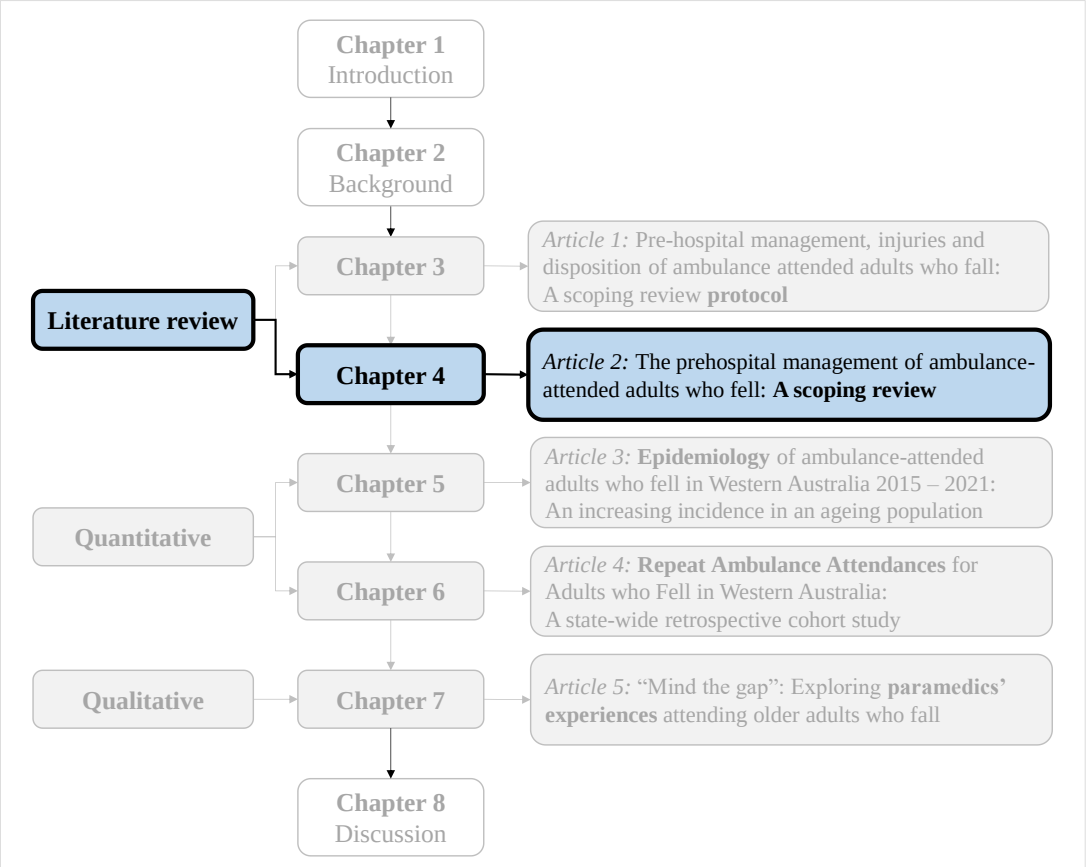
Chapter 4

Systematic Scoping Review

4.1 Overview

Prehospital literature on the management of falls varied greatly so a scoping review was determined appropriate to explore the breadth of published research available. The aim of this scoping review was to map and synthesise the evidence for the prehospital management of EMS-attended adult patients who fall, identify knowledge gaps and propose recommendations for further research of EMS management of falls in the prehospital setting. Six databases (Medline, Scopus, CINAHL, Cochrane, EMBASE and ProQuest) were searched to identify sources that reported on the population, (adults who fell); context (attended by an ambulance/EMS); concept, (reported re-attendance, non/transport, mortality, patient characteristics, injuries, observations, interventions, disposition or alternative care pathways); and were a primary source of peer-reviewed information published in English. The findings of this scoping review are reported in the following manuscript, published in Australasian Emergency Care.

Thesis Context



Article 2 The Prehospital Management of Ambulance-attended Adults Who Fell: A Scoping Review

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Literature review

The prehospital management of ambulance-attended adults who fell: A scoping review

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ABSTRACT

Background: The ageing population is requiring more ambulance attendances for falls. This scoping review aimed to map and synthesise the evidence for the prehospital management of Emergency Medical Services (EMS) attended adult patients who fall.
Methods: The Joanna Briggs Institute methods for scoping reviews were used. Six databases were searched (Medline, Scopus, CINAHL, Cochrane, EMBASE, ProQuest), 1st August 2021. Included sources reported: ambulance attended (*context*), adults who fell (*population*), injuries, interventions or disposition data (*concept*). Data were narratively synthesised.
Results: One-hundred and fifteen research sources met the inclusion criteria. Detailed information describing prehospital delivered EMS interventions, transport decisions and alternative care pathways was limited. Overall, adults < 65 years were less likely than older adults to be attended repeatedly and/or not transported. Being male, falling from height and sustaining severe injuries were associated with transport to major trauma centres. Older females, falling from standing/low height with minor injuries were less likely to be transported to major trauma centres.
Conclusion: The relationship between patient characteristics, falls and resulting injuries were well described in the literature. Other evidence about EMS management in prehospital settings was limited. Further research regarding prehospital interventions, transport decisions and alternative care pathways in the prehospital setting is recommended.

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1. Introduction

Falls are globally prevalent, with 37 million requiring medical attention annually [1]. Falls are the second leading cause of injury deaths globally, after traffic collisions, accounting for approximately 684,000 fatalities annually [1]. The risk of a fall increases with age, immobility and fragility, as does the risk of morbidity and mortality from falls [1–4]. Adults aged > 65 years (older adults) account for the greatest number of fatal falls globally [1], and Emergency Medical Services (EMS) are responding to an increasing number of older adults who fall, in part due to an ageing population [5–8].

EMS's objective, when responding to people who fall, is to provide interventions, alleviate symptoms and/or prevent further deterioration and, where necessary, transport the patient to hospital. Patient management is largely based on the underlying cause of the fall, and injuries sustained. Falls can be caused by intrinsic factors, e.g. poor balance, or extrinsic factors e.g. environment, which influences how these patients are managed by EMS [1]. Treatment decisions are based on clinical practice guidelines/protocols. Fall-related injuries can vary from none to life-threatening and tend to increase in severity with age [1,5,6,9,10]. Falls can result in major injury so it is crucial that EMS ascertain when it is appropriate to transport patients to hospital [11]. Patients who fall may only require lift assistance, i.e. when a person requires physical help to return to a preferred position [12], (e.g. older/obese adults with mobility limitations). Depending on available health services, EMS can employ options for patients who fall other than transport to hospital [13,14]. Patients may be referred to their general practitioner (GP) or an allied health service such as a falls clinic, which are commonly utilised in the UK [13,14], but less commonly elsewhere [6,11]. Transport to a dedicated "trauma centre" may be optimal for some patients but the definition of a trauma centre varies between countries, making direct comparisons problematic [15].

As pathways emerge as alternatives to transport to an emergency department (ED), a challenge for EMS is to ascertain when it is appropriate to decide against transporting patients to an ED, and which alternative pathway of care will be chosen [16]. Non-transport rates of older adults who fall are shown to vary from 11% to 56% between the UK, USA and Australia [16]. Potential risks of non-transport of older adults include increases in unplanned health-care use, i.e. EMS re-attendance, self-presentation to an ED and hospitalisations [16–18]. A meta-analysis found a reduced likelihood of patient transportation to an ED when seen by Emergency Care Practitioners (ECPracs), compared with conventional EMS [19]. ECPracs have an expanded set of treatment/referral options compared with paramedics/conventional EMS, resulting from different qualifications/training [19–21]. However, there is scant published evidence about the EMS management of falls in the prehospital setting.

Scoping reviews are useful when a body of literature has not yet been comprehensively reviewed or exhibits a heterogeneous nature not amenable to a more precise systematic review [22]. Therefore, this scoping review aimed to map and synthesise the evidence for the prehospital management of EMS attended adult patients who fall, identify knowledge gaps and propose recommendations for further research of EMS management of falls in the prehospital setting.

2. Research question

The research question was: What evidence exists for the prehospital management of EMS attended adults who fall? The research objectives were: i) Describe the adult populations attended by EMS after a fall, ii) Describe what injuries occur after falling, iii) Identify EMS interventions provided in the prehospital setting for adults who fall, and iv) Identify the disposition of patients who fall.

3. Methods

3.1. Design

The review was conducted according to a published protocol [23]. A scoping review design based on the Joanna Briggs Institute guidelines for scoping reviews was used [22], as this allows for a wide breadth of inclusion for all relevant studies. The review was reported in accordance with the Preferred Reporting Items for

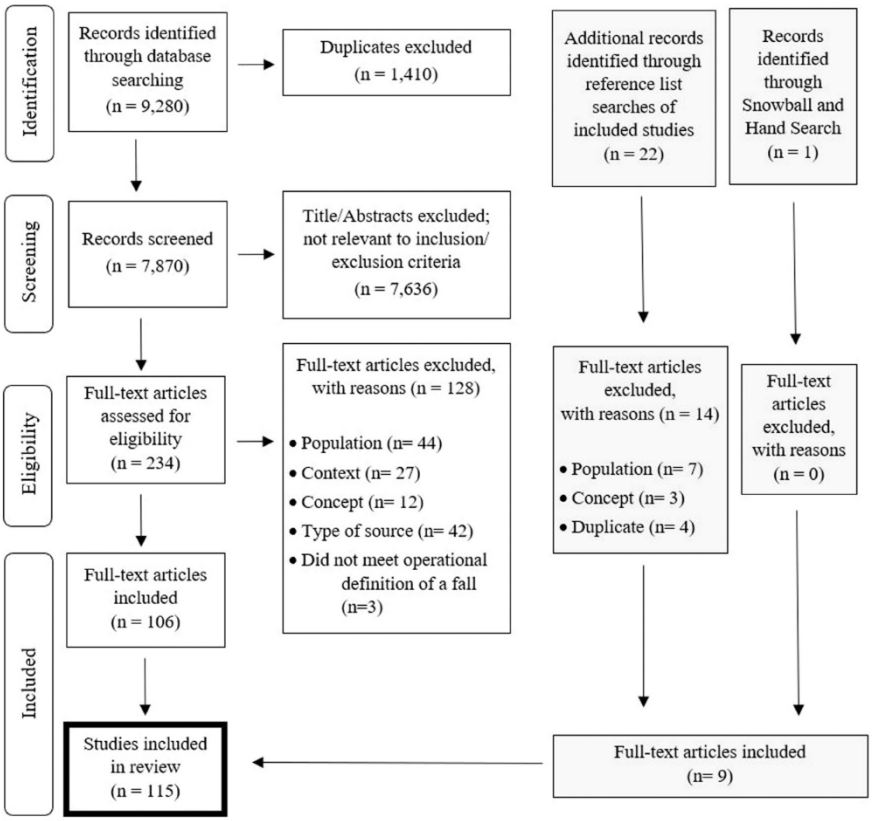

Fig. 1. Flow chart of source selection in accordance with PRISMA guidelines.

Systematic reviews and Meta-Analyses (PRISMA) extension for scoping reviews PRISMA-ScR checklist (Appendix 4) [24].

3.2. Search strategy

A research librarian assisted with the development of search terms and the search strategy was finalised by two researchers (Appendix 2). Six online databases were searched (Medline, Scopus, CINAHL, Cochrane, EMBASE and ProQuest), 1st August 2021, using indexing terms and MeSH headings, and a hand search of key journals not included in these databases (Appendix 2). Additional records were identified through reference list and snowball searches (Fig. 1).

3.3. Sources of evidence screening and selection

Results of the search were uploaded to Rayyan [25], an online reference manager, and screened for duplicates. Two authors (PW, PB and/or SM) independently conducted title and abstract examination for sources matching the inclusion/exclusion criteria. Full text review of studies remaining was completed by two reviewers (PW, PB and/or SM). Exclusion at the full text stage was detailed by both researchers, (Fig. 1). Any disagreements (n = 3) were resolved by consensus or a third researcher.

3.4. Inclusion criteria

Study designs meeting inclusion criteria were: Non/randomised controlled trials, controlled before-and-after studies and cohort studies. As this was a scoping review, review articles, case reports, case series, conference abstracts and trial protocols were also included. Sources meeting the inclusion criteria described the *population*, (adults who fell); *context* (attended by an ambulance/EMS); *concept*, (reported re-attendance, non/transport, mortality, patient characteristics, injuries, observations, interventions, disposition or alternative care pathways); and were a primary source of peer-reviewed information published in English (Appendix 1) [23]. Studies focussed on ED-treated falls, falls from motor vehicles, assaults or suicide were excluded. Systematic reviews were identified as a secondary source and reviewed to identify potential studies for inclusion.

3.5. Data extraction and synthesis

The following data were extracted: author; year of publication; country, objectives; population; concept; context and outcomes. Data extraction was completed by one author and reviewed by a second (Appendix 3). Data were grouped into four main themes, aligning with the study objectives (patient characteristics, injuries, interventions and disposition) before exploring and synthesising the

Table 1
Characteristics of included studies.

Study characteristic		(N = 115)	Percentage
Year of publication	1980 – 1989	1	1
	1990 – 1999	4	3
	2000 – 2009	23	20
	2010 – 2019	82	71
	2020 – current	5	4
Country	Australia	29	25
	Austria	1	1
	Brazil	7	6
	Canada	4	3
	China	1	1
	England	9	8
	Germany	1	1
	Ireland	1	1
	Japan	2	2
	Netherlands	2	2
	New Zealand	1	1
	Poland	1	1
	Qatar	1	1
	Scotland	1	1
	Switzerland	3	3
	UK	14	12
	USA	35	30
	Wales	2	2
Study design	Randomised Control Trial	4	3
	Cohort	58	50
	Case control	4	3
	Cross sectional	26	23
	Case reports and studies	23	20

evidence. Sub-themes arose from familiarisation with the data within each theme, grouping similar content. As per scoping review methodology, quality assessments of included studies were not undertaken [22,24].

4. Results

4.1. Included studies

A total of 115 studies were included from 16 countries, spanning from 1988 to 2021 [6–14,17,18,26–129], and most commonly using a cohort study design (Table 1). Fifty-two sources contained a study population of exclusively adults who fell [6–10,12,13,18,27,28,31–33,35,37,40,41,43,44,51–53,55,56,60,62–64,67,71,74,79,82,84,86–88,91,95,97,100,105,107,112,114–116,118,123,124,126,127], and 63 contained a study population with a subset of adults who fell [11,14,17,26,29,30,32,34,36,38,39,42,45–50,54,57–59,61,65,66,68–70,72,73,75–78,81,83,85,89,90,92–94,96,98,99,101–104,106,108–111,113,117,119–122,125,128,129]. All sources were unique apart from five sources where we accepted non-overlapping data. Fig. 1 presents inclusion and exclusion of sources [24].

Of the five systematic reviews identified as secondary sources to identify potential studies for inclusion [22], one review, (identifying 16 studies), concluded there was a lack of studies investigating prehospital interventions and patient outcomes [130]. One review reported a lack of evidence describing prehospital management of femoral neck fractures, administration of analgesia and immobilisation [131]. Three systematic reviews examined transport decisions: alternatives to conveyance [132], avoiding unnecessary conveyance [133], and non-conveyance [16].

4.1.1. EMS staff

EMS staff differ by country and include extended care paramedics (ECP, Australia [107], and New Zealand[81]), ECPracs [7,13,14,17,50,59,81] or emergency physicians (Japan [50], USA[59]), paramedics [7,59,107] (USA [59], UK [13,14], and Japan[50]), emergency medical technicians [7], and ambulance officers (technicians [7,13,14,59], non-clinician UK alarm service [13], specialist nurse or rapid response team [54], specialist falls response paramedic and social worker team[13]). UK ambulance services deployed practitioners with advanced training, such as ECPracs, non-emergency-crewed vehicles, (i.e., emergency medical technicians and social worker or emergency medical technicians and specialist nurse, where the social worker and nurse are defined as non-emergency crew), and single-crewed vehicles to older patients who had fallen, and one described a specialist falls response vehicle [13].

4.2. Results of synthesis

Fig. 2 summarises the four themes (including sub-themes) reported by each of the included studies.

4.3. Demographic characteristics

4.3.1. Sex

Older women sustained more falls than older men [8–10,41,51–53,67,107,119,121,125]. Men more frequently sustained severe or traumatic injury [29,44,62,92,101], resulting from high velocity falls, while working for income (18% vs. 4%) [56], from height [32,35,51,55,60,62,71,78,80,82,106], compared with women who more frequently fell from sitting/standing [27,31,33,56,86,106,118], or the same level [51,105,107,117]. Women were more likely to have one injury, (to the neck/back, abdomen/pelvis or limbs), likely a fracture, compared with men who were more likely to sustain > 1 injury such as a luxation and/or contusion to their head [51].

4.3.2. Age

Older adults fell more frequently than younger adults [9,38,40,41,51,66,83,97,113], from standing [12,14,17,27,28,30,31,60,69,85,118], slips [30,84,105,117], trips [30,105], low levels or stairs [90,118] and were often attended by alternative EMS, (e.g. ECPracs [14,17,81], specialist nurse or rapid response team [54], or emergency physicians [50]). The age-specific rate of falls was highest in adults ≥ 70 [57] and > 85 year olds [8,107] in both sexes, although women fell more often than men within the > 85 year old age group [8,107]. Elderly patients were more likely to be under-triaged, with one study reporting an under-triage rate of 12% [94]. Older adults who fell had a high risk of mortality or 'talk-and-die', described as patients who talked during their initial EMS encounter, seem to have relatively minor injuries, but then subsequently die [68,85]. Older adults were frequently attended for lift assistance [18,37,64,95,115], not transported [6,13,17,18,30,36,37,46,52–54,64,66,67,86,100,114,115,129], repeat falls [67], re-attended [6,12,37,53], or attended for falls [66,120,121], from standing [11,88,98,105,107,112,114,116] resulting in pain/injury around the spine [33,58,93,98,101,112,113] and pelvis [27,28,107]. Adults (often < 65 years old) [42,75], were more often transferred to a major trauma centre [35,48,58,60], due to major trauma [39,42,44,47,58,62,80,89,102,104,111], frequently having fallen from height [32,35,55,60,62,71,78,80,82,106], in contrast with older adults transferred to hospital [6,53,60,64,65,67,70,74,83,86,93,95,96,100,114], due to injuries of similar [29,42,111,118], or less severity [39,65,96]. Adults aged 65–74 years had fewer fall-related ambulance dispatches, hospital admissions and fall injury-related hospital admissions, than adults aged > 85 years of age [123].

4.3.3. Comorbidities

Older adults commonly had > 1 pre-existing medical condition [6,76,83]. Nausea, urinary tract infections and/or neurological conditions were associated with non-injurious falls and had a 31% transport rate to hospital [123]. When initial measures were taken by EMS, blood pressure in adults who fell varied from normotensive [68] to hypertensive [127]. Dementia was associated with increased

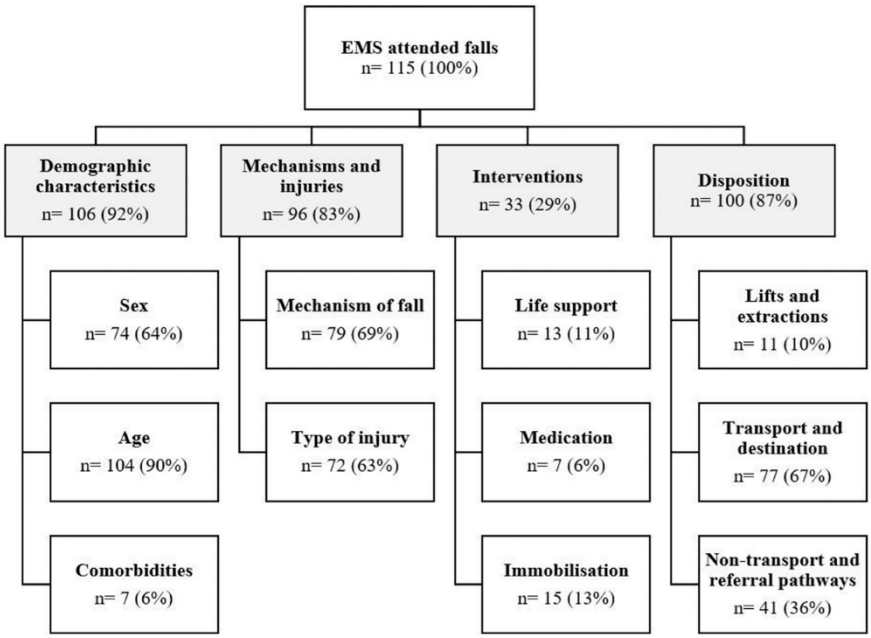

Fig. 2. Themes reported by each included study and sub-themes present within each.

fall risk, and increased level of fall-related trauma (in older adults) [76,83].

4.4. Mechanisms and injuries

4.4.1. Definition of fall

Fall definitions were narratively described, or defined by height, Definitions most commonly included the generic term 'fall'; [14,17,26,27,29,61,80,92,110] ground level fall/from standing height/ standing; [28,31,32,36,122] falls from < 2 m, < 5 m [111,122], "slips, trips and falls"; [30,33] falls from height [56,72,111]. falls from stairs [118], or height [62].

4.4.2. Type of injury

Fractures were the most frequently described injury from falls [82,84,103,106–108]. Falls from height resulting in fractures were reported as proportion of fractures by bone [82], and per vertebra [106]. Head injuries were reported broadly as head and neck injury [9,17,31,124], pain [33], or soft tissue [58]. Case studies contained more detail: hematoma [27], discoloration [27], "time critical" head injury, bleeding, tonic-clonic seizure [80], tracheal disruption [118], or facial fractures [87]. Traumatic brain injury was common in adults suffering low velocity falls from standing [102,111,118], and from horses while not wearing a helmet, often resulting in transport, and associated with arterial hypotension, contributing to a risk of low Glasgow coma scale (GCS) [102,118], and mortality [102]. Chest injuries [58] were associated with falls from height [39]. Injuries to the pelvis varied from pain [9,28,31,35,68,117], to broadly "injured" [69,101], fractures [58,88,107], and mostly affected older adults [9,28,31,35,68,69,88,107,117,123]. Extremity injuries were reported as localised, such as thigh-tenderness with localised oedema [35], "hip-to-foot" [9,49,69], region or "extremity" [31,69,107], "soft tissue limb injuries" [17,58], and "shoulder-to-hand" [9,49]. A fall resulting in "multiple trauma" [9,29,32,38], broadly described as other injury [51,58], often included cuts [51], perforation [51], contusion [51,108], excoriation [51], fracture [51,108], luxation [51], or amputation [108].

4.5. Interventions

4.5.1. Life support

Unresponsive and unconscious patients were treated with high-flow oxygen [71,87,118], intubation [62,118], rapid sequence intubation [80], or placement of a definitive airway [118]. Cardiopulmonary resuscitation was delivered to patients who had a cardiac arrest after falling [110], with defibrillation performed on cardiac arrest patients with a shockable rhythm [34]. Among patients who initially survived a fall, rapid sequence induction, blood transfusions and open/tube thoracostomy were utilised by helicopter emergency medical service (HEMS) [60]. In a case of multiple impalement resulting from a fall, an emergency physician administered fluid, resuscitation and analgesia [126]. An objective of HEMS is minimising environmental exposure [35].

4.5.2. Medication

Morphine, fentanyl, methoxyflurane (inhaled), acetaminophen (oral), ibuprofen (oral), oxycodone (oral), and acetaminophen and codeine (oral) were medications reported as administered in the prehospital setting [107]. Morphine was the most common analgesic administered [31,45]. Medications administered included cardiac arrest medications [34,45], nitro-glycerine, acetylsalicylic acid, midazolam, naloxone, glucose, and albuterol, administered due to the patients underlying conditions [45]. Intravenous acetaminophen was reported in a case of impalement, which was the only case to employ sedation [44].

4.5.3. Immobilisation

Back [9], trunk [9], and spinal [58,98] injuries sometimes involved fractures only [113], or potentially the spinal cord [98], and were often immobilised when transported to prevent secondary injury [49,87,89,98,118]. Spinal precautions were reported by efficacy [49], reliability [89], and clinical sensibility [89,113] of spinal precaution use, by context and types of precautions used [124]. Immobilisation training was highlighted as important as rates of spinal immobilisation vary by type of EMS [49]. Head [93], and neck immobilisation included cervical collars [106,118], rigid cervical orthosis [33], thoracic-lumbar spinal orthosis [106], and head blocks [127]. Broader spinal precautions included backboards [71], long spine-boards [93], spider-straps via HEMS extraction [71], scoop-stretchers [127], halo immobilisation [106], and lumbar-support corset [106]. Pelvic injuries were treated with analgesia [31,107,123], pelvic binder, pelvic circumferential compression device [104], or secured scoop, and were associated with falls from height or high velocity falls [80].

4.6. Disposition

4.6.1. Lifts and extractions

When patients are not transported, an intervention, frequently described as 'lift assists' was commonly implemented when attending older adults with repeat falls [12,30,37,59,79,86,95]. HEMS commonly attended falls, utilising a variety of extraction interventions including seats, nets and bags [26]. Sling harnesses are a HEMS extraction option for conscious patients and one death was reported as resulting from a patient losing consciousness and falling during extraction [84]. Improvised packaging was reported when a patient did not fit in the standard basket [35]. Lift assists accounted for a large proportion of ambulance attendances and were often associated with non-transportation of patients who fell [43], predominantly older adults [12,30,37,86,95]. Repeat lift assist attendances were documented as ranging from one to ≥ 21 attendances [79].

4.6.2. Transport and destination

Transfer methods included direct transfer to a trauma centre, indirect transfer to hospital prior to trauma-centre transfer and non-transfers, (to a non-trauma centre and not subsequently transferred) [85,115]. A clinical decision making tool for the care of older people who have fallen is used to assess if patients require transport to ED or referral (UK) [91]. When spinal precautions were used, transport was the usual disposition (USA) [27,49]. Reported transport destinations included: ED [27–29,31,33,34,43,49,56,110,113,122,128], trauma unit (UK) [111], or a major trauma centre (UK) [111]. All transport destinations and methods had a majority of falls from "low levels", although the majority of "high level" falls were transported directly to a major trauma centre, whereas low level falls were more commonly transported to hospital ED (Australia) [11,42], (England) [111]. Indirect transport, or transported to another hospital prior to trauma centre transfer, commonly resulted from "falls from standing" rather than "falls from height" [42]. Those patients not directly transported to a major trauma centre or not transported prior to death or discharge were older adults who had sustained a head injury from a fall [42]. HEMS attended falls due to geographical and topographical access impediments, rather than injury severity and/or critical skills [60,72]. Reduced mortality was shown in adult patients with major trauma transported by HEMS compared with ambulances [90]. Extractions and rescues via HEMS were most often flown to the nearest trauma center [26,35,44,80,92]. Inappropriate HEMS transport of falls patients was associated with a GCS > 8 and patient age > 55 years [99].

4.6.3. Non-transport and alternate care referral pathways

Falls accounted for the largest number of non-urgent conveyances to hospital [61]. It was common for older adults to experience no [31,117], or unspecified injuries [9,52], ending in non-conveyance [8,36,40,113]. Reasons for non-transport included being treated at the scene [13,43], due to no/minor injuries [12,18,52,54], described as 'attended and not transported' [128], or a patient's refusal to travel [12,18,52,54], sometimes specifically against medical advice [66]. Refusal for referral was less common [59]. Older adults more frequently accepted referrals from paramedics compared with ECPracs [59]. ECPracs more frequently than paramedics, treated older adults at home and did not transport them to ED, resulting in 24% of older falls patients requiring further hospital attendances after not being transported [17]. EMS re-attendances commonly involved older adults for lift assistance, were non-transported due to no/minor injury, treated on scene, refused to travel or referred to a GP (USA) [12], (England) [18]. EMS re-attendances resulting in transport to hospital commonly involved > 1 ambulance due to a severe fall [18]. Alternate care and referral pathways differ between countries and often include multiple services.

5. Discussion

This review synthesised published literature of EMS management of patients who fall in the prehospital setting. Findings comprehensively identified patient characteristics, the mechanism of injury, injuries sustained, diversity of 'fall' definitions and disposition. However, few publications described prehospital interventions, disposition decision making or alternate referral pathways (Fig. 2).

Older adults fall frequently, repeatedly and require multiple EMS attendances, though specific comorbidities are not often described. Multiple comorbidities are associated with increasing age and this increases the risk of falls, emphasizing how the risk of falls is a multifaceted problem [6,123]. Adults were more often attended due to major trauma, frequently after falling from height, than older adults who were commonly attended due to injuries of similar or less severity [39,42,65,75,96]. Older adults, regardless of sex, fall more frequently and are at a higher risk of mortality due to falls than younger adults [8]. Older adults as a high-risk population are well-explored in the literature and described as increasingly requiring EMS attendance, for minor to life-threatening injury [6,12,37,53]. Older adults were often attended and not transported, consistent with findings from other literature reviews summarising transport decisions [16,132,133]. Transport destination were highly variable for older adults, and interventions, such as lift assists, often coupled with non-transport [16]. Appropriate prehospital interventions can improve health outcomes of non-transported older people who have fallen [16]. The appropriateness of transport after a fall requires further research as decisions should be based on individual patient needs, particularly when considering high-risk older adults [17,54,59,91,105,115,117].

Fall mechanism and frequency were widely reported and differed between sexes. Males who fell often sustained severe injuries, due to falls from height, commonly resulting in transport to a major trauma centre; compared with females who were older, more frequently sustained minor injuries, due to falls from low height, and often transported to hospital, consistent with Meschial [51] who reported sex differences in mechanism of injury and disposition among the elderly. Differences in older adults who fall are important since this is key in the implementation of prevention strategies [51]. Men were more likely to fall from height compared with women, consistent with Holloway-Kew [56]. Men were more likely to sustain > 1 injury [51], and generally severe traumatic injuries, resulting from high velocity falls [29,44,51,62,92,101]. Women were significantly more

likely to sustain a single injury, resulting from falls from standing level [29,44,51,62,92,101,105,107,117]. The prehospital management of falls is based on presenting injury, not sex, so these findings should be applied to falls prevention strategies in an effort to reduce the demand on EMS, by targeting the prevention of specific types of falls/fall-related injuries that are more prevalent among males or females.

Fall definition and mechanism of injury were inconsistent, although some common descriptors such as non/traumatic fall were present across the literature. Other unique descriptors highlighted high-risk groups such as "elderly falls" [17], "older falls" [8], "frequent falls" [132], or "repeat falls" [6]. These studies identify two high-risk groups: repeat fallers and older adults, which should be considered when researching falls. Flavell [130] found that prehospital literature lacks a unifying falls definition and defined falls by height for the purpose of their study. It is important that prehospital falls studies have consensus on defining falls, in order for research to inform practice.

A range of prehospital staff were dispatched according to patient needs [13,14,50,59,107]. We found a diverse range of EMS staff and paramedic clinical levels, although few sources compared the differences of intervention delivery between different EMS staff types. Simpson [107] reported paramedic trainees administered analgesia to 72% of patients, paramedic interns 56% of patients, qualified paramedics 60% of patients and paramedic specialists 66% of patients [107].

Lift-assists were the most commonly reported intervention provided [79], and patients requiring lifts often required repeat attendance [37]. Lift-assists comprise a large part of EMS workload and are widely described, although the specific methods used are not as well reported and would potentially benefit from further research. A significant amount of literature alludes to the correlation between lift assists and non-conveyance of patients, and this is largely due to non-injurious falls where an uninjured patient is not able to independently return to a seated or standing position [12,37,59,79,86]. Specialist falls response vehicles have been implemented in high-density locations, such as the UK [13], though the existing literature may not be directly relevant to more dispersed populations. HEMS were deployed in Qatar [75], USA [26], UK [80], Germany [78], Japan [90] and Australia [60], when necessary due to access and logistical difficulties [26,35,44,80,92,99].

Sources reporting life support and medication focused on tailored delivery based on individual patient needs. Interventions for airway management were consistent, specifying the early establishment of a definitive airway and administration of oxygen as best practice for patients with airway/breathing problems [71,87,118]. A USA study described patients assigned a dispatch priority, of which 6741 (9%) were assigned as falls [45]. There was a low incidence of cardiopulmonary procedures in patients who fell and a higher rate of medication administration, in particular 1589 cases of morphine use, accounting for 72% of all medication administered [45]. Lift assists and analgesics were the most frequently reported interventions.

Transport, alternate care, referral pathways and destination decisions were highly variable within the literature. Referral pathways and alternative EMS responses were commonly described in the UK, due to the availability of multiple prehospital services [13,14]. This is unique in comparison with other countries such as Australia, where prehospital falls are attended by volunteer/paramedic staff and additional treatment is provided by back-up ambulance crews or in hospitals. An ECP (NZ) has an expanded set of skills to safely treat in the home and community without hospital attendances [81]. An ECPrac (UK) has a paramedic and/or nursing background with additional training, and the ability to refer patients to other health and social care professionals, where appropriate [14].

5.1. Limitations

This review included peer-reviewed literature in the English language, likely omitting non-English evidence and grey literature. Scoping reviews are focused on breadth rather than depth of evidence and usually do not conduct quality assessments of included studies;[22,24] though the aim was to map available literature. Studies on ambulance-transported patients may be subject to survivor bias.

6. Conclusion

There is a research gap regarding EMS management of falls in the prehospital setting. Patient characteristics and injuries are well documented, but the type and amount of prehospital interventions, decisions around disposition and whether transport occurs and alternative health care pathways are sparsely reported. We recommend future research in this area that identifies the specific context of falls, reports what prehospital interventions are undertaken and describes how decisions to transport are made.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.auec.2022.07.006.

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End of Manuscript

4.2 Extension of Results and Updated Literature Review

4.2.1 Extended Results

All findings from the scoping review were reported in the published manuscript, although all tables and figures presenting these findings were not able to be published. The remainder of this chapter presents the unpublished tables, figures, and an updated literature review.

A plethora of falls definitions exist within prehospital literature and are shown in Figure 4.1. While distance fallen is commonly used, falls are often defined by: mechanism, what someone fell from, the way they fell, and some identify high risk groups, i.e., “older fallers” (38) and “repeat fallers”.(39) Definitions appear to differ in older adults compared to those <65 years of age, largely relating to activity level and the reduction of co-ordinated physical function linked to increasing age. A summary of mechanisms of falls and fall injuries, reported in the scoping review, by sex and age are presented in Table 4.1. A summary of interventions delivered in the prehospital setting, by age, is presented in Table 4.2. A summary of patient disposition based on ambulance transport decisions, is presented in Table 4.3, by age. The references found in Figure 4.1, and Table 4.1 through to Table 4.4, refer to the reference list within this thesis.

Figure 4.1
Fall definitions reported in prehospital literature regarding ambulance-attended adults

		Adults <65 years	Older adults >=65 years
Definition by height [1]	Low	Ground level,(40-42) Standing,(43-52) sitting,(45, 47) trip,(50, 52, 53) Slide,(52) Slip,(50, 54) <1m,(55) ≤1m,(56) <2m,(57, 58) <3m,(59, 60) fall from elevation ≤3 ft. (1 m) or down 5 stairs,(61) fall of: 0, 1-4, 5-9 feet,(41) falls from stairs, less than 3 meters high and/or at ground level due to slip or trip.(60)	Same level,(10) level surface,(62, 63) standing,(10, 46, 48, 64) ground level,(64) slips,(10, 65, 66) trips,(10, 52, 65, 66) slide,(52, 65) fall from bed.(10)
	Medium	1-5m,(55) <3m,(50) 2-5m,(57) <10 feet,(45) <5m,(43) fall from elevation of 3–10 ft. (1–3 m) or down [5 – 15 stairs].(61)	-
	High	From high height,(63, 67, 68) from height,(44, 49, 69-73) higher than standing level,(44) >1m,(56) >2m,(58, 74) >3m,(59, 75) >=3m, ,(60) >5m,(43, 55) fall >=5m or >=3x body length,(57) fall from elevation, >=10 ft. (3 m) or down [15 stairs],(61) fall of: 5-9, 10-14, 15-19, >20 feet,(41) 10-19 feet.(45)	From height.(48)

	Adults <65 years	Older adults >=65 years
Definitions by context	From train,(40, 76) fence, (40) canal(40) or horse, (40) scooter,(43) skateboard,(43) skates,(43) vertical falls,(41) down inclines,(41) steps,(41) stairs,(68) unknown,(41) indoors,(52, 77) mechanical,(41) mode of fall (cliff/canyon, walking, stairs/ladder,(67) building, play equipment, other, unknown),(55) fall not further specified (NFS) (but mainly due to slip or trip),(50) Meters of fall,(78) fallers,(67) accidental,(67) construction works,(67) fall onto head (axial load),(61) plunge.(79)	Elderly falls,(80) older fallers,(38) frequent,(54, 81) repeat,(39) stairs,(10, 62) steps,(10) ladder,(10, 62) bed,(10) chair,(10) other,(10) fall in toilet/shower,(66) indoors,(77) inside,(52) drop,(65) unspecified,(65) accidental,(72, 82) 1 or more falls,(83) 2 or more falls in the past 12 months,(83) 3 or more falls in the past 12 months.(83)
Definitions by prehospital diagnosis	17A: Not dangerous body area and/or not recent,(84) 17B: Possibly dangerous body area, serious haemorrhage and/or unknown status,(84) 17D: Dangerous body area, long fall (>6 ft.), unconscious or not alert, and/or abnormal breathing.(84)	Traumatic or medical fall,(8) dizziness,(10) loss of balance,(10) no recollection,(10) injurious fall,(4, 66, 85) collapse.(65)

[1] *Definition by height*: This refers to papers who have described a fall as either "low", "medium" or "high" height and then subsequently what fall they consider fits into that category. This data was collected via a systematic review of prehospital literature.

Table 4.1
Mechanism of fall and type of injury

	Male	Female	Adults >=16 years and <65 years of age	Older adults >=65 years of age
MOI	High velocity fall, fall from height(40, 45, 55, 59, 67, 71, 78, 79, 86, 87) or high level(63) impalement injury.(88)	Fall from sitting, standing (45-47, 89-92) or the same level.(52, 54, 63, 93) a higher proportion of women than men experienced a fall from height during leisure time (48% vs. 33%).(92)	Fall height is shown to be a significant predictor of mortality (HEMS).(72)	Frequently fall, (9, 51, 63, 81, 82, 85, 94-96) from ground level,(40, 42) trips,(52, 53) slips,(52-54, 97) standing,(44, 46, 47, 53, 55, 62, 64, 80, 91, 98, 99) low level falls or stairs,(68, 91) Slips and trips were the most common mechanism of falls requiring hospitalisation (52%),(66) and spinal injuries.(51)
Types of injuries	Blunt-cut, luxation or contusion, (63) head injury and tonic-clonic seizure.(87)	Excoriation or fracture.(63)	Thoracic injury after a fall from height,(57) fracture,(67),(76) extremity fractures(100) extremity injuries,(76) chest or abdominal wall contusion,(76) TBI,(101) pelvic ring injuries,(74) amputation,(76) laceration/ contusion,(76) major trauma,(102) spinal injuries.(45, 61)	TBI from low velocity standing level falls,(103) hip/pelvis injuries(9, 42, 47, 54, 60, 62, 64, 86) and fractures,(50, 83, 93) falls on the same level commonly caused head or face injuries, upper extremity injuries, hip or lower extremity injuries,(62) major trauma,(104) spinal cord injury from a low fall,(56) fractures accounted for 57% of injurious hospitalisations.(66) **Older men:** skin tear/flap, abrasion, laceration,(10) vertebral fracture,(105) head and neck pain,(106) head laceration.(107) **Older women:** bruise, suspected fracture or pain only,(10) females of all ages had higher rates of hospitalisation for injurious falls, particularly for upper and lower limb fractures, including hip fractures, (63, 66) haematoma.(106)

	Male	Female	Adults >=16 years and <65 years of age	Older adults >=65 years of age
Injury location	Head, face or skull,(55, 63) or neck, (55) maxillofacial trauma.(108)	Neck, abdomen, pelvis, back, upper and lower limbs.(63)		Spine,(60) and pelvis. (9, 42, 47, 50, 54, 60, 62, 64, 83, 86, 93) **Older men:** head and face, neck, arm and hand,(10) maxillofacial trauma was most common in adults 70+ years old.(108) **Older women:** chest, pelvis, hip, leg or foot.(10)

MOI: Mechanism of injury, HEMS: Helicopter emergency medical services, TBI: Traumatic Brain Injury

Table 4.2
Prehospital interventions in ambulance-attended falls patients

	Adults >=16 years and <65 years of age	Older adults >=65 years of age
Life support	Rapid sequence intubation,(55, 87) intubation,(71) IV line,(86, 87) procedures*,(84, 109) blood transfusion,(55) thoracostomy,(55) oxygen,(79, 110) fluid resuscitation,(88) the commencement of resuscitation was more likely when the MOI was a fall compared with a motor vehicle collision.(111)	Oxygen,(91) placement of definitive airway,(91) BLS,(112) ALS,(112) or both BLS and ALS,(112) intravenous fluids.(107)
Medications and dressings	Analgesia,(47, 88, 100, 113) beta blockers, refused analgesia,(87) medications*,(84, 109) cardiac arrest medications*,(84, 109) sedation,(113) and intravenous paracetamol, ketamine and fentanyl,(113) morphine,(109) pain control,(45)	Analgesia,(93) wet dressing and bandage.(107)
Immobilization	Immobilisation*,(41, 45, 51, 60, 79, 114) pelvic binder,(87) long spine board,(41) cervical collar,(41, 45) spinal precautions,(110) PCCDs,(74) halo,(45) thoracic-lumbar spinal orthosis,(45) lumbar spine corset,(45) immobilized patients were more likely to be involved in high falls.(60)	Immobilisation,(107) Spinal precautions,(46, 56) cervical collar,(91, 107) backboard,(91) rigid cervical orthosis,(90) scoop stretcher,(107) more than half of non-immobilized patients had a low fall with the majority being older than 55 years.(60)
Lifts and extractions	GEMS lift assist,(53) HEMS extraction via seat,(115) net,(115) bag,(115) scoop,(87) improvised packaging,(87) back board and spider straps,(79) single sling harness.(97)	GEMS Lift assist,(53, 65, 99, 116) lift assist and not conveyed.(89, 99, 117, 118)

*A broad term used by the referenced study to describe a group of interventions
GEMS: Ground emergency medical services, MOI: Mechanism of injury, BLS: basic life support, ALS: advanced life support, PCCD: pelvic circumferential compression device.

Table 4.3

Disposition of ambulance-attended patients who had fallen

	Adults >=16 years and <65 years of age	Older adults >=65 years of age
Transported	GEMS,(40-43, 47, 49, 60, 61, 63, 69, 71, 75, 76, 84, 101, 110, 111, 114, 119-122) non-urgent transport to hospital,(123) GEMS to MTC,(102) HEMS extraction(69, 72, 79, 87, 113, 115, 124, 125) and direct transport to a trauma centre(55, 57, 86) or MTC,(55) HEMS univariate analysis showed that the following characteristics were not associated with inappropriate HEMS transport: gender, blunt/penetrating mechanism, transport agency, transport time, and injury mechanism other than fall (P = .008).(126) Compared with GEMS, patients transported by HEMS were characterized by having a greater injury severity, (69) Equestrian accidents represent a significant proportion of HEMS missions,(125) falls <2m: more likely to be transported to a trauma unit,(103) falls >1m more likely to be adult (mean age 44 years) and transported following SCI.(56) Falls >2m: more likely to be transported to a MTC.(103)	GEMS,(7, 8, 10, 46, 51, 64, 66, 92, 95, 104-107, 116, 127-132) urgent,(38) time critical,(8) acute not time critical,(8) not urgent, (8, 38) lift assistance,(133) repeated transports,(134) HEMS,(97) to ED,(4, 90, 135) more likely to be transported to a trauma unit than a MTC post TBI,(103) transported to trauma centre,(91, 112, 136) transported to non-trauma centre,(136) more likely to be transported if from a nursing home than from community.(96, 137) Geriatric patients are 1.8 times more likely than younger adults to be transported for an injury resulting from a fall.(138) Older patients, low-energy trauma, and minor injury severity had the most pronounced survival benefit when rescued by HEMS.(59) Falls <1m more likely to be an older adult (mean age 70 years) and transported following SCI.(56)
Non-transported	Refusal to travel,(53, 139) reported attendances only,(9, 100) non-conveyance,(42, 70, 139) discharge at scene rates were higher for older patients, men, patients calling out of hours, where the reason for calling was falls, calls categorised as non-emergency, patients calling from areas of social deprivation, and patients' attended by paramedics with extended skills.(140)	Not-transported, (4, 7, 8, 10, 39, 127) lift assistance,(89, 99, 117) assistance only,(141) refusal to travel,(53, 94) refused treatment and transport,(7) treated on scene,(7, 80, 128, 129) non-conveyance(70) from nursing home compared to community,(81, 142) reported attendance only,(135, 143) referred to community based social services,(118) no treatment required,(7) the majority of older adults who refused transport received follow-up care, with a significant number requiring hospital admission at the time of their follow-up.(94)

	Adults >=16 years and <65 years of age	Older adults >=65 years of age
Re-attendance	-	Re-attendances,(8) lift assistance with re-attendance,(99, 135) multiple re-attendances,(39, 83, 135) avoiding re-attendance using ECPracs,(80) subsequently transported.(8, 141)
Alternate care referral pathways	Non-conveyance due to referral to other health care facilities,(70) secondary triage of low acuity patients.(122)	Alternate care referral pathways to: primary care review,(80) CRS direct from paramedic,(52) community based social services and not transported,(118) non-emergency care staff,(127-129, 144) GP.(54)

GEMS: Ground emergency medical service, HEMS: Helicopter emergency medical service, MTC: Major trauma centre, SCI: spinal cord injury, ED: Emergency Department, CRS: community rehabilitation service, GP: General practitioner.

4.2.2 Updated Literature Review

The initial literature search strategy captured relevant literature published no later than 1st August 2021. To provide an up-to-date literature review, this search strategy was re-run on [22nd September 2023] and all additional relevant studies from 1st August 2021 until 22nd September 2023 were included for review. The updated search conducted 22nd September 2023, used the same inclusion criteria and search strategy. A total of 2,049 titles and abstracts were retrieved, and 115 duplicates were removed. Sixteen additional sources meet these criteria,(23, 34, 145-158) five of which address the gap previously reported in our scoping review, namely non-transport and alternative referral pathways.(145-147, 153, 155) The 16 newly identified sources are presented in Table 4.4.

Table 4.4
Studies identified in the updated literature search: ambulance-attended adults who fell

#	Reference	Country	Study design	Sample	Prehospital management reported
1	Charlton, 2022[145]	England	Cross-sectional study	426	Identifying predictors of conveyance to emergency departments and appropriateness of a fall's rapid response service to older adults who fall.
2	Charlton, 2023[146]	England	Cross-sectional study	1,091	The falls rapid response service is clinically effective regarding falls compared to standard ambulance crews.
3	Chiang, 2022[147]	Taiwan	Prospective study	54	Emergency Medical technicians evaluating home environmental falls risk and hazards.
4	Heinonen, 2022[148]	Finland	Retrospective cohort study	9,834	One-third of EMS missions did not result in patient transport to the hospital. Abnormalities in multiple respiratory-related vital signs were associated with an increased likelihood of death within 30 days
5	Jeruzal, 2022[23]	USA	Retrospective observational study	9,652	Falls that occur in public locations, in patients with a previous fall, or result in no clinical detection of apparent illness or injury have a significantly increased odds of non-transport.

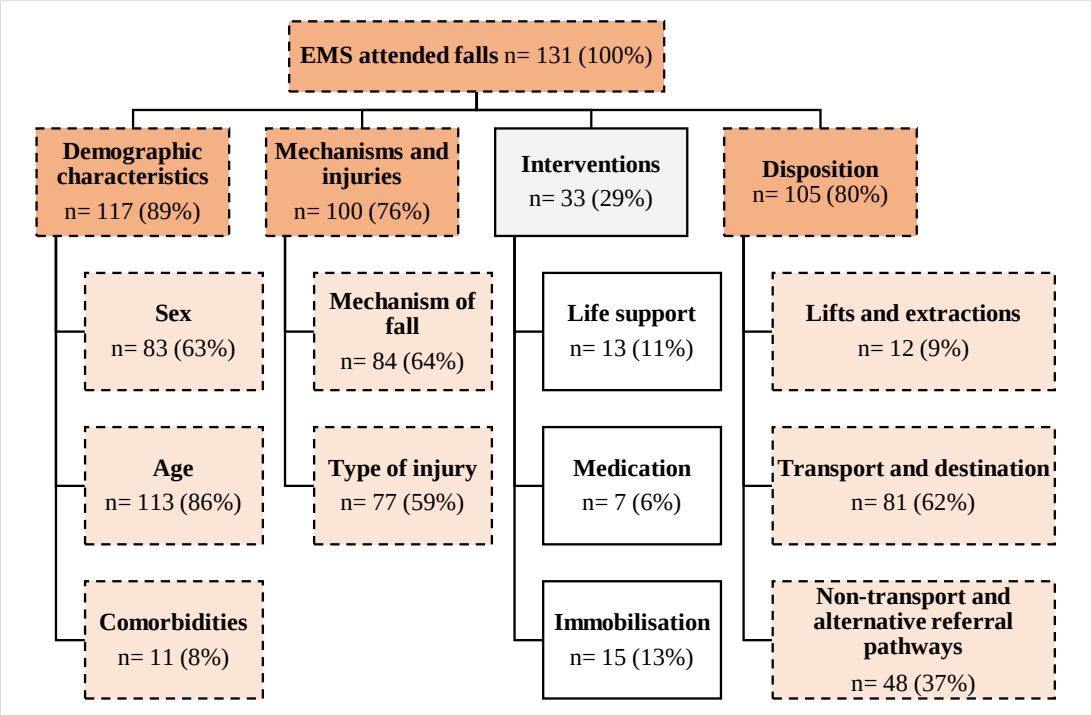
#	Reference	Country	Study design	Sample	Prehospital management reported
6	Joiner, 2022[149]	USA	Retrospective study	195,204	Males, older age groups, and Hispanic/Latino patients had higher odds of non-transport among this population of community-dwelling adults aged 60 or greater.
7	Kasvi, 2023[150]	Finland	Pilot study	15	Non-conveyance, referral and alternative health care pathways.
8	McKay, 2023[151]	Canada	Retrospective record review	142	The majority (85%) of calls resulted in transport to the hospital; the notable exception was fall-related events, and of these falls, a third (32%) were treated at home.
9	McManamny, 2022[152]	Australia	Retrospective cohort study	1,199	Older adults from rural Victoria have high rates of emergency ambulance attendance and transportation to an emergency department.
10	Mikolaizak, 2022[153]	Australia	Retrospective cohort study	221	Non-transported fallers have a high risk of future health service use for fall and other medical-related reasons.
11	Nicholson, 2022[154]	England	Qualitative study	10	Paramedics conveyance decisions for older people are complex in nature and may serve as a basis for developing an intervention to safely decrease emergency department conveyance.
12	Quatman-Yates, 2022[155]	USA	Quality improvement initiative	892	Community-FIT may offer a powerful mechanism for community paramedics to reduce fall-related transports to hospital.
13	Rundle, 2023[156]	USA	Retrospective methodology study	1,780,371	The occurrence of outdoor fall injuries.
14	Schultz, 2023[157]	Australia	Retrospective analysis	415	Open limb fractures are a relatively infrequent injury presentation encountered by ambulance clinicians.
15	Tohira, 2022[34]	Australia	Retrospective methodology study	1,648	Machine-learning models incorporated with features generated by natural language processing improved the performance of classifying fall cases compared with models without such features.
16	Tohira, 2022[158]	Australia	Retrospective cohort study	69,916	Dementia is common amongst older adults attended by paramedics and is associated with higher ambulance utilization per person.

EMS: Emergency Medical Services

Eight sources focused solely on the reporting of falls,(23, 34, 145-147, 149, 155, 156) while the other eight had a sub-group of people who had fallen.(148, 150-152, 154, 157, 158) Two relevant literature reviews were identified in the search and report on physical and clinical outcomes in older people requiring an ambulance following a fall,(159) and paramedicine scope regarding falls amongst older adults in rural and remote communities.(160) Prehospital falls literature has identified patients with a high risk of future health service use,(151, 153, 159) and interventions to facilitate the prehospital management of patients who fall.(145-147, 153, 155, 159, 160) The development of specific prehospital guidelines and interventions has the potential to alleviate the growing demand EMS experience, attending and managing falls.

Figure 4.2 presents the additional information that the 16 newly identified sources added to the literature review. This figure highlights how prehospital interventions remain an area yet to be explored in depth.

Figure 4.2
An updated map of themes reported by each included study and sub-theme present within each



Note: The highlighted boxes with dotted borders draw attention to the updates made following the updated scoping review findings.

4.3 Supplementary Material

Given that 115 sources were included in the final scoping review, the data summary tables presenting the *Evidence summary of sources meeting the inclusion criteria*, and the *Characteristics of included sources* accounted for 173 pages, and were provided as supplementary material to the published scoping review. They are not included in full in this thesis, but for illustrative purposes, Supp Table 4.1 and Supp Table 4.2 provide excerpts from each of these summary tables.

Supp Table 4.1
[Excerpt Only] Data table: Evidence summary of sources meeting inclusion criteria

Citation	Aim	Design	Sample (Falls)	Patient characteristics	MOI and Injuries	Interventions	Disposition
Carpenter, 2013	This study provides a demographic analysis of hoist rescue operations per-formed by the only FAA Part 135 hoist-approved civilian HEMS operator in the United States.	Retrospective descriptive study	82	All persons hoisted between May 29, 2001, and May 28, 2011	The most common indications were fall injuries (82/214, 38%). (6/214, 2%) - "fall from horse"	82 hoist rescues using 'Seat', 'Net' and 'Bag' rescue	HEMS extraction
Fair, 2012		Case study	1	90-year-old woman	Patient found lying on bed-Room floor, large hematoma with discoloration above the left eye. Patients awake and able to speak, no memory of fall.	Spinal precautions were implemented by EMS	Transported via EMS
Fitzharris, 2012	The aim was to determine the level of, and factors associated with, adherence to the prehospital trauma triage criteria for urban patients transported in New South Wales, Australia.	Retrospective study	2121	Persons injured by falls (2121) accounted for 22.7% of all P4 qualifying patients. P4 = ≥3m fall Males: 5556 (59.5%) Mean age: 39.4 (SD: 24.2)	Injured persons who sustained a traumatic injury who met the P4 triage criteria		Transported by road directly from the scene of injury to hospital with an urban area

MOI: Mechanism of injury

Supp Table 4.2

[Excerpt Only] Characteristics of included sources

No.	Citation	Country	Title	Results/ conclusions
2	Carpenter, 2013	USA	A 10-year analysis of 214 HEMS backcountry hoist rescues	Male victims, falls, and summer rescues rep-resent a majority of hoist operations. Most patients requiring a hoist were transported to a hospital for definitive care.
3	Fair, 2012	USA	Accurate Triage and Specialized Assessment Needs of the Geriatric Trauma Patient Who Experiences Low-Energy Trauma	Injuries occurring in the younger adult that pose little risk or short recovery times cannot be categorized or triaged in the same way for the older adult patient. Geriatric injury patients presenting to the emergency department require an adapted specialized needs assessment by healthcare workers proficient in complications and risks specific to this vulnerable population.
7	Fitzharris, 2012	Australia	Adherence with the pre-hospital triage protocol in the transport of injured patients in an urban setting	Analysis indicated that female gender, increasing patient age, patients classified as having had a fall, where the qualification level of treating officer–Levels 3, 3C and Level 4 relative to Level 1 and Level 5 officers, were factors associated with significantly lower levels of protocol adherence with respect to hospital destination. Injured persons who sustained a traumatic injury and transported by road directly from the scene of injury to hospital with an urban area–and who met the P4 triage criteria, were the subject of analysis.

Supp Table 4.3 presents the inclusion and exclusion criteria used during the title, abstract and full text review in the scoping review. Supp Table 4.4 presents the contents of each executed search strategy and the date they were run.

Supp Table 4.3
Inclusion and exclusion criteria for scoping review

	Inclusion	Exclusion
Population	Adults	Only children
	Attended by an ambulance	GP patient papers
	Fall	Non-fall injuries
	Outside of hospital	In hospital/nursing home
Context	Attended by ambulance	Not attended by ambulance
	Transportation by ambulance	
Concept	Ambulance re-attendance	Patient satisfaction
	ED presentation	Emergency Department studies
	Hospitalisation	Fall prevention programs,
	Mortality	The financial burden of falls,
	Epidemiology of patients	Patients who fall in hospital,
	Characteristics of patients	Newspaper articles
	Nature of injuries/observations	Blogs
	Interventions received	Suicide
	Reported disposition	
	Non-transportation	
	Alternate care pathways	
Types of sources	Primary sources of information	Non-English
	Case reports	

Inclusion: Falls from …	Exclusion: Falls from …
Balconies + bridges	Suicides
Horses	Kicked by horses
E-bikes	Petrol powered motorbikes
Stationary vehicles	Moving vehicles
Mobility scooters	Golf karts
Intoxicated/drug-affected	Assaults
Fall followed by syncope	Syncope followed by fall
Slipping off chairs	Lowering self to ground
Attempting somersault/backflip	Sports

Supp Table 4.4
Search strategies executed 1st August 2021 for Scoping Review

Line	Search Strategy	Number.
Scopus search strategy (first executed 27.03.2020)		
1	(TITLE-ABS-KEY (Fall OR Fell)) AND (TITLE-ABS-KEY (ambulance OR EMS OR "emergency medical services")) AND (LIMIT-TO (LANGUAGE, "English"))	2,071
	executed 28.07.2020 *Update search: published 2020* *(50 more articles since last search – 19 duplicates will be in this search of 69 exported articles)*	69
	executed 01.08.2021 *Update search: published 2020 – current*	233
CINAHL search strategy (first executed 27.03.2020)		
1	ambulance or EMS or emergency medical services	39,730
2	MM "Emergency Service"	31,584
3	MM "Ambulances"	2,708
4	fall or fell	61,849
5	MM "Accidental Falls"	15,080
6	S1 OR S2 OR S3	69,727
7	S4 OR S5	61,849
8	S6 AND S7	1,222
	Update search: 27.03.2020 – 28.07.2020	13
	Published in 2020 – current	161
Medline (Ovid) search strategy (first executed 27.03.2020)		
1	Exp Ambulances/	8,551
2	Exp Air Ambulances/	2,705
3	Ambulances.mp.	9,378
4	(Ambulance* or EMS or "emergency* medic* service*").mp.	61,623
5	Exp Emergency Medical Services/	137,217
6	1 or 2 or 3 or 4 or 5	148,786
7	Exp Accidental falls/	23,666
8	(Fall* or fell*).mp.	328,004
9	7 or 8	328,004
10	6 and 9	4,106
11	Emergency Medical Technicians/	5,656
12	("emergency medic* tech*" or EMT or paramedic*).mp.	34,060
13	Exp "Transportation of Patients"/	16,325
14	11 or 12 or 13	48,814
15	10 and 14	432
	Update search: 27.03.2020 – 28.07.2020	5
	Published in 2020 – current	31

Line	Search Strategy	Number.
ProQuest search strategy (first executed 27.03.2020)		
S1	fall* or fell*	91,270,629
S2	ambulance*	3,043,749
S3	EMS or "emergency medical service"	836,021
S4	EMT or "emergency medical technician"	338,348
S5	paramedic*	1,379,992
S6	2 or 3 or 4 or 5	4,926,254
S7	1 and 6	1,138,924
S8	1 and 2 and 3	26,016
S9	8 and 5	
S10	2 and 3 and 1 and 4 and 5	2997
S11	Limited to ProQuest Central due to Database restrictions "in “Export Results”	2624
	Update search: 27.03.2020 – 28.07.2020	5
	Published in 2020 – current	31
EMBASE (Ovid) search strategy (first executed 28.07.2020)		
1	Exp Ambulance/	14,177
2	(Ambulance* or EMS or “emergency* medic* service*”).mp.	42,572
3	Exp Emergency Medical Services/	101,482
4	Ambulance*.mp.	19,940
5	1 or 2 or 3 or 4	126,888
6	Falling/	40,502
7	5 and 6	1,197
	Published in 2020 – current	154
Cochrane search strategy (first executed 28.07.2020)		
1	MeSH descriptor: [Ambulances] in all MeSH products	151
2	MeSH descriptor: [Emergency Medical Services] explode all trees	3,786
3	MeSH descriptor: [Accidental Falls] explode all trees	1,447
4	(Emergency medical services OR Ambulance OR Paramedic)	4,099
5	(Accidental falls OR fall OR falls)	19,883
6	#1 or #2 or #4	6,597
7	#3 or #5	19,883
8	#6 and #7	442
	With Cochrane Library publication date in the last year	46

4.4 Summary of Chapter Findings

The evidence regarding the patient characteristics, injuries sustained, prehospital interventions and patient disposition of ambulance-attended adults who fell, is synthesised in this chapter and scoping review. The aim was to map and synthesise the available evidence to identify knowledge gaps and propose recommendations for further research of EMSs management of falls in the prehospital setting.

After determining that 89% of sources reported on demographic characteristics, 76% reported on injuries and injury mechanisms, 29% reported on prehospital interventions and 80% reported on disposition, the implications of this were discussed. Prehospital interventions including life support, medication, immobilisation and lifts and extractions, were sparsely reported on and require further exploration. The non-transport of adults who fall and the use of alternative referral pathways in the prehospital setting were inconsistently identified, reported or used globally. The identified knowledge gaps led us to propose two primary recommendations: 1) Prehospital interventions should be clearly reported in published literature, and 2) Policy and CPGs that inform transport decision-making, and alternative referral pathways should be described clearly.

To explore what prehospital interventions were available, to report their use, and to inform prehospital CPGs in the management of falls, a thorough understanding of falls management in the prehospital setting was required. This led to the development of a state-wide retrospective cohort study to gain an in-depth understanding of patients who fall and require an ambulance in WA. The next chapter presents the epidemiology of ambulance-attended adults who fell between 2015 and 2021 as a state-wide retrospective cohort study.

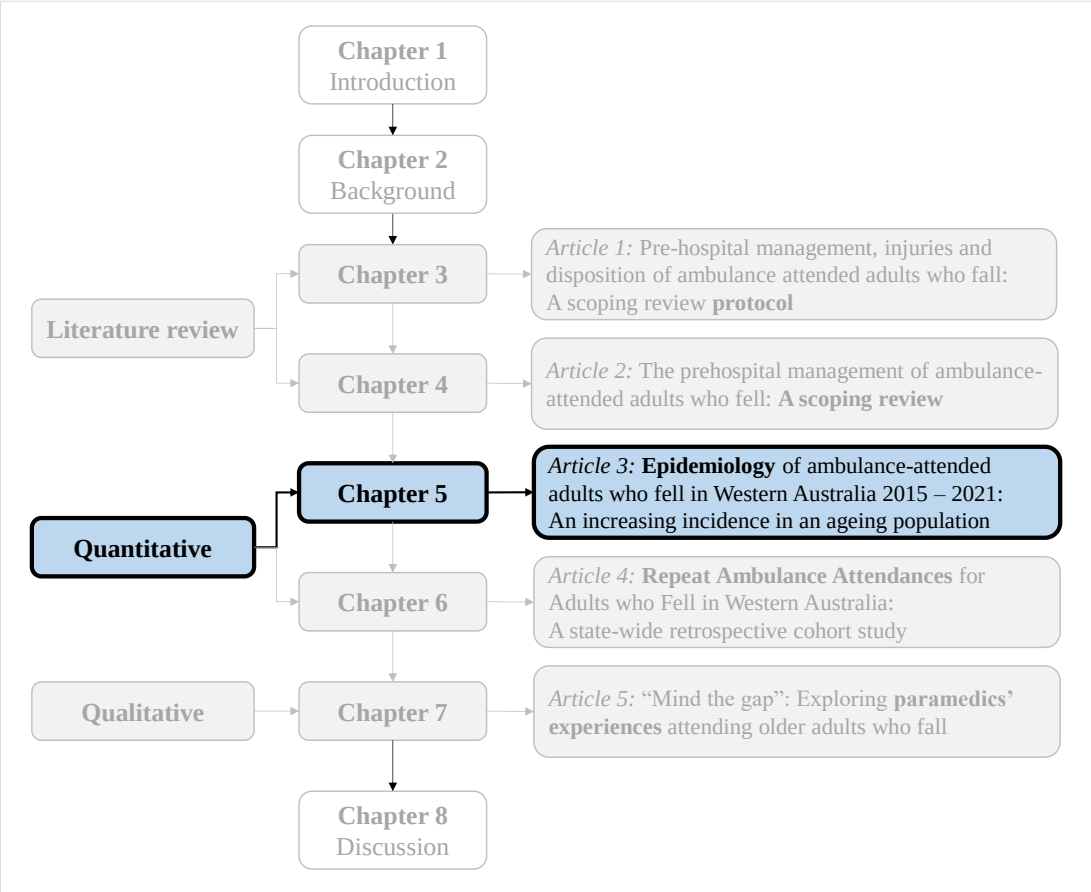
Chapter 5

Epidemiology of Falls

5.1 Overview

This chapter describes the epidemiology of all ambulance-attended adults who fell in WA over a seven-year period (January 1st, 2015, and December 31st, 2021). The aim was to describe the incidence rate and characteristics of ambulance-attended falls in WA, including fall-related injuries, prehospital interventions delivered, and disposition (including transported to a hospital or otherwise) using St. John Western Australia (SJWA) ambulance data. The findings are reported in a manuscript, peer-reviewed and published in *Injury*.

Thesis Context



Article 3 Epidemiology of Ambulance-attended Adults Who Fell in Western Australia 2015 – 2021: An Increasing Incidence in an Ageing Population

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Injury

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Epidemiology of ambulance-attended adults who fell in Western Australia 2015 – 2021: An increasing incidence in an ageing population

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ABSTRACT

Background: Emergency Medical Services (EMS) are attending an increasing number of adults who fall. This study aimed to describe the incidence, patient characteristics, treatments and disposition of ambulance attended patients who fell in Western Australia (WA).
Methods: An ordinal logistic regression (using STATA) was conducted in this retrospective cohort study, analysing predictors of lower compared to higher transport urgency levels. Participants were adults (≥ 18 years) who fell and required ambulance attendance in WA between 1st January 2015 – 31st December 2021.
Results: A total of 188,720 patients (female – 107,811, 57 %) were attended by ambulances after falls, (median age – 80 years [IQR 67–87]). The age-standardized incidence rate of ambulance attended falls increased from 115 cases/100,000 person-years to 161 cases/100,000 person-years between 2015 and 2021. A total of 89,140 (47 %) patients had an injury recorded by paramedics, most often lacerations or suspected fractures. The electronic patient care record showed, 50,044 (26.5 %) patients received medication and 30,954 (16.4 %) patients received other intervention, e.g., ECG. A total of 148,050 (78 %) patients were transported to hospital with the following urgency levels: 2,371 (2 %) via urgency one; 27,882 (19 %) via urgency two, 93,447 (63 %) via urgency three and 22,584 (15 %) via urgency four and five (< 1 % unknown urgency). Positive predictors of lower level transport urgency to hospital included being female and older than 65 years of age.
Conclusion: Older, female patients had higher odds of being transported via a lower urgency, with 50 % of this cohort transported via urgency three. While 19 % of patients were attended via a Priority one, only 1 % were transported to hospital via urgency one. The incidence rate of falls requiring ambulance attendance has increased over time, increasing the demand placed on EMS annually.

Background

The risk of a fall increases with age, immobility and frailty as does the risk of consequent morbidity and mortality [1–3]. Adults aged 65 years and over (older adults) account for the greatest number of fatal falls globally [2], with 37 million falls requiring medical attention each year [2]. Emergency Medical Services (EMS) are responding to an increasing number of older adults who fall, at least in part likely due to an ageing population [4–7].

When responding to an individual who has fallen, the objectives of EMS is to provide interventions to alleviate symptoms and/or prevent further deterioration and, where necessary, to transport the patient to the hospital. Patient management is largely based on the underlying causes of falls and/or the injuries sustained [8]. Falls can be caused by intrinsic factors, e.g. poor balance, or by an acute medical condition like stroke, or by extrinsic factors, e.g. environmental conditions, causing slips and trips [4]. Fall-related injuries can vary from none to life-threatening, including lacerations or fractures, and tend to increase

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in severity with age [2,4,5,9,10]. Falls can result in major injury or be the presenting symptom of an acute systemic medical event, so it is crucial that EMS ascertain when it is appropriate to urgently transport patients to the hospital [11]. Prehospital referrals to other community services are commonly utilized in the UK [12], but are less common in the Australian prehospital setting [5,11].

Non-transport rates of older adults who fall are shown to vary from 11 to 56 % between the UK, USA and Australia [13]. Potential negative outcomes associated with non-transport of older adults include subsequent increases in unplanned health-care use, i.e. EMS re-attendance, self-presentation to an emergency department (ED), hospitalizations and even death [13–15]. Ambulance attendances for older adults are frequently due to falls, and often involve low acuity presentations with no injury that potentially do not require transport [13–15].

This study investigated ambulance-attended falls in Western Australia (WA). The aims of the study were to: 1) describe the characteristics of patients attended; 2) estimate the crude, and age-standardized incidence rates; 3) identify the prevalence of injuries sustained; 4) describe prehospital interventions used in the management of patients; 5) summarize the frequency of the disposition of patients attended; and 6) determine patient and fall characteristics associated with low transport urgency.

Methods

Study design and participants

This retrospective cohort study included all patients attended by St John Western Australia (SJWA) ambulance service, who were aged ≥ 18 years and described as having experienced a fall between 1st January 2015 and 31st December 2021. This study was approved by the Curtin University Human Research Ethics Office (HR128/2013–69) and SJWA Research Governance Committee [approved 11th March 2022].

Setting

St John WA is the sole provider of road-based EMS in the state of WA, covering the largest area of any single ambulance service in the world [16,17], employing approximately 770 paramedics in the Perth metropolitan area, 3200 volunteer emergency medical technicians (EMT) and 90 paramedics in country WA [16,17]. No referral pathways to alternative healthcare are currently available to EMS staff in WA when managing patients who fall.

Data sources and collection

Data were obtained from SJWA ambulance electronic patient care records (ePCR) and ambulance dispatch data. Falls were identified by the Medical Priority dispatch System dispatch code and by searching free-text records [18] within the ePCR data, in which paramedics described each patient's relevant history and conditions. The following operational definition of falls was used: falls from balconies, bridges, e-bikes, stationary vehicles, mobility scooters, intoxicated/drug-affected falls, or slipping off chairs. We excluded falls resulting from suicide attempts, motorcycles, moving vehicles, golf karts, assaults, lowering self to the ground or sports.

The following information was collected from the ePCR and dispatch data: patients' demographic details (age, sex); dispatch priority determined by ambulance dispatchers (from 1 to 3: 1 for highest priority and 3 for lowest priority); problem code (the primary issue defined by the attending EMT/paramedic); if the patient received a backup ambulance, repeat attendances, clinical information (temperature, pulse rate, respiratory rate (RR)/dyspnoea, systolic (SBP) and diastolic blood pressure), examination text (paramedics written notes of attendance), Glasgow coma scale (GCS), oxygen saturation, electrocardiogram (ECG) derived variables (e.g. pulse), injuries sustained, injury location, pain score (0–10), blood sugar level, medications administered (time, dose, route of administration, effect); other interventions (type, effect). We computed triage revised trauma scores (tRTS) as a surrogate measure for patients' physiological condition severity level [19]. The tRTS in the prehospital setting helps to assess the severity of trauma patients, provides a reliable prediction for the state of the patient and for predicting anatomical injury severity. This also provides validation to the transport decisions of EMS staff. We used the first measured values of SBP, GCS, and RR recorded on the ePCR to compute tRTS. Each value was coded, ranging from zero to four, based on its value. The coded values of the SBP, GCS, and RR were then summed to yield the tRTS, from '0' to '12' per patient [19].

Patient disposition (patient transported to hospital or not), was extracted as well as the transport urgency level, determined by paramedics/EMTs at the scene, which ranged from 1 to 5 (1 for most, and 5 for least urgent), and transport destination (levels according to the WA trauma service role delineation and trauma service organizational chart [20]). Before modeling, we re-categorized transport urgency into four categories (1, 2, 3, 4&5) by combining urgency 4 and 5 and excluding urgency 6 (inter-hospital transfers) [21]. Urgency 4 and 5 were combined due to their similarly defined clinical meanings on the Australasian triage scale. The regression model analyzed predictors of lower compared to higher transport urgency levels, categorized as Cut1, urgency 1 vs. 2,3,4&5; Cut2, urgency 1,2 vs. 3,4&5; Cut 3, urgency 1,2,3 vs. 4&5.

Data analysis

Descriptive statistics summarize the characteristics of patients who fell. The age and sex of all patients and all injured patients are graphically presented in a butterfly plot (Tornado chart) constructed using Microsoft Excel (Microsoft, Redmond, Washington). The relationship between age, sex and injured status was assessed through univariate logistic regression. A Kutools count of the number of a word's appearances was conducted on the examination text of all patients for prehospital intervention terms (electronic lifting cushion (ELK) and Camel (air-powered cushions designed to inflate and gradually lift a person who has fallen), extraction, assistance, floor, hoist, lift, lift assistance, lift assistance only, lift only, pick up, scoop, and stretcher) to ensure all interventions were captured.

We computed crude annual incidence of ambulance-attended falls using annual WA population estimates from 2015 to 2021. We computed age-standardized incidence rate by the direct method using the Australian standard population in 2001 [22]. MedCalc (MedCalc Software Ltd, Ostend, Belgium) was used to compute the incidence rate ratio and incidence rate difference in ambulance-attended falls across the seven year study period [23]. We derived a multi-level mixed-effects ordered logistic regression model to identify factors associated with transport urgency. We included those patients who were transported to ED and excluded those who were not transported. We used the mixed-effects model because multiple patients had ambulance attendances multiple times, and a new variable 'patientID' was developed to group patients who appeared in the data multiple times. A likelihood-ratio test was included in the model to confirm that there was enough variability between patients to favor a mixed-effects ordered logistic regression over a standard ordered logistic regression. We then modeled transport urgency as a function of sex, age, reported injury, first GCS, year, and dispatch priority attendance by using a two-level ordered logistic model with random effects at the person level (patientID: accounting for repeat appearances in data). Independent variables were assessed to ensure an absence of confounding in the model, by comparing the crude to the adjusted coefficient and calculating the change in the estimated regression coefficient. If the calculated change in the independent variable was > 15 %, we concluded possible confounding. Data analysis was performed using STATA statistical software version 17.0 (College Station, Texas). In all cases, significance was accepted at $p < 0.05$.

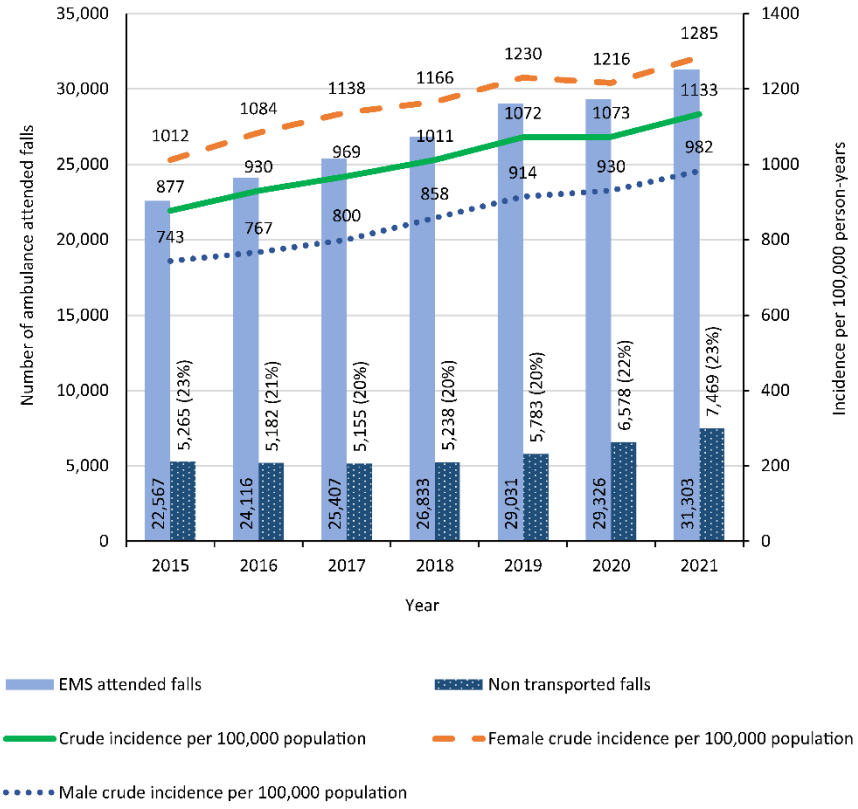

Fig. 1. Number of ambulances attended adult patients who fell, and crude incidence per 100,000 person-years, by calendar year.

Results

There were 1404,856 emergency ambulance attendances during the study period, of which 188,720 (13.4 %) were identified as responding to falls by adults. Ambulance-attended adults who fell accounted for 6.6 % of the overall EMS workload in WA. The number of falls increased each calendar year and the crude incidence rate of falls for females was consistently greater than that for males during each year of the study period (Fig. 1).

Characteristics of patients attended by SJWA in response to falls (Objective 1)

The median age of patients was 80 years [IQR 67–87 years], with female patients ($n = 107,811$) being 57 % of the cohort, (Table 1). Females were older (median age, Females: 81 [69–88], vs. Males: 78 [64–86]) and had a higher crude incidence rate of falls than men (Fig. 1). Most patients were attended via a priority 2 ambulance response (Table 1). A significant association was identified between the sex and age category in both the uninjured ($p < 0.001$) and injured patients ($p < 0.001$) (Fig. 2). The majority of patients had a calculated tRTS of 12 ($n = 159,685$, 85 %), 4 % had a tRTS of 11, 2 % had a tRTS of 9–10, 7 % had a tRTS of 8, and the final 2 % of patients were distributed between tRTS 0–7. Of all patients with a tRTS of 12, 126,748 (79 %) were transported. Of the 13,000 patients with a tRTS of 8, 10,014 (77 %) were transported.

The incidence rate of ambulance-attended falls (Objective 2)

The overall crude incidence of ambulance-attended falls increased from 877 to 1133 per 100,000 population from 2015 to 2021 (Table 2), and the cumulative incidence increased by 4.6 % over the study period. The crude incidence of ambulance-attended falls increased in females and males between 2015 and 2021. The age-standardized incidence rate for all ambulance-attended adults who fell; all patients with an injury; and all adults ≥ 65 years of age increased between 2015 and 2021.

The incidence rate ratio and incidence rate difference between ambulance-attended falls in 2015 ($n = 22,567$, estimated pop = 2547,745) to 2021 ($n = 31,303$, estimated pop = 2762,234) were as follows [24]: the incidence rate difference (−1:404, 95 % CI −1:378, −1:434) between the two rates 2021 (1:88) – 2015 (1:11) was significant ($p < 0.001$). The incidence rate ratio for 2015/2021 = 0.7816, (95% CI 0.7683, 0.7951) ($p < 0.001$).

Frequency of injuries sustained by adult patients who fell in WA (Objective 3)

Patients with a reported injury were frequently older adults with 76,831 (88 %) ≥ 50 years of age and 60,314 (69 %) ≥ 70 years of age, with a median age of 79 years [IQR 65–87 years], (Table 3). The odds of a female having a reported injury were 1.18 times as high (95 % CI 1.15, 1.20, $p < 0.001$, $z = 17.23$) as males, on average. Across the seven years,

Table 1
Patient demographic, dispatch and transport information of all ambulance attended adults who fell in WA between 2015 – 2021.

	18 – 64.9 years		65 – 74.9 years		75 – 84.9 years		85 + years		Total	
	n	%	n	%	n	%	N	%	n	%
male sub-total	**20,380**		**13,602**		**22,352**		**23,562**		**79,896**	
dispatch priority										
1	7255	36	3257	24	4388	20	4188	18	19,088	24
2	9665	47	6499	48	11,261	50	12,591	53	40,016	50
3	3423	17	3824	28	6657	30	6753	29	20,657	26
4	37	<1	22	<1	46	<1	30	<1	135	<1
Transported	16,630	82	10,124	74	16,928	76	18,259	77	61,941	78
Transport urgency										
1	611	3	275	2	306	1	229	1	1421	2
2	4629	23	2316	17	3254	15	2979	13	13,178	16
3	9193	45	6118	45	10,582	47	11,882	50	37,775	47
4	1941	10	1259	9	2504	11	2835	12	8539	11
5	138	1	93	1	151	1	178	1	560	1
6 [a]	30	<1	21	<1	45	<1	49	<1	145	<1
Unknown	88	<1	42	<1	86	<1	107	<1	323	<1
Transport destination										
MTC	3708	18	1389	10	1938	9	2036	9	9071	11
TTS	4513	22	2979	22	4989	22	6231	26	18,712	23
ED	8337	41	5705	42	9934	44	9941	42	33,917	42
Unknown	72	<1	51	<1	67	<1	51	<1	241	<1
Not transported	3750	18	3478	26	5424	24	5303	23	17,955	22
female sub-total	**20,626**		**15,901**		**29,538**		**41,682**		**107,747**	
dispatch priority										
1	4684	23	2387	15	4137	14	5817	14	17,025	16
2	11,272	55	8347	52	16,175	55	23,871	57	59,665	55
3	4643	23	5133	32	9164	31	11,916	29	30,856	29
4	27	<1	34	<1	62	<1	78	<1	201	<1
Transported	17,035	83	11,934	75	22,704	77	33,668	81	85,341	79
Transport urgency										
1	251	1	165	1	240	1	292	1	948	1
2	3654	18	2311	15	3831	13	4899	12	14,695	14
3	10,558	51	7581	48	14,923	51	22,599	54	55,661	52
4	2285	11	1682	11	3410	12	5384	13	12,761	12
5	160	1	107	1	153	1	303	1	723	1
6 [a]	43	<1	23	<1	50	<1	84	<1	200	<1
Unknown	84	<1	65	<1	97	<1	107	<1	353	<1
Transport destination										
MTC	2661	13	1358	9	2457	8	3823	9	10,299	10
TTS	4591	22	3476	22	7107	24	12,773	31	27,947	26
ED	9712	47	7053	44	13,060	44	16,984	41	46,809	43
Unknown	71	<1	47	<1	80	<1	88	<1	286	<1
Not transported	3591	17	3967	25	6834	23	8014	19	22,406	21
Total	**41,006**		**29,503**		**51,890**		**65,244**		**187,643**	

This table shows a summary of 187,643 SJWA attended patients and excludes 1077 (0.5 %) patients due to unknown age and sex demographic data.
[a] Urgency 6 were excluded from logistic regression analysis, as detailed in the methods. MTC: Major Trauma Center (Level 6). TTS: Tertiary Trauma Service (Level 5). ED: Other Emergency Department (< Level 4).

the most commonly reported regions patients sustained injuries were the 'Head and Neck', $n - 37{,}878$ (female $-$ 21,970, 58 %), and 'Hip to Foot', $n - 34{,}740$ (female $-$ 20,930, 60 %).

Interventions used in the management of patients (Objective 4)

Ambulance staff recorded interventions for 80,998 patients (female, $n = 48{,}152$, 59 %), (Table 4). Of these, 50,044 (62 %) patients (female, $n = 31{,}692$, 39 %) received medication. Fentanyl Citrate (IV) was the most frequently administered medication, administered to 20,810 males and 33,697 females.

The keywords relating to prehospital lifts and extractions that were present within the examination text appeared in the following descending order of frequency: assistance ($n = 29{,}782$), lift, ($n = 15{,}090$), scoop ($n = 10{,}561$), hoist ($n = 8028$), ELK ($n = 8029$), lift only ($n = 3023$), lift assistance ($n = 1083$), extraction & extrication ($n = 800$), pick up ($n - 537$), lift assistance only ($n - 384$), and Camel ($n - 236$).

Disposition of adult patients attended by SJWA in response to a fall (Objective 5)

A total of 148,050 (78 %) patients were transported to the hospital and 40,670 (22 %) patients were not transported, with female patients representing the majority in both groups (Table 1). Patients $\geq$ 85 years had the highest frequency of transport to the hospital (females = 33,668, 23 %; males = 18,259, 12 %) and female patients $\geq$ 85 years had the highest frequency of non-transport (8014, 20 %), (Table 1).

Model interpretation: transport urgency (Objective 6)

A reported likelihood-ratio test showed enough variability between personID to favor mixed-effects ordered logistic regression (LR test vs. model: Chibar2(01) = 653.61, p-value = < 0.001), supporting the use of this model [25]. The estimate of σ_u^2 was 0.38 with a standard error of 0.02.

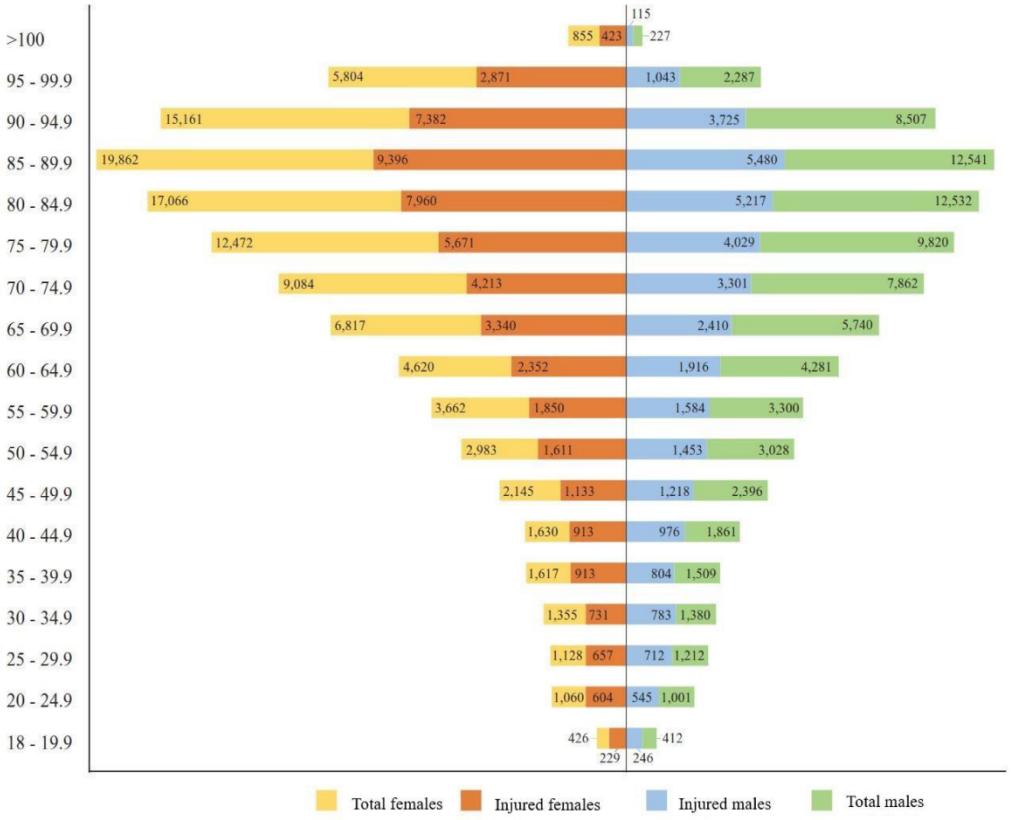

Fig. 2. Butterfly chart of all ambulance attended adults by age and sex.

Table 2
Age-standardized and crude incidence rates (per 100,000-person years) of ambulance-attended adults who had fallen in WA, by sex and age groups, 2015–2021.

Year		2015	2016	2017	2018	2019	2020	2021
Age-standardized rate (All) [a]		1108	1158	1179	1202	1253	1215	1247
Age-standardized rate (injured) [a]		397	424	452	462	498	516	593
Age-standardized rate (≥ 65 yrs.) [a]		5046	5298	5398	5534	5786	5554	5692
Crude [b]	**All**	877	930	969	1011	1072	1073	1133
	Females	1012	1084	1138	1166	1230	1216	1285
	Males	743	777	800	858	914	930	982
	18–64	330	340	348	351	366	367	382
	65–74	1661	1776	1848	1924	1997	2024	2082
	75–84	6077	6241	6316	6503	6940	6485	6698
	85+	18,826	19,974	20,563	21,087	21,760	21,042	21,423
Female (age-sex-standardized)	**18–64**	327	343	353	360	377	370	383
	65–74	1819	1865	1978	1994	2163	2115	2215
	75–84	6535	6706	6870	6941	7320	6932	7162
	85+	19,008	20,965	21,835	21,880	22,281	21,483	21,961
Male (age-sex-standardized)	**18–64**	333	336	342	342	354	365	381
	65–74	1502	1687	1716	1851	1826	1928	1942
	75–84	5536	5694	5677	6004	6514	5988	6188
	85+	18,512	18,306	18,452	19,791	20,917	20,349	20,599

Rates (per 100,000 people) of ambulance attended adults who fell were calculated as follows.

[a] Directly age standardized to the Standard Population for Use in Age-Standardisation - 30 June 2001. (24).

[b] Crude rates based on the WA population aged > 18 years, using Australian standard population [3101.0 National, state and territory population. TABLE 55. Estimated Resident Population by Single Year of Age, Western Australia] and [3101.0 National, state and territory population. TABLE 4. Estimated Resident Population, States and Territories (Number)] data were used to calculate population rates. (24).

Table 3
Comparison of age and sex by region of injuries reported on the electronic patient care record in WA, 2015–2021.

	18 – 64.9 years [n, %]		65 – 74.9 years [n, %]		75 – 84.9 years [n, %]		85+ years [n, %]		Total [n, %]	
Male: No injury	10,143	50	7891	58	13,106	59	13,199	56	44,339	55
Male: Injured	10,237	50	5711	42	9246	41	10,363	44	35,557	45
Head and neck	4615	23	2539	19	4143	19	4608	20	15,905	20
cervical	445	2	165	1	249	1	209	1	1068	1
forehead	1420	7	853	6	1505	7	1725	7	5503	7
ear	156	1	58	<1	107	<1	134	1	455	1
eye	1056	5	532	4	908	4	968	4	3464	4
mouth	390	2	117	1	181	1	149	1	837	1
nose	411	2	282	2	473	2	430	2	1596	2
occipital	332	2	126	1	231	1	205	1	894	1
parietal	1727	8	917	7	1419	6	1607	7	5670	7
throat	70	<1	22	<1	41	<1	51	<1	184	<1
Hip to foot	3940	19	2216	16	3554	16	4098	17	13,808	17
groin	39	<1	16	<1	39	<1	51	<1	145	<1
ankle	859	4	204	1	164	1	118	1	1345	2
foot	262	1	128	1	169	1	151	1	710	1
knee	1095	5	594	4	1000	4	1091	5	3780	5
lower leg	629	3	327	2	558	2	748	3	2262	3
neck of femur	547	3	681	5	1306	6	1690	7	4224	5
upper leg	300	1	187	1	359	2	424	2	1270	2
Shoulder to hand	3492	17	1971	14	2996	13	3369	14	11,828	15
elbow	510	3	498	4	1052	5	1470	6	3530	4
hand	513	3	367	3	787	4	910	4	2577	3
lower arm	433	2	368	3	696	3	993	4	2490	3
shoulder	853	4	410	3	583	3	623	3	2469	3
upper arm	529	3	366	3	665	3	867	4	2427	3
wrists	300	1	168	1	287	1	333	1	1088	1
Trunk, back and pelvis	1856	9	1060	8	1698	8	1854	8	6468	8
central front	37	<1	20	<1	27	<1	19	<1	103	<1
back	552	3	291	2	378	2	339	1	1560	2
buttock	89	<1	61	0	104	<1	118	1	372	<1
flank	210	1	112	1	170	1	174	1	666	1
lower chest	368	2	229	2	309	1	258	1	1164	1
lower quadrant	91	<1	42	<1	56	<1	51	<1	240	<1
upper chest	131	1	66	<1	101	<1	80	<1	378	<1
pelvis	181	1	98	1	128	1	134	1	541	1
sacral	274	1	104	1	150	1	160	1	688	1
thoracic	272	1	100	1	153	1	146	1	671	1
upper quadrant	187	1	104	1	163	1	157	1	611	1
lumbar	431	2	196	1	240	1	250	1	1117	1
Female: No injury	**9633**	**47**	**8348**	**52**	**15,907**	**54**	**21,610**	**52**	**55,498**	**52**
Female: Injured	**10,993**	**53**	**7553**	**48**	**13,631**	**46**	**20,072**	**48**	**52,249**	**48**
Head and neck	4614	22	3207	20	5781	20	8365	20	21,967	20
cervical	441	2	176	1	341	1	426	1	1384	1
forehead	1063	5	762	5	1584	5	2709	6	6118	6
ear	93	<1	42	<1	88	<1	165	<1	388	<1
eye	754	4	617	4	1315	4	1927	5	4613	4
mouth	367	2	219	1	376	1	394	1	1356	1
nose	350	2	325	2	615	2	696	2	1986	2
occipital	305	1	171	1	325	1	511	1	1312	1
parietal	1247	6	837	5	1766	6	3105	7	6955	6
throat	92	<1	37	<1	82	<1	92	<1	303	<1
Hip to foot	4444	22	3044	19	5387	18	8055	19	20,930	19
groin	43	<1	43	<1	111	<1	166	<1	363	<1
Ankle	1662	8	556	3	503	2	437	1	3158	3
foot	400	2	213	1	233	1	235	1	1081	1
knee	1714	8	1106	7	1616	5	1793	4	6229	6
lower leg	631	3	395	2	760	3	1447	3	3233	3
neck of femur	737	4	1124	7	2703	9	4570	11	9134	8
upper leg	334	2	315	2	634	2	905	2	2188	2
Shoulder to hand	3462	17	2373	15	4327	15	6307	15	16,469	15
elbow	443	2	400	3	881	3	1605	4	3329	3
hand	406	2	350	2	746	3	1091	3	2593	2
lower arm	483	2	389	2	831	3	1368	3	3071	3
shoulder	786	4	631	4	969	3	1245	3	3631	3
upper arm	736	4	728	5	1134	4	1527	4	4125	4
wrists	551	3	401	3	742	3	823	2	2517	2
Trunk, back and pelvis	1980	10	1409	9	2479	8	3672	9	9540	9
central front	36	<1	19	<1	35	<1	50	<1	140	<1
back	376	2	245	2	388	1	625	1	1634	2
buttock	149	1	89	1	176	1	305	1	719	1
flank	255	1	135	1	254	1	411	1	1055	1
lower chest	186	1	153	1	311	1	486	1	1136	1

(continued on next page)

Table 3 (*continued*)

Female: No injury	**9633**	**47**	**8348**	**52**	**15,907**	**54**	**21,610**	**52**	**55,498**	**52**
Female: Injured	**10,993**	**53**	**7553**	**48**	**13,631**	**46**	**20,072**	**48**	**52,249**	**48**
lower quadrant	60	<1	25	<1	59	<1	60	<1	204	<1
upper chest	92	<1	67	<1	113	<1	142	<1	414	<1
pelvis	173	1	106	1	259	1	384	1	922	1
sacral	362	2	172	1	297	1	476	1	1307	1
thoracic	234	1	103	1	176	1	288	1	801	1
upper quadrant	111	1	115	1	143	<1	224	1	593	1
lumbar	427	2	224	1	346	1	464	1	1461	1
Total	**41,006**		**29,503**		**51,890**		**65,244**		**187,643**	

*All injuries were reported by paramedics in the examination text of their scene summary based on after paramedics' clinical examination. This table shows a summary of 187,643 SJWA attended patients and excludes 1077 (0.5 %) patients due to unknown age and sex demographic data. The categories under the Injured subheading are not mutually exclusive.

Table 4
Patients' first observations and all interventions, by age and sex.

Males	18 – 64.9 years (n)	65 – 74.9 years (n)	75 – 84.9 years (n)	85 + years (n)	Total (n)
Observations [a]					
GCS					
13–15	18,193	12,758	21,209	22,441	74,601
9–12	611	304	511	529	1955
6–8	124	38	70	72	304
4–5	23	8	7	5	43
3	100	38	48	51	237
Respiratory rate					
10–29	18,693	12,831	21,265	22,524	75,313
>29	279	262	519	517	1577
6–9	23	20	22	13	78
1–5	17	4	5	7	33
0	249	113	128	98	588
Systolic blood pressure					
>89	16,926	11,825	20,072	21,352	70,175
76–89	178	170	209	207	764
50–75	46	55	79	76	256
1–49	8	5	10	6	29
Oxygen saturation					
<40	1286	762	1176	1292	4516
40–59.9	4	6	7	4	21
60–79.9	62	95	145	147	449
80–93.9	1121	1481	2445	2589	7636
>= 94	16,788	10,886	18,166	19,127	64,967
Pain score					
0	4120	4343	7913	8529	24,905
1	626	519	920	1055	3120
2	842	619	1030	1163	3654
3	601	382	631	620	2234
4	532	305	433	417	1687
5	747	397	601	557	2302
6	641	299	428	358	1726
7	780	366	393	381	1920
8	1286	575	683	590	3134
9	649	266	310	214	1439
10	1241	469	483	396	2589
Medications [b]					
Fentanyl citrate (intra venous)	9493	3536	4050	3731	20,810
Methoxyflurane (inhalation)	2970	1113	1203	979	6265
Fentanyl (intra nasal)	1935	950	1259	1217	5361
Oxygen (nasal prongs)	902	832	1242	1293	4269
Paracetamol (oral)	1170	658	1060	980	3868
Ondansetron wafer (oral)	1559	606	732	561	3458
Ondansetron (oral)	1576	544	588	463	3171
Normal saline 0.9 % (intra venous)	868	548	654	553	2623
Ketamine (intra venous)	796	169	122	113	1200
Other interventions [b]					
IV cannulation	4171	2074	2727	2422	11,394
3 lead ECG	1557	1304	2236	2416	7513
12 lead ECG	597	711	1181	1211	3700
Blood taken	392	361	573	469	1795
Female					
Observations [a]					
GCS					
13–15	19,178	15,147	28,239	40,026	102,680
9–12	342	238	500	845	1925

(*continued on next page*)

Table 4 (*continued*)

Female					
6–8	72	41	61	99	273
4–5	12	5	9	14	40
3	47	22	22	37	128
Respiratory rate					
10–29	19,369	15,207	28,459	40,311	103,346
>29	250	219	425	664	1558
6–9	19	13	12	18	62
1–5	3	1	5	12	21
0	159	102	122	89	472
Systolic blood pressure					
>89	17,431	13,896	26,630	37,991	95,948
76–89	186	108	137	187	618
50–75	54	49	63	65	231
1–49	10	6	8	11	35
Oxygen saturation					
<40	1149	840	1421	2026	5436
40–59.9	56	106	163	237	562
60–79.9	43	74	123	168	408
80–93.9	766	1366	2506	3874	8512
>= 94	17,843	13,263	24,975	35,027	91,108
Pain score					
0	3010	3729	8001	11,794	26,534
1	604	607	1291	2011	4513
2	919	762	1576	2342	5599
3	698	531	1019	1299	3547
4	645	446	747	863	2701
5	941	657	1087	1278	3963
6	888	559	822	896	3165
7	1181	677	936	952	3746
8	1915	1190	1551	1590	6246
9	923	589	700	596	2808
10	1859	992	1244	1223	5318
Medications [b]					
Fentanyl citrate (intra venous)	10,061	5876	8174	9586	33,697
Methoxyflurane (inhalation)	5011	2511	3135	3155	13,812
Fentanyl (intra nasal)	3532	2356	3387	4172	13,447
Paracetamol (oral)	2293	1332	2030	2271	7926
Ondansetron wafer (oral)	1671	851	1318	1539	5379
Oxygen (nasal prongs)	597	778	1247	2012	4634
Ondansetron (oral)	1270	686	960	1231	4147
Oxygen (nasal prongs)	248	357	789	1093	2487
Normal saline 0.9 % (intra venous)	635	384	546	582	2147
Ketamine (intra venous)	541	221	198	170	1130
Other interventions [b]					
IV cannulation	3835	2429	3766	4852	14,882
3 lead ECG	1160	1126	2420	3891	8597
12 lead ECG	248	357	789	1093	2487
Blood taken	230	246	443	586	1505

[a] Observations reflect the categorical breakdown used to determine traumatic Revised Trauma Score, they are not mutually exclusive and are the first recorded observation per patient. Observations were recorded for 184,908 patients (98 %).

[b] Medications and other interventions are not mutually exclusive and present the total number of times administered by sex and age group. Patients appear in these groups multiple times in order to reflect the frequency of medication/intervention administration.

Predictors of low transport urgency included sex, age, reported injury, first GCS, year, and dispatch priority attendance. All variables were significant predictors (Wald test used for categorical variables; odds of each category level reported i.e. male vs. female) of being transported to the hospital via a lower urgency (i.e., urgency 3 compared to 2 or 1). There was no evidence of confounding the independent variables with the outcome variable. A cross-tabulation (Fig. 2) showed a significant association between age and sex ($p- < 0.001$) so this interaction was assessed in the ordinal logistic regression with no evidence of confounding.

The odds of being transported via a lower urgency increased: with increasing age categories; when female compared with male; and when female compared with a male of the same age category, (Table 5).

The odds of being transported via a lower urgency decreased: when reportedly injured; with a GCS of ≤ 12 compared with 13–15; with each increasing year from 2015 to 2021; and when attended by an ambulance dispatched as a priority 1 compared with priority 2 or 3, (Table 5).

Discussion

The annual number of adults who fell and required an ambulance in WA increased between 2015 and 2021, corresponding with the growing burden of falls worldwide. Fall-related deaths have been rising far more rapidly over the past two decades than any other type of injury [26]. In Australia and the United States, fall rates rose by around 3 % yearly between 2007–2016 [4,27], with rates increasing faster than would be expected due merely to the ageing of the population [4]. Ambulance responses to falls accounted for 13.4 % of the total EMS workload in WA between 2015 and 2021. This proportion is similar to other Australian states although these studies looked exclusively at older adults [5,7,9,10,28,29].

There was a high frequency and rate of ambulance-attendance for falls in WA, particularly for older people, consistent with the epidemiology of fall-related EMS attendances in New South Wales [7,9,10,28] and Victoria, Australia [5,29]. Older females experienced ambulance-

Table 5
The predictors of low transport urgency.

		Unadjusted OR (95 % CI)	P-value	Adjusted OR (95 % CI)	Z	P-value
Sex						
	Female	1.31 (1.28, 1.34)	<0.001	1.40 (1.33, 1.47)	13.49	<0.001
	Male	1		1		
Age (years)						
	<= 64.9	1		1		
	65 – 74.9	1.23 (1.18, 1.28)	<0.001	1.16 (1.09, 1.22)	5.02	<0.001
	75 – 84.9	1.50 (1.18, 1.28)	<0.001	1.45 (1.38, 1.52)	14.70	<0.001
	>= 85	1.76 (1.70, 1.81)	<0.001	1.72 (1.63, 1.80)	21.68	<0.001
Age (years) ## Sex*						
	<= 64.9 Female	0.76 (0.72, 0.79)	<0.001	1		
	<= 64.9 Male	0.48 (0.45, 0.50)	<0.001	1		
	65 – 74.9 Female	0.84 (0.80, 0.88)	<0.001	0.87 (0.80, 0.94)	−3.58	<0.001
	65 – 74.9 Male	0.64 (0.61, 0.68)	<0.001	1		
	75 – 84.9 Female	0.96 (0.92, 1.01)	0.083	0.78 (0.73, 0.83)	−7.35	<0.001
	75 – 84.9 Male	0.84 (0.80, 0.88)	<0.001	1		
	>= 85 Female	1.10 (1.06, 1.15)	<0.001	0.76 (0.71, 0.81)	−8.40	<0.001
	>= 85 Male	1	<0.001	1		
Reportedly injured						
	No	1		1		
	Yes	0.70 (0.69, 0.72)	<0.001	0.69 (0.67, 0.70)	−32.26	<0.001
First GCS						
	3–5	0.004 (0.003, 0.006)	<0.001	0.007 (0.006, 0.009)	−36.10	<0.001
	6–8	0.03 (0.03, 0.04)	<0.001	0.05 (0.04, 0.06)	−30.89	<0.001
	9–12	0.27 (0.25, 0.29)	<0.001	0.33 (0.30, 0.35)	−29.49	<0.001
	13–15	1		1		
Year						
	2015	1	<0.001	1		
	2016	0.91 (0.87, 0.95)	<0.001	0.90 (0.86, 0.94)	−4.37	<0.001
	2017	0.85 (0.79, 0.89)	<0.001	0.85 (0.81, 0.89)	7.11	<0.001
	2018	0.82 (0.79, 0.86)	<0.001	0.80 (0.76, 0.83)	−9.88	<0.001
	2019	0.85 (0.82, 0.89)	<0.001	0.82 (0.79, 0.86)	−8.64	<0.001
	2020	0.79 (0.76, 0.83)	<0.001	0.76 (0.73, 0.80)	−12.13	<0.001
	2021	0.76 (0.72, 0.79)	<0.001	0.73 (0.70, 0.77)	13.90	<0.001
Priority						
	Priority 1	0.23 (0.22, 0.24)	<0.001	0.27 (0.26, 0.28)	72.85	<0.001
	Priority 2	0.50 (0.49, 0.52)	<0.001	0.52 (0.50, 0.53)	−45.94	<0.001
	Priority 3	1		1		

* Predictors of low transport urgency (dependent variable). Cut1, urgency 1 vs. 2,3,4&5; Cut2, urgency 1,2 vs. 3,4&5; Cut 3, urgency 1,2,3 vs. 4&5. Based on OR [Cut1: −5.29 (95 % CI-5.36, −5.22) SE: 0.04; Cut2: −2.20 (95 % CI −2.25, −2.14), SE: 0.03; Cut3 1.30 (95 % CI 1.24, 1.36) SE: 0.03]. Variable constant of multi-level regression: PersonID [0.40, SD 0.36 – 0.44: SE: 0.02]. LR test: prop >= chi-bar-squared < 0.0001. Multi-level ordered logistic regression was conducted to adjust for patients who appear in the data set multiple times between Jan 1st 2015 – Dec 31st 2021. A total of 135,633 observations of 91,805 individual patients who were transported via urgency 1–3 were analyzed in this ordinal logistic regression. A mixed effects logit regression group variable by individual person identification number to account for people who appear in the data set multiple times. All assumptions were met for this regression model: ordinal dependent variable, no multi-collinearity and presence of proportional odds. Cut1, urgency 1 vs. 2,3,4&5; Cut2, urgency 1,2 vs. 3,4&5; Cut 3, urgency 1,2,3 vs. 4&5 (urgency level 4&5 is considered one category in this model). Standard error (SE). Unadjusted OR calculated with a '#' function. Adjusted OR calculated with '##' Stata function.

attended falls at a higher frequency than males and had a higher frequency of reported injuries overall [9]. Females ≥ 65 years had a higher frequency of reported injuries to the head and neck, hip to foot, shoulder to hand and trunk, back and pelvis than males in the same age categories, consistent with findings in Sydney, Australia [9].

Interventions are infrequently reported in prehospital EMS research and those that are reported focus on the administration of analgesia [30]. The five most common medications administered to patients attended in WA were all analgesia, consistent with practices reported in NSW [31]. Methods of lift assistance, although infrequently coded in the data, were frequently reported in examination text and are one of the most common, non-medication interventions delivered in the prehospital setting, consistent with other prehospital literature on falls [30]. Prehospital literature reporting on interventions for the management of falls largely reports on lift assistance [32–34]. Recommendations for these patients refer to the implementation of falls prevention strategies and appropriate referral pathways to engaging prehospital staff with other health professionals [18,30,35,36].

Predictors of low/non-urgent transport to the hospital after a fall included older age and female sex. Older adults who fell accounted for a large proportion of ambulance attendances although only 2 % of all attendances resulted in urgency one, lights and sirens transport to the hospital, and 22 % were not transported, consistent with findings from Victoria, Australia [5]. Patients with minor injuries may be referred to their general practitioner (GP), urgent care center or referred by prehospital emergency care staff to allied health service, although this is not a service provided in WA [35,36]. Cox et al.[5] suggest that an elderly specific prehospital trauma triage guideline may need development due to the number of older adults meeting major trauma guidelines who are not being triaged to a specialized service. This study supports the findings from a growing body of evidence, suggesting that older adults are largely transported via non time-critical urgencies, or not transported, following an ambulance attended fall. Our findings are consistent with the growing body of prehospital literature questioning if: on-scene referral pathways and alternative health care pathway ilow-acuitymplementation could potentially meet the needs of low-acuity older adults [5,7,9,13,37,38].

Recommendations for future practise

As alternative healthcare, referral pathways and prehospital clinical guidelines for the management of patients who fall exist within other EMS services, there is the potential that these could be adapted for use in WA, provided the appropriate research is conducted.

Future research

Exploring the prevalence and impact of repeat falls on EMS services would potentially provide insight into what falls account for a significant EMS workload. Further exploration of patients who refuse to travel to hospital could be beneficial in exploring high risk sub-groups of patients who fall. Exploring this patient cohort could allow for targeted treat and refer, discharge protocols and linkages to other community or hospital services.

Conclusion

The growing demand for EMS responses to falls between 2015 and 2021 showed the increasing burden that older adults who fall are placing on WA's prehospital system.

Despite high demand, only 1 % of adults who fell received a lights and sirens transport to hospital, highlighting that over 76 % of these transported attendances and over 21 % of non-transported attendances were low-acuity in nature. The increased frequency of injuries with age, even when minor, should be considered in further practice advancements. Further exploration of the health and ongoing care needs of older adults who have fallen could be beneficial to the cohort of patients identified as having a high odd of non-urgent transport.

Prior presentations

This research has been presented at the 2022 European Emergency Medicine Congress EUSEM, (Berlin, Germany), and the Safety 2022 Conference 14th World Conference on Injury Prevention & Safety Promotion (Adelaide, Australia), as abstracts.

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Declaration of Competing Interest

The author declares no conflict of interest.

Conflicts and Acknowledgments

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End of Manuscript

5.2 Summary of Chapter Findings

This chapter reporting on the epidemiology of ambulance-attended falls shows that 188,720 patients were attended by SJWA ambulance for falls, 57% of them female with a median age of 80 years. The age-standardised incidence rate of ambulance-attended falls increased from 115 cases/100,000 person-years to 161 cases/100,000 person-years between 2015-2021. The research findings presented an increase in the crude incidence of ambulance-attended falls, suggesting an increase in the demand for ambulance-attendances in the WA prehospital setting.

Female patients and older adults had a higher odds of being transported to hospital following a fall, via a lower urgency. This finding is supported by the fact that 62% of this cohort were transported via urgency 3 or less, and 22% were not transported. While 19% of patients were attended via a priority one dispatch, only 1% were transported to hospital via urgency one. The research findings within this chapter showed an increase in the crude and age-standardised incidence and that a large proportion of ambulance-attended adults who fell were low acuity cases.

These findings informed the rationale of the subsequent study asking, what is contributing to this growing demand? As a large proportion of the patients identified in this chapter appeared to have been repeatedly attended, it led to the development of a retrospective cohort study to further explore this subset who were potentially contributing to this growing demand. The next chapter presents the epidemiology of ambulance-attendances for repeat falls as a state-wide retrospective cohort study.

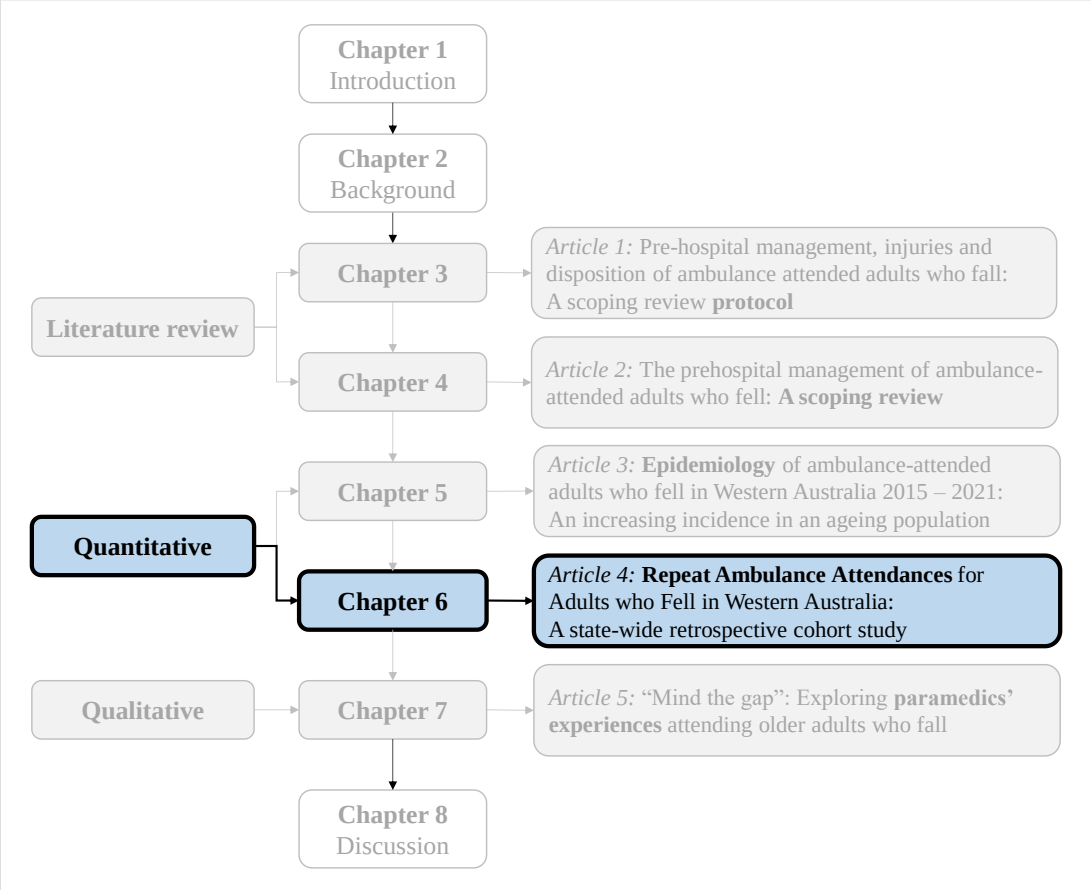
Chapter 6

Epidemiology of Repeat Falls

6.1 Overview

This chapter describes the epidemiology of ambulance-attended adults in WA who experienced repeat falls. Within this retrospective cohort study, all patients attended by an ambulance following a fall over a seven-year period (January 1st, 2015, and December 31st, 2021) were explored to identify those attended multiple times. The findings are reported in a manuscript that is currently under review with *Prehospital Emergency Care*.

Thesis Context



Article 4 Emergency Medical Service Attendances for Adults With Repeat Falls in Western Australia: A State-wide Retrospective Cohort Study.

Title

Emergency Medical Service attendances for adults with repeat falls in Western Australia: A state-wide retrospective cohort study

Authors

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Word count: 3,691

Abstract (350 words)

Objectives: The risk of falls increases with age and often requires an emergency medical service (EMS) response. We compared the characteristics of patients attended by EMS in response to repeat falls within 30 days and 12 months of their first EMS-attended fall; and explored the number of days between the index fall and the subsequent fall(s).

Methods: This retrospective cohort study included all adults (>=18 years of age) who experienced their first EMS-attended fall between 1st January 2016 and 31st December 2020, followed up until 31 December 2021. Patients who experienced >=1 subsequent fall, following their first recorded fall, were defined as experiencing repeat falls. Multivariable logistic regression was used to identify the factors associated with repeat falls; and Kaplan-Meier analysis was used to estimate the time (in days) between consecutive EMS-attended falls.

Results: A total of 128,588 EMS-attended fall-related incidents occurred involving 77,087 individual patients. 54,554 (71%) patients were attended only once for a fall-related incident (30,280 females; median age 73 years, inter-quartile range (IQR): 55-84). A total of 22,533 (29%) patients experienced repeat EMS-attended falls (13,248 females; median age 83 years, IQR: 74-89, at first call). These 22,533 patients accounted for 58% (74,034 attendances) of all EMS-attendances to fall-related incidents. Time between EMS-attended falls decreased significantly the more falls a patient sustained. Among the 22,533 patients who experienced repeat falls, 3,103 (14%) sustained their second fall within 30 days and 13,363 (59%) within 31 days to 12 months. Patients who were transported to hospital, via any urgency, at their first EMS-attended fall, had a reduced odds of sustaining a second EMS-attended fall within both 30 days and 31 days to 12 months, compared to non-transported patients.

Conclusion: Nearly 30% of all patients attended by EMS for a fall, sustained repeat falls, which collectively accounted for nearly 60% of all EMS-attendances to fall-related incidents. Further exploration of the role EMS clinicians play in identifying and referring patients who sustain repeat falls into alternative pathways is needed.

Word count: 327 words

Keywords: Accidental Falls, Emergency Medical Services, Recurrent falls, frequent falls, Older Adults, Aged

Introduction

Emergency Medical Services (EMS) are responding to an increasing number of people who have fallen (1-4). Increasing age is a risk factor associated with falling (5, 6). As the proportion of older adults in the population increases globally, an increase in the incidence of falls is growing concurrently (7). Falls at any age have the potential to result in minor to life threatening injuries, even death (8), and often require prehospital emergency care with treatment on scene or transport to hospital. Moreover, there is a risk of a subsequent fall following an initial fall (2, 9, 10).

Patients categorized as experiencing 'repeat falls' are described as sustaining one or more subsequent falls, following their initially recorded fall (2, 9, 10). The risk of repeat falls increases with age and immobility (5, 9, 11-13). Repeat falls are shown to be associated with reduced independence (14), reduced quality of life (14), and with repeat transports to hospital in older adults (5, 9, 11-13). Multiple EMS globally have reported an increase in falls-related attendances for repeat falls (1-4, 11). A study in the USA, showed that among older adults attended by EMS for a fall, nearly 20% experienced one repeat transport within 30 days, and 40% within 6 months (11).

This study aimed to examine EMS-attended adults who sustained repeat falls in Western Australia (WA). The study objectives were to 1) compare the characteristics of patients who sustained one fall compared to those who sustained repeat falls; 2) describe the characteristics of patients attended in response to repeat falls within 30 days and 31 days to 12 months of their first EMS-attended fall; 3) explore the number of days between the index fall and the subsequent fall(s); and 4) compare the mortality in patients who sustained one fall compared to those who sustained repeat falls.

Methods

Study Design and Setting

This retrospective cohort study included all adult patients (>=18 years of age) attended by St. John Western Australia (SJWA) EMS in response to a fall between 1st January 2015 and 31st December 2021. SJWA is the sole provider of road-based emergency medical services in the state of WA, covering the largest geographical area (2.5 million square kilometers) of any single EMS in the world; responding to more than 280,000 calls for EMS assistance each year (15). SJWA EMS is staffed by paramedics in the metropolitan area, with a mix of paramedic and volunteer ambulance officer crews in rural areas (15). Following an EMS attendance, a patient can be transported to hospital via transport urgency 1 (most urgent) to 5 (least urgent). During the study period no alternative referral pathways to other healthcare providers were available to EMS staff in WA when managing patients who fall.

Data Collection/Data Source

Data were obtained from SJWA EMS electronic patient care records (ePCR), where paramedics and emergency care technicians (EMTs) (hereafter collectively referred to as EMS clinicians) described each patient's presentation and clinical management, together with EMS dispatch data. Falls were identified by researchers using data from the Medical Priority Dispatch System (16), and by searching free-text fields within the ePCR fields, using manual screening, machine learning and natural language processing (17). The machine learning model used to identify the cohort presented in this study has been described in a recent published study (17). All identified falls from these sources were included after removal of duplicate cases. Falls identified as: suicide, patient not located on scene, motor vehicle incidents, assaults or kicked by an animal were excluded.

Using probabilistic linkage techniques, we linked records in the WA Death Registry (18) with those in the ePCR by surname, given name, date of birth, and residential address. Date of death was extracted for all patients with a death registration. We also linked records in the ePCR associated with the same individual using the same techniques, to identify people who had multiple emergency EMS attendances. For this linkage we used "Fine-grained record linkage software" (Fril, version 2.1.5, Emory University and Center for Diseases Control and Prevention, Atlanta, Georgia, U.S.), supplemented by Python Record Linkage Toolkit (version 0.14.0). Fril has elsewhere been reported to perform well for identifying the same individual, with 99% precision (positive predictive value) and 95% recall (sensitivity) (19). This screening could include false positive links, so it was refined by using machine learning techniques (17). Missing examination texts were exceedingly rare because this field on the ePCR is where the primary EMS clinicians record details of the case. Hence, we believe that the risk of missing falls is minimal.

We defined a patient's **index fall** as their first recorded fall in the data set. Therefore, patients who only sustained one single fall during the study period, only sustained their **index fall.** We defined patients who experienced >=1 subsequent fall, following their index fall, as experiencing repeat falls. For the purpose of this study, and to identify patients who experienced repeat falls, a one-year phase-in period and one-year follow-up period were applied to this data set.

The data extracted were from 1st of January 2015 to the 31st of December 2021. Patients who sustained any EMS-attended fall in 2015 (one-year phase-in period) were excluded, as were any patients who experienced their index fall in 2021 (the one-year follow-up period). This allowed follow-up on all patients who sustained their index fall in 2016 to 2020, as this study focused on subsequent falls that occurred within 30 days and 12 months of a patient's index

fall (2). A 5-year cohort of all EMS-attended adults who sustained their index fall between 1st January 2016 and 31st of December 2020 formed the study cohort.

Data Extraction

Patients' demographic details (age, sex); EMS dispatch priority to the patient [from 1 (highest) to 3 (lowest)]; clinical information (Glasgow coma scale (GCS) score, pain score (0-10), medications administered (time, route of administration)) stratified by sex; other interventions (type, effect) stratified by sex, were extracted from the ePCR and computer aided dispatch system (CAD). Free texts were searched in the event of missing demographic or dispatch priority data. Injury location was extracted and allocated into the following categories: head and neck; hip to foot; trunk, back and pelvis; and shoulder to hand, as described in the ePCR (20). Any reported injury was included in the analysis of results as described in the ePCR, e.g., abrasion, bleeding, dislocation.

Patient disposition (non-transport/transported from the scene to hospital) was extracted. For transported patients, transport urgency level, was determined by the EMS clinicians at the scene. Transport destination level was coded according to the WA trauma service role delineation and trauma service organizational chart (21). A triage revised trauma scores (tRTS) was computed as a surrogate measure for patients' physiological condition severity level (22). The first measured values of systolic blood pressure (SBP), Glasgow coma scale (GCS), and Respiratory rate (RR) recorded on the ePCR were used to compute tRTS, to then calculate a tRTS, from '0' to '12' per patient. Lower tRTS scores indicated a high injury severity (22).

Measures/Outcomes

The independent variables explored included: demographic information (age, sex), dispatch priority, observations [SBP, pain, injury status and location (head or neck; hip to foot; shoulder to hand; and trunk, back or pelvis), respiration rate, oxygen level, GCS], and patient disposition (transport urgency, non-transport, and transport destination). The patient data analyzed in the model reflects all patient data collected at their first EMS-attended fall. Odds ratios (OR) were produced in the multivariable logistic regression allowing for the identification of factors (from the patient's index fall) that are associated with the likelihood of a repeat fall. A Wald test was conducted on all categorical variables to assess their significance as predictors of the dependent variable.

Statistical Analysis

Descriptive statistics were used to summarize the characteristics of all study participants. Kaplan-Meier plots estimating the time (in days) between consecutive EMS-attended falls were generated for the first five patient falls. Patients who only sustained n EMS-attended falls (where $n < 5$) in the study period, or who were reported to have died after their n-th fall, were censored for their n+1 fall. The censor date was either the 31st December 2021 or the patient's date of death, if earlier. Differences in time between consecutive falls were assessed using log-rank tests. Data analysis was performed using STATA statistical software Version 17.0 (College Station, TX, USA).

We could not derive a cox proportional hazards model (proportional hazards assumption) and non-proportional hazards models (Weibull survival distribution: generalized gamma distribution) to determine the association between survival time (time to second EMS-attended fall) of patients because our data violated the model's assumptions, even after data stratification. Multivariable logistic regression was used to investigate the association

between independent variables recorded at a patient's index fall and the likelihood of experiencing a repeat fall within two-time frames: i) within 30 days, and ii) between 31 and 365 days of the index fall. To ensure all patients were alive and therefore at risk of experiencing a second fall, patients who died within 30 days of their index fall were excluded from the regression model exploring repeat falls within 30 days. Similarly, patients who died within 365 days of their index fall were excluded from the regression model exploring repeat falls between 31 and 365 days of their index fall. All patients who were therefore alive and could potentially have experienced the outcome of interest, namely a second fall, were included in the model.

Ethical approval

Curtin University Human Research Ethics Committee approval [HR128/2013-85, 09 Mar 2022] and SJWA Research Governance Committee approval [11 Mar 2022] was obtained.

Results

Study Cohort

Between January 1st 2016 and December 31st 2020, 77,087 patients sustained their index fall. Following-up until December 31st 2021 (12 month follow up), we included 128,588 EMS-attendances to falls. A total of 54,554 (71%) individual patients only had one EMS-attended fall-related incident. A total of 22,533 (29%) individual patients had more than one EMS-attended fall. These 22,533 patients accounted for 58% (74,034 attendances) of all EMS-attendances to fall-related incidents. Figure 1 graphically presents all EMS-attendances to falls by fall frequency. A total of 177 falls identified as: suicide, patient not located on scene, motor vehicle incidents, assaults or kicked by an animal were excluded.

The 22,533 (29%) patients who experienced repeat falls sustained between 2 and 131 EMS attended falls in total (median: 2, interquartile range (IQR): 2-4). Age ranged from 18 to 112 years at the first fall; 19,843 (88%) were aged 65 years or older and 9,261 (41%) were 85 years of age or older. Overall, 13,363 (59%) of repeat falls occurred within 12 months: 3,103 (14%) of patients sustained their second fall within 30 days of their index fall, and 10,260 (46%) between 31 days to 12 months. Table 1 provides patient and case information. Some patients experienced a high number of repeat falls, with 568 (3%) of patients sustaining 10 or more falls, accounting for 8,264 (11%) of all EMS-attendances to falls. Of these 568 patients, 104 (18%) had their second fall within 30 days of their index fall, 342 (60%) had their second fall within 31 to 365 days of their index fall (total in 12 months, 446, 79%), and 52 (9%) died within 30 days of their last fall.

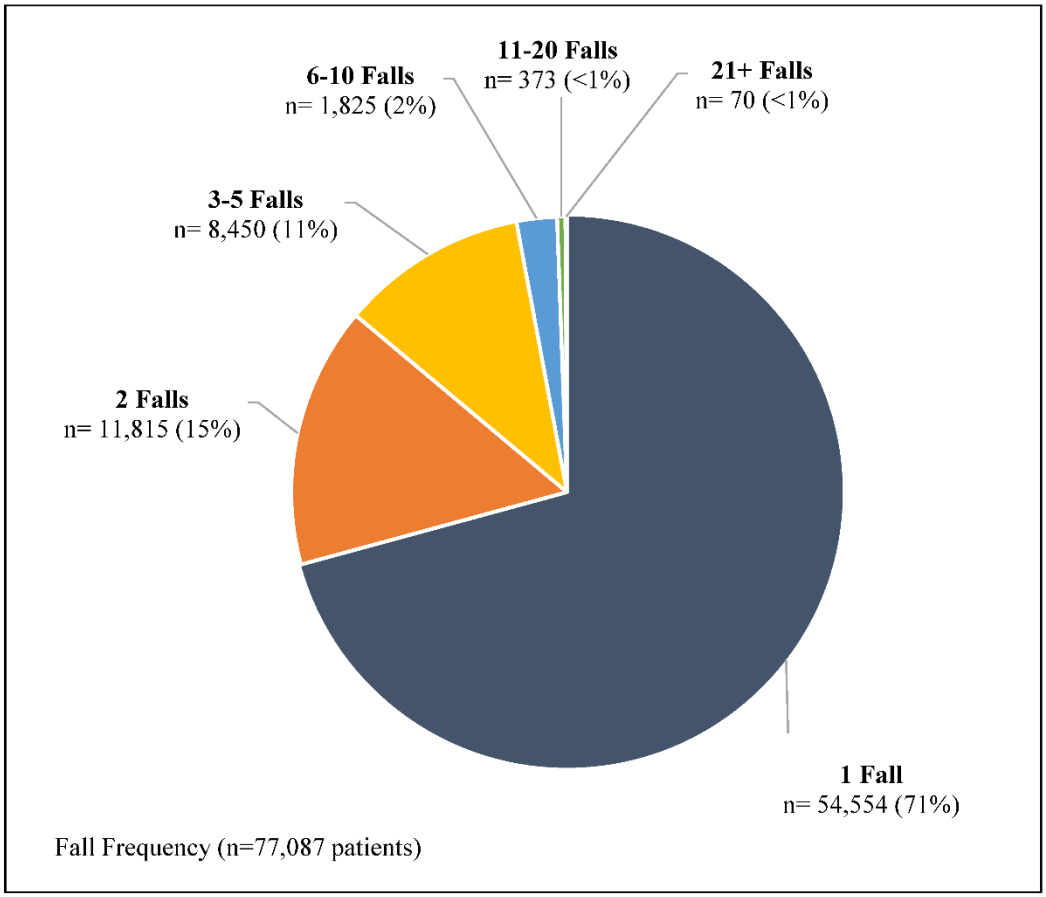

Figure 1. The total number of subsequent EMS-attended falls for the 77,087 adults who sustained an index EMS-attended fall between 1st January 2016 – 31st December 2020.

Table 1. Characteristics of all 77,087 EMS-attended patients who fell

	Sustained one fall (only fall) (n=54,554)		**Patients who sustained repeat falls (first fall of multiple)** (n=22,533)									
	Index fall		**Index fall**		**Total number of falls sustained** (data from final fall)							
					2		**3**		**4**		**5+**	
			n=22,533		n=11,815		n=4,848		n=2,310		n=3,560	
Age at first call, mean (SD) years												
	68 (21)		80 (14)		79 (14)		81 (13)		81 (12)		79 (13)	
Age at first call, median (IQR) years												
	73 (55-84)		83 (74-89)		83 (73-89)		84 (76-89)		83 (75-89)		82 (74-88)	
Age at first call (years) (n %)												
<=65	19,254	35	2,658	12	1,413	12	417	9	194	8	299	8
65-75	9,536	17	3,254	14	1,531	13	552	11	266	12	474	13
75-85	12,773	23	7,328	33	3,477	29	1,378	28	623	27	1,041	29
85+	12,392	23	9,261	41	5,379	46	2,495	51	1,227	53	1,745	49
Sex (n %)												
Female	30,280	56	13,248	59	6,961	59	2,883	60	1,368	59	2,032	57
Male	23,768	44	9,255	41	4,839	41	1,958	40	942	41	1,527	43
Dispatch priority (n %)												
1	13,941	26	4,070	18	2,343	20	871	18	392	17	504	14
2	28,299	52	12,308	55	5,938	50	2,487	51	1,183	51	1,819	51
3	12,215	22	6,135	27	3,486	30	1,472	30	729	32	1,222	34
Reportedly injured (n %) [a]												
Yes	29,825	55	10,456	46	5,593	47	2,224	46	1,004	43	1,422	40
Head/neck	12,750	23	4,503	20	2,428	21	942	19	437	19	609	17
Trunk/back/pelvis	5,492	10	1,881	8	1,003	8	372	8	189	8	259	7
Hip/foot	9,745	18	4,142	18	1,809	15	729	15	328	14	457	13
Shoulder/hand	11,824	22	3,362	15	2,206	19	914	19	385	17	591	17
First GCS (n, %)												
13-15	50,611	93	21,676	96	11,118	94	4,547	94	2,164	94	3,327	93
9-12	1,171	2	350	2	358	3	153	3	85	4	126	4
6-8	230	<1	46	<1	60	1	15	<1	9	<1	14	<1
3-5	232	<1	19	<1	34	<1	16	<1	6	<1	6	<1
Treatments (n, %) [b]												
Any medication	19,570	39	5,322	24	3,033	26	1,100	23	429	19	664	19
IV cannulation	5,603	10	1,683	7	754	6	277	6	101	4	130	4
ECG	4,213	8	2,148	10	1,336	11	534	11	269	12	403	11
Oxygen	1,518	3	537	2	323	3	103	2	45	2	41	1
Pain score (n, %)												
0	29,666	54	14,944	66	7,967	67	3,482	72	1,716	74	2,770	78
1-3	6,755	12	2,934	13	1,467	12	586	12	255	11	377	11
4-6	5,968	11	1,772	8	914	8	316	7	135	6	185	5
7-9	8,187	15	2,051	9	1,017	9	325	7	154	7	163	5
10	3,472	6	802	4	435	4	132	3	50	2	64	2
Transported (n %)												
Yes	48,046	88	18,075	80	9,960	84	3,980	82	1,816	79	2,567	72
Transport urgency (n %)												
1	1,158	2	186	1	152	1	47	1	15	1	25	1
2	11,187	21	3,087	14	1,711	14	623	13	274	12	358	10
3	29,108	53	11,745	52	6,435	54	2,640	54	1,197	52	1,726	48
4-5	5,887	11	2,887	13	1,593	13	647	13	324	14	447	13
Transport destination (n %)												
Level 3 Trauma	12,309	23	4,188	19	2,266	19	899	19	376	16	538	15
Level 4 Trauma	14,282	26	5,844	26	3,210	27	1,271	26	647	28	891	25
Level 5 Trauma	14,470	27	5,820	26	3,259	28	1,323	27	563	24	812	23
Major trauma	6,985	13	2,223	10	1,225	10	487	10	230	10	326	9
Not transported (n %)												
Yes	6,508	12	4,458	20	1,855	16	868	18	494	21	993	28
Died within (days) of 'index fall' (n %)												
30 days	3,012	6	206	1	183	2	18	<1	3	<1	2	<1
365 days	8,604	16	2,614	12	1,789	15	508	10	202	9	115	3
Died within (days) of 'final fall' (n %)												
30 days	3,012	6	2,103	9	1,090	9	492	10	230	10	291	8
365 days	8,604	16	6,473	29	3,285	28	1,488	31	711	31	989	28
Second fall within (days) (n %)												
30 days	-		3,103	14	1,522	13	666	14	348	15	567	16
365 days	-		13,363	59	6,270	53	2,998	62	1,515	66	2,580	72

This table shows a summary of 77,087 SJWA attended patients. **Patients who sustained more than or equal to 2 falls:** All patients' data from their first fall of those who sustained multiple falls, is reported in **"Index fall (first fall of multiple)"**. The transport destination level was coded according to the WA trauma service role delineation and trauma service organizational chart. 536 (0.007%) patients had unknown sex demographic data. Glasgow Coma Scale (GCS). 2,752 (0.03%) patients had unknown GCS data at first fall.

Due to some patients having incomplete demographic and/or clinical data, some reported characteristics may be unknow.

All patients who sustained exactly two falls are reported in **"2 falls"**. All patients who sustained exactly three falls are reported in **"3 falls"**.

All patients who sustained exactly four falls are reported in **"4 falls"**. All patients who sustained five or more falls are reported in **"5+ falls"**. The reported data reflects what information was recorded at the patient's final fall, whether they had 2, 3, 4, or 5+ falls total.

[a] The injury locations are not mutually exclusive. Injury location was extracted and allocated into the following categories: **head and neck** (cervical, forehead, ear, eye, mouth, nose, occipital, parietal; and throat regions); **hip to foot** (groin, ankle, foot, knee, lower leg, neck of femur and upper leg regions); **trunk, back and pelvis** (central front, back, buttock, flank, lower chest, lower quadrant, upper chest, pelvis, sacral, thoracic, upper quadrant, and lumbar regions); and **shoulder to hand** (elbow, hand, lower arm, shoulder, upper arm, and wrist), as described in the ePCR.

[b] These groups are not mutually exclusive. Electrocardiogram (ECG) includes 3 lead and 12 lead. IV – intravenous. Oxygen administered via nasal prongs.

Injuries, Observations, and Treatments

A total of 10,456 (46%) patients who sustained repeat falls were injured at their first fall (6,371 females, 61%). Within this cohort of patients who sustained repeat falls, females had a higher reported frequency of head and neck (2,650, 59%), trunk, back and pelvis (1,166, 62%), shoulder to hand (2,011, 60%), and hip to foot injuries (2,561, 62%), than males at their first fall. Patients median GCS at their first fall was 15 [IQR 15-15], regardless of sex or whether they sustained repeat falls. For patients who experienced repeat falls, median GCS from their 2nd fall was 15 [IQR 14-15] regardless of sex. Median tRTS for all patients, male or female, was 12 [IQR 12-12]. Males had a median pain score of '0' at their only fall (IQR: 0-4) and at their first of multiple falls (IQR: 0-1). Females had a median pain score of '1' at their only fall (IQR:0-6) and '0' at their first of multiple falls (IQR: 0-3).

A higher frequency of medication administration is shown in patients who sustained one single fall (19,570, 39%) compared to patients who sustained repeat falls, at their first fall (5,322, 24%). Intravenous cannulation, 3 lead and 12 lead electrocardiogram (ECG) were the most frequently used interventions. Injuries, observations, and treatments/interventions are detailed further in Table 1.

Disposition

A total of 66,121 (86%) patients were transported to hospital at their index fall, shown in Table 1. Of the 22,533 patients who experienced repeat falls, 18,075 (80%) were transported at their index fall. A total 8,636 (48%) patients experienced a repeat transport (transported at first and second fall) within 12 months: 1,714 within 30 days and 6,922 within 31 days to 12 months of their initial transport. Further details about patient disposition are shown in Table 2.

Table 1 reports total patient deaths within 30 days, or 365 days of their index and final fall. In patients who sustained one fall, 3,012 (6%) died within 30 days of their fall and 8,604 (16%) within 365 days of their fall. In patients who sustained repeat falls, fewer died within 30 days of their index fall (206, 1%), and within 365 days of their index fall (2,614, 12%) compared to those who sustained one fall.

Table 2. Repeat transport to hospital within 30 days and 12 months of index fall in patients who sustained repeat falls

	Patients who sustained repeat falls (multiple falls)	**Repeated transport in 30 days**	**Repeated transport in 31 days to 12 months**	**Repeated transport total (12 months)**
	Index fall, n=22,533 (first fall of multiple)			
All transports	**n= 18,075 (80)**	**1,714 (9)**	**6,922 (38)**	**8,636 (48)**
Age (Mean, SD)	80 (14)	80 (14)	81 (13)	81 (14)
Age (Median, IQR)	83 (75-89)	84 (75-89)	84 (76-90)	84 (76-89)
Sex (female), (n %)	10,648 (59)	920 (54)	4,030 (58)	4,950 (57)
Injured (n %)	9,699 (54)	892 (52)	3,708 (54)	4,600
Transport urgency (n %)				
1	186 (1)	9 (<1)	74 (1)	83 (1)
2	3,087 (17)	245 (14)	1,109 (16)	1,354 (16)
3	11,745 (65)	1,093 (64)	4,586 (66)	5,679 (66)
4&5	2,887 (15)	341 (20)	1,091 (16)	1,432 (17)
Transport destination (n %)				
Level 3 Trauma	4,188 (23)	408 (24)	1,580 (23)	1,988 (23)
Level 4 Trauma	5,844 (33)	573 (33)	2,258 (33)	2,831 (33)
Level 5 Trauma	5,820 (32)	526 (31)	2,243 (32)	2,769 (32)
Major trauma	2,223 (12)	207 (12)	841 (12)	1,048 (12)

This table shows a summary of 22,533 SJWA attended patients. 170 (0.007%) patients had a Non-Australian Triage cale case (scheduled transfer to residential aged care facility or home) and are not included under transport urgency.

Kaplan-Meier

Time between calls decreased significantly the more falls a patient sustained ($p<0.001$), as shown in Figure 2. The Kaplan-Meier estimates for median time between the second and third fall was 558 days (18 months) [25%: 135 days; 75%: 1,913 days]. The median time between third and fourth fall was 310 days (10 months) [25%: 76 days; 75%: 1,090 days]. The median time between fourth and fifth fall was 199 days (6 months) [25%: 53 days; 75%: 697 days].

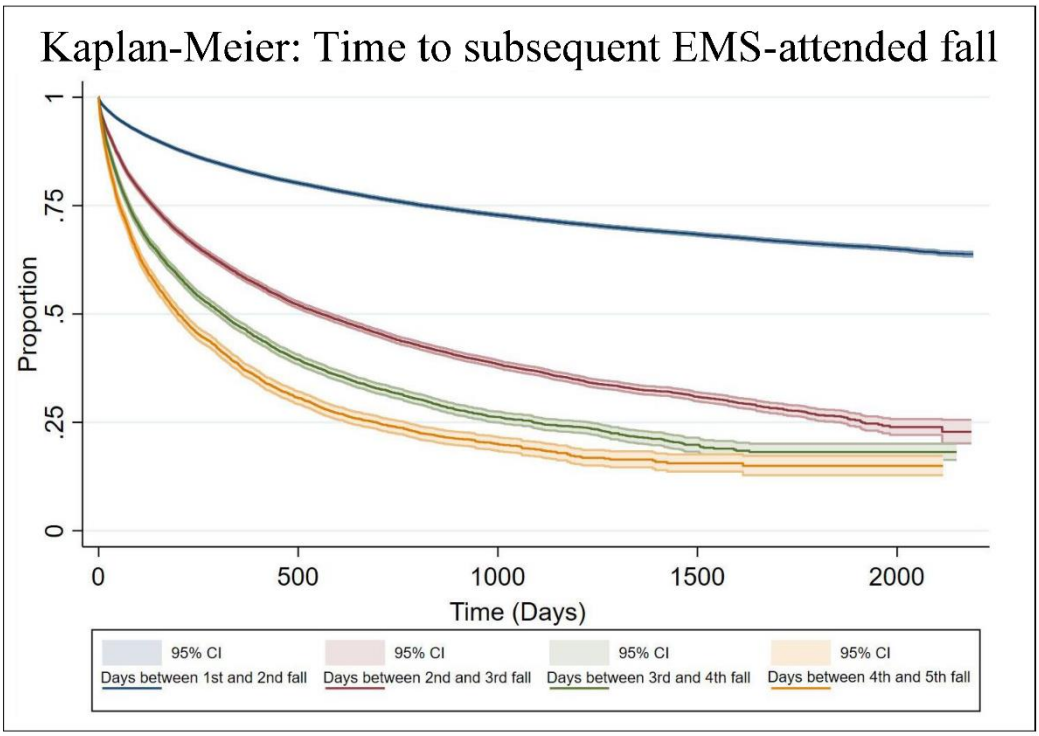

Figure 2. Days between subsequent falls for patients who experienced between 1 and 5 EMS-attended repeat falls

Footnote: As the p-value for the log-rank test is <0.001, we conclude that there is a significant difference in the time to event between the four different groups.

Multivariable logistic regression: likelihood of experiencing a repeat fall

The odds ratios of second EMS-attended fall following an index fall, are shown in Table 3. All assessed variables were found to be independently associated with the odds ratio of a patient sustaining a second fall within 30 days or 31 days to 12 months of their index fall.

Male patients attended by the EMS for an index fall had an increased odds of sustaining a second fall within 30 days and 31 days to 12 months. Older adults (≥65 years of age) and patients attended via low dispatch priority (2 vs 1, 3 vs 1) at their index fall had an increased odds of a second EMS-attended fall within 30 days and 31 days to 12 months. Patients with a reported injury to their head and neck, trunk, back and pelvis, shoulder to hand, or hip to foot, at their first fall had a reduced odds of sustaining a second EMS-attended fall within 30 days and 31 days to 12 months. Patients who were transported, via any urgency, at their index EMS-attended fall, had a reduced odds of sustaining a second EMS-attended fall within 30 days and 31 days to 12 months, compared to non-transported patients.

Table 3. Factors associated with a second EMS-attended fall within 30 days and 31 to 365 days following the index fall: a Multivariable logistic regression model

Patients who sustained a second ambulance-attended fall within 30 days or 12-months of their initial ambulance-attended fall								
	Second ambulance-attended fall within 30 days				Second ambulance-attended fall within 31 to 365 days			
	aOR	p value	95%CI		aOR	p value	95%CI	
Sex								
Female	1				1			
Male	1.31	<0.001	1.22	1.42	1.24	<0.001	1.19	1.30
Age (years)								
<=64.9	1				1			
65-74.9	2.29	<0.001	1.99	2.63	2.89	<0.001	2.65	3.14
75-84.9	3.81	<0.001	3.38	4.31	5.33	<0.001	4.95	5.74
>=85	5.31	<0.001	4.71	5.98	9.73	<0.001	9.04	10.47
Dispatch priority								
1	1				1			
2	1.33	<0.001	1.19	1.48	1.20	<0.001	1.13	1.27
3	1.46	<0.001	1.29	1.64	1.18	<0.001	1.10	1.27
Shoulder to hand injury								
Not reported	1				1			
Yes	0.85	0.005	0.76	0.95	0.93	0.019	0.87	0.99
Head and neck injury								
Not reported	1				1			
Yes	0.84	<0.001	0.76	0.92	0.84	<0.001	0.79	0.89
Trunk, back and pelvis injury								
Not reported	1				1			
Yes	0.80	0.002	0.69	0.92	0.95	<0.001	0.77	0.91
Hip to foot injury								
Not reported	1				1			
Yes	0.84	0.001	0.76	0.93	0.82	<0.001	0.77	0.87
Transported status and Urgency								
Not reported	1				1			
Urgency 1	0.17	<0.001	0.10	0.27	0.45	<0.001	0.36	0.57
Urgency 2	0.20	<0.001	0.18	0.23	0.45	<0.001	0.41	0.49
Urgency 3	0.27	<0.001	0.25	0.30	0.59	<0.001	0.56	0.63
Urgency 4&5	0.37	<0.001	0.32	0.42	0.67	<0.001	0.62	0.73

aOR: Adjusted odds ratio. **Patient data from their first ambulance-attended fall was used for this model.** 95%CI: 95% confidence interval.

Reference group: patients who sustained one ambulance-attended fall during the study period and survived to 30 days (model 1) and 365 days (model 2). A total of n= 3,103 patients sustained a second ambulance attended fall within 30 days of their index fall and n=10,260 within 31 to 365 days. A total of n=51,542 patients who sustained one ambulance attended fall survived to 30 days without a second fall, and n=45,950 survived to 365 days without a second fall.

Head and neck refer to injuries of the: cervical, forehead, ear, eye, mouth, nose, occipital, parietal; and throat regions.
Hip to foot refers to injuries of the: groin, ankle, foot, knee, lower leg, neck of femur and upper leg regions.
Trunk, back and pelvis refers to injuries of the: central front, back, buttock, flank, lower chest, lower quadrant, upper chest, pelvis, sacral, thoracic, upper quadrant, and lumbar.
Shoulder to hand refers to injuries of the: elbow, hand, lower arm, shoulder, upper arm, and wrist.

Discussion

Patients who experienced repeat EMS-attended falls accounted for 29% of all patients attended in response to fall-related incidents. Repeat falls patients also accounted for nearly 60% of all EMS-attendances to fall-related incidents, in the same time period. The results of this study confirm previous findings that a large proportion of EMS workload relating to falls is attending the same patients repeatedly.

There is a growing body of literature indicating that older adults are increasingly using EMS services in response to falls, as they are a vulnerable population at risk of repeat falls (23). Our study findings are consistent with a study from the USA that showed nearly one third of older adults who called 911 for a fall, called EMS again for fall assistance (9). Similarly, our results of showed that time between subsequent falls decreases, with consecutive falls (9). This was shown in an EMS system with no scope for the referral of adults who fall to other health care providers (9). This is similar to WA where there are no alternative referral pathways available to EMS clinicians when managing patients who fall, until after ED attendance. Other options available internationally, such as the Falls Decision tree with the London Ambulance service (24) or St John New Zealand's referral to their falls prevention service (25), are established examples of alternate referral pathways in the prehospital setting. Demand for EMS by older adults who fall, when not addressed with interventions to foster falls prevention, has increased since 2000 (1, 2, 4, 13, 26).

Our findings show that older, uninjured, non-transported patients have an increased odds of sustaining a second EMS-attended fall within 30 days and 12 months of their initial fall. Transport to hospital became progressively less frequent with subsequent calls, which is consistent with findings from Quatman et al. in a study based in the USA (9), which showed a reduction in transport frequency from 75% of first calls to 21% after the fourth call. Patients

transported (via any urgency) at their first EMS-attended fall, have a reduced odds of a second EMS-attended fall within the subsequent 30 days or 31 day to 12-month period. Tiedemann et al., (23, 27) recommended that the identification of individuals in Australia at high risk of future falls, for onward referral to prevention interventions may reduce EMS-attendances for repeat falls. Our findings show that patients transported at their first fall were less likely to sustain repeat falls. This is potentially the result of patients experiencing onward referrals to preventative interventions during emergency departments or hospital admission, although this requires further research (23, 27). While some patients who fall and require EMS, do not require transport to hospital, guidelines for EMS clinicians to identify and target these high-risk patients, and to refer to alternative falls programs, could be beneficial in addressing this growing demand (26, 28-31).

The findings of our WA study show that 9% of patients who sustained repeat falls, experienced a repeat transport within 30 days of their index fall. Evans et al., (USA) found 18.3% of EMS-attended patients who fell experienced a repeat transport in 30 days, higher than our findings at 30 days (11). This difference may be due to geographical differences in study location, as WA has a much larger area than North Carolina, with North Carolina accounting for only 5% of the square kilometers of WA. When comparing findings across different EMS, it is important to consider differences in primary care and available alternative referral pathways.

The effectiveness of falls prevention programs has been demonstrated globally (9, 12, 32-34). A systematic review and meta- analysis (34), indicated that RCT's of falls prevention programs effectively demonstrate a reduction in falls rates by between 9% and 10% in multifactorial interventions (26, 28, 34, 35). Research into the implementation of referral pathways by EMS identified facilitators and barriers when implementing prehospital

guidelines (26, 28, 29). Further exploration of EMS organizational structures that currently work effectively with referral pathways, could assist in diversifying strategies to approach the development of prehospital guidelines for referral to other services (26, 28, 29). Despite the evidence supporting the efficacy of falls prevention programs, a communication gap exists between EMS and community-based allied health and alternative health care pathways (9, 27, 31, 34, 35).

Limitations

There are several limitations of our study. This study only included those falls patients who were attended by the EMS and so any patients who experienced falls or repeated falls and were privately transported or did not call EMS are not included. This data set includes only those who called '000' for EMS, which potentially underrepresents those who received care and support for falls in residential aged care facilities and social care in their homes. Socioeconomic, disability, comorbidity status and general medication use are not recorded in the ePCR or CAD and therefore, were not included in this study.

The authors are confident that all efforts have been made to identify any missing falls cases through a combination of manual searching by multiple researchers (PMW, HT, PB, DM), machine learning and natural language processing for data identification (17). Machine learning and natural language processing to identify falls in electronic patient care records from EMS-attendances is a strength of this study, as only 60% of falls cases identified through manual review were actually dispatched as 'falls'. This is particularly novel as several previous studies have identified falls solely on the basis of a 'falls' EMS dispatch code (4, 36, 37). The results of our study may not be applicable to other EMS with different EMS staffing profiles and policies.

Conclusion

Considering all EMS-attended adults who fell, nearly a third experienced repeat falls. Of these patients, 59% sustained their second EMS-attended fall within 12 months of their first fall. EMS-attended adults sustained falls in a shorter time frame, with every additional fall experienced, reinforcing the importance of identifying patients who sustain a second EMS-attended fall. Future research exploring EMS-attended falls would benefit by identifying repeat falls, to expand on contributing factors to EMS demand. It is important to consider patients attended by EMS repeatedly for falls when addressing prehospital falls management guidelines. Further exploration of the role EMS clinicians play in identifying and referring patients who sustain repeat falls into alternative pathways is needed. This could potentially be supported by the development of specific education, protocols and guidelines for the prehospital management and referral of older adults who fall.

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Declarations of interest statement

RB is a current employee of St John WA and DB is a past employee. JF holds an adjunct research professor position with St John WA and receives research funding from St John WA.

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End of Manuscript

6.2 Extension of Results

All findings from the retrospective cohort study in this chapter were reported in the submitted manuscript to *Prehospital Emergency Care*, although not all tables and figures presenting these findings were able to be published. The remainder of this chapter presents the unpublished figure and tables:

- Figure 6.1 shows all 77,087 adults, who were attended a total of 128,588 times, who sustained one or more ambulance-attended falls (index fall between 1st January 2016 – 31st December 2020).
- Table 6.1 shows first observations at each fall, in 77,087 ambulance-attended adults who fell.
- Table 6.2 shows a summary of 77,087 SJWA attended patients and excludes 536 (0.007%) patients due to unknown sex demographic data.

Figure 6.1
Ambulance attendances

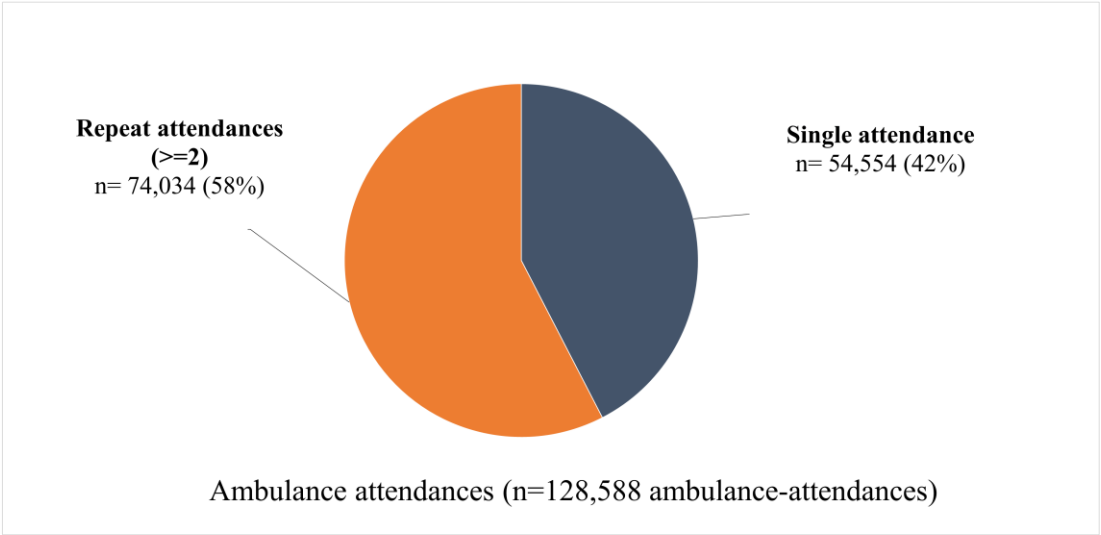


Table 6.1
First observations at each fall, in 77,087 ambulance-attended adults who fell

	Falls sustained					
	One fall	Repeat falls (multiple falls)				
			Total number of falls sustained (data from final fall)			
	Index fall (only fall) *n=54,554*	Index fall (first of multiple) *n=22,533*	2 *n=11,815*	3 *n=4,848*	4 *n=2,310*	5+ *n=3,560*
Males	**23,768**	**9,255**	**4,821**	**1,965**	**941**	**1,528**
First observations (n)						
GCS						
13-15	21,853	8,862	4,514	1,835	870	1,426
9-12	643	181	169	65	41	52
6-8	136	25	25	8	5	6
3-5	154	13	21	8	3	4
Pain score						
0	14,542	6,625	3,487	1,490	755	1,234
1-3	2,863	1,131	569	209	87	142
4-6	2,265	638	306	111	45	80
7-9	2,889	632	335	112	40	52
10	1,209	229	142	36	15	19

	Falls sustained					
	One fall	Repeat falls (multiple falls)				
			Total number of falls sustained (data from final fall)			
	Index fall (only fall) *n=54,554*	**Index fall (first of multiple)** *n=22,533*	**2** *n=11,815*	**3** *n=4,848*	**4** *n=2,310*	**5+** *n=3,560*
Females	**30,280**	**13,248**	**6,974**	**2,876**	**1,367**	**2,031**
First observations (n)						
GCS						
13-15	28,758	12,814	6,604	2,712	1,294	1,901
9-12	528	169	189	88	44	74
6-8	94	21	35	7	4	8
3-5	78	6	13	8	3	2
Pain score						
0	15,124	8,319	4,480	1,992	961	1,536
1-3	3,892	1,803	898	377	168	235
4-6	3,703	1,134	608	205	90	105
7-9	5,298	1,419	682	213	114	111
10	2,263	573	293	96	35	45

Table 6.2
Interventions in 77,087 ambulance-attended adults who fell

	Falls sustained					
	One fall	Repeat falls (multiple falls)				
			Total number of falls sustained (data from final fall)			
	Index fall (only fall) n=54,554	Index fall (first of multiple) n=22,533	2 n=11,815	3 n=4,848	4 n=2,310	5+ n=3,560
Males	**23,768**	**9,255**	**4,821**	**1,965**	**941**	**1,528**
Interventions (n)						
Medications						
Fentanyl (IN)	21,853	8,862	4,514	1,835	870	1,426
Fentanyl citrate (IV)	643	181	169	65	41	52
Ketamine (IV)	136	25	25	8	5	6
Methoxyflurane (IH)	154	13	21	8	3	4
Normal saline (IV)						
Ondansetron (O)						
Ondansetron wafer (O)						
Oxygen (NP)						
Paracetamol (O)						
Other interventions						
3 lead ECG	2,863	1,131	569	209	87	142
12 lead ECG	2,265	638	306	111	45	80
Blood taken	2,889	632	335	112	40	52
IV cannulation	1,209	229	142	36	15	19

	Falls sustained					
	One fall	Repeat falls (multiple falls)				
			Total number of falls sustained (data from final fall)			
	Index fall (only fall) n=54,554	Index fall (first of multiple) n=22,533	2 n=11,815	3 n=4,848	4 n=2,310	5+ n=3,560
Females	**30,280**	**13,248**	**6,974**	**2,876**	**1,367**	**2,031**
Interventions (n)						
Medications						
Fentanyl (IN)	5,629	1,780	721	255	128	85
Fentanyl citrate (IV)	16,970	4,632	1,464	499	165	135
Ketamine (IV)	495	115	44	16	11	8
Methoxyflurane (IH)	7,436	1,704	590	182	59	67
Normal saline (IV)	968	259	99	29	6	18
Ondansetron (O)	2,080	575	198	74	19	17
Ondansetron wafer (O)	2,519	689	302	97	41	50
Oxygen (NP)	1,786	621	302	97	41	50
Paracetamol (O)	3,476	1,033	446	135	50	63
Other interventions						
3 lead ECG	3,018	1,436	615	220	91	109
12 lead ECG	934	401	206	56	28	29
Blood taken	735	258	118	30	19	15
IV cannulation	7,030	2,082	777	270	85	84

These groups are not mutually exclusive and present the total times medications and interventions were administered/delivered.
IV: intra venous. IN: intra nasal. IH: inhalation. O: oral. NP: nasal prongs. Normal saline = 0.9%. Medications and other interventions present the total number of times administered by sex. ECG: Electrocardiogram.
Total number of falls sustained demonstrate the interventions delivered at the final fall sustained. The final fall recorded was used to determine total number of falls sustained.

6.3 Summary of Chapter Findings

This chapter provides a state-wide retrospective cohort study detailing ambulance-attendances for adults with repeat falls. Nearly 30% of all patients attended by an ambulance for a fall, sustained repeat falls, and collectively accounted for nearly 60% of all ambulance-attendances to fall-related incidents. A Kaplan-Meier analysis demonstrated that time between ambulance-attended falls decreased significantly the more falls a patient sustained. Patients identified as male, attended via priority 2 or 3, 65 years of age or older, not transported, or uninjured, at their first ambulance-attended fall, had an increased odds of experiencing a second ambulance-attended fall in the 30 days and 31-365 days following their index fall. The next chapter presents an exploratory qualitative study of paramedics' experiences attending and managing patients who have fallen in the WA prehospital setting.

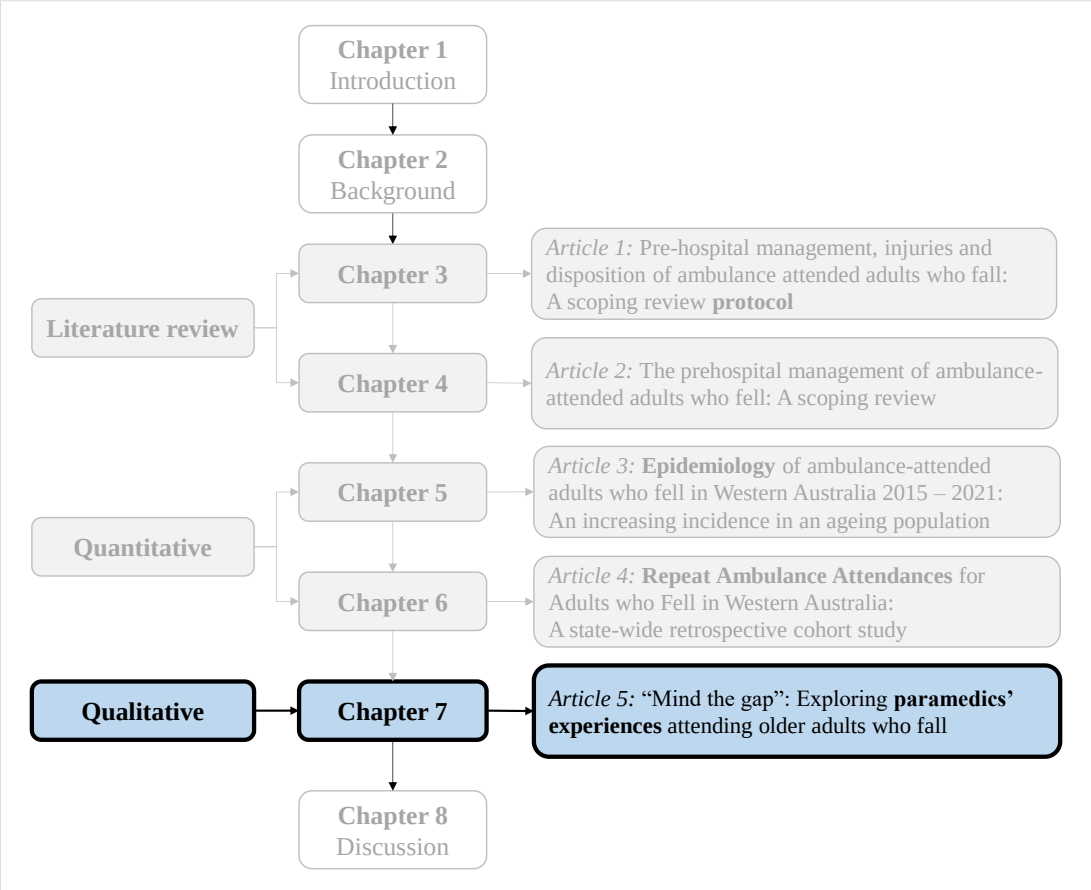
Chapter 7

Paramedic Perspectives about Falls

7.1 Overview

This chapter explores the perspectives of paramedics attending and managing adults who fell. In this exploratory qualitative study, paramedics completed semi-structured interviews to explore their experiences about falls in the prehospital setting. The findings are reported in a peer-reviewed manuscript that is published in *Australasian Emergency Care*.

Thesis Context



Article 5 "Mind the Gap": An Exploratory Qualitative Study of Paramedics' Experiences Attending Older Adults Who Fall in Western Australia

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Research paper

"Mind the gap": An exploratory qualitative study of paramedics' experiences attending older adults who fall in Western Australia

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ABSTRACT

Purpose: To explore paramedics' experiences and perspectives about attending and managing older adults who had fallen.
Procedures: This qualitative, exploratory study used a purposive sample of paramedics in Western Australia. Participants had at least one year of clinical experience. Semi-structured interviews were undertaken. Data were analysed via an inductive thematic approach.
Findings: Fourteen paramedics were interviewed (Median age: 38 years, n = 5 females). The main theme identified that experiences were positive when attending patients with high-acuity medical problems or injuries following falls because binary decision-making (transport vs non-transport) was appropriate. Themes highlighted that decision-making for low-acuity falls attendances was a complex balance between 1) patient context, 2) risk management, 3) paramedic reactions, and 4) the lack of alternate referral pathways available. Experiences could be stressful and frustrating when attending falls call-outs for older adults with no injuries or medical problems. Participants concurred that when transport to hospital was not required there were no available, alternative pathways to refer onwards for appropriate health or social care.
Conclusion: Attending low-acuity call-outs for falls was often frustrating and required complex decision-making, with gaps in services identified. Further exploration of alternative referral pathways for health care for pre-hospital management of adults who fall is required.

Introduction

Emergency medical services (EMS) dispatches to falls are increasing in Australia, [1,2] and are often the first point of medical attention for individuals who have sustained a fall. Falls are the most frequent reason for injury-related hospitalisations, contributing to 42% of hospitalised injuries in 2019–2020 [2]. Fall injuries and subsequent hospital or emergency department (ED) admissions most frequently occur in older adults (> 65 years of age) and are most likely to occur at home [2]. The number of older adults admitted to hospital after a fall has been increasing annually and, although the number of admissions dropped in 2020 during the coronavirus (COVID) pandemic social restrictions, by June 2020 the number of older adults hospitalised for falls returned to pre-pandemic levels [2].

Globally, research has focused on evaluating EMS providing health and social referrals to suitable community services for patients who do not require transport to hospital after a fall, using decision support tools (i.e., London Ambulance Service (LAS) Falls Decision tree [3] or the St John New Zealand referral to the falls prevention service [4]) to standardise decision-making [5–7]. However, findings to date have not identified if these service changes improve older adults' outcomes after a fall and if they can be implemented into health services.

Road-based EMS in the state of Western Australia (WA), cover the largest area of any single ambulance service in the world [8,9]; with approximately 770 paramedics in the Perth metropolitan area, and 3200 volunteers and 90 paramedics in country WA [8,9].

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In WA, people who fall can be transported to hospital following ambulance-attendances or not transported and remain at home. An ambulance responding to a patient is allocated to respond via a priority 1 (emergency), priority 2 (urgent), or priority 3 (non-urgent). Between 20–23% of patients who fell were not transported to hospital following an EMS attendance between 2015–2021 [3]. To date, there are no alternative referral pathways for health care currently available to EMS staff across WA when managing patients who fall.

Paramedics' perceptions about whether there is organisational support for their decision not to transport to hospital, influences their response to falls [10,11]. Paramedics' confidence in their own clinical decision-making is also influential in their response to falls [10,11]. Understanding paramedics' experiences, attitudes and actions when attending older adults who have fallen can assist in informing emerging alternative interventions and pathways. This is critical, given the potential for older people to experience poor outcomes after falling such as fear of falls, functional decline, loss of independence,[12,13] the substantial cost of providing ambulance services,[14–16] and the need for paramedics to make decisions about which patients need transport to hospital and who can be safely managed at home [17].

Previous studies have examined EMS decision-making about whether to transport older patients who have fallen to hospital. However taking a broad perspective to further understand the experiences of paramedics' attendances to older adults who fall can assist in providing new insights into delivering effective care for older people who fall, including care from EMS. Findings from a scoping review suggested that evidence of EMS's management for falls is limited and the review concluded that more research regarding prehospital interventions, transport decisions and alternative referral pathways for health care is required [18].

Exploring paramedics' experiences of their journey from call dispatch to discharging patients from prehospital care, and their perceptions about the management of older patients who fall, can provide a valuable insider perspective about these increasingly used services. This is particularly relevant in the local setting of WA where no alternative referral pathways are currently offered by paramedics in the prehospital setting. The objective of this study was to explore paramedics' experiences and perspectives about attending and managing older adults who had fallen. Findings aimed to inform future planning for the management of EMS services for older adults experiencing falls in WA.

Methods

Study design

An exploratory qualitative study using semi-structured interviews was conducted. We took an experiential approach to explore participants' own meanings, experiences and perspectives when attending falls call outs [19]. An inductive thematic analysis was undertaken as this type of analysis allowed us to develop themes strongly linked to the data collected [19]. The study was reported following the COnsolidated criteria for REporting Qualitative research (COREQ) [20]. The COREQ checklist is shown in Appendix 1.

Participants and setting

A purposive sample of paramedics and ambulance officers, with at least one year (working either full time, or part time equivalent, of one year) of clinical experience working on-road in WA formed the participant group [21]. Experience was sought so that participants would have attended a number of call outs for older people with falls and have relevant feedback to offer. Researchers aimed to include at least two paramedics from rural WA in the sample. All paramedics and ambulance officers who met the inclusion criteria were invited to participate; and those who agreed provided written, informed consent.

Participants were recruited between July and December 2021. Physical and virtual flyers were distributed in ambulance depots, via yammer (work based social media platform), and via email. Snowball sampling [19,21] and word of mouth contributed to the recruitment process. Paramedics who contacted the researcher (PW) were given a verbal explanation about the study and written plain language statement. Paramedics who agreed to participate provided written informed consent and verbal consent immediately prior to the interview (conducted by PW).

Data collection

Semi-structured interviews were planned to be approximately one hour, with extra time allowed if necessary. Interviews were audio-recorded and conducted in a private and quiet place, to ensure a comfortable environment for the participants. Interviews were conducted virtually when required due to geographical location. A 5-step process to develop the semi-structured interview topic guide was used [22]. This consisted of 1) identifying the prerequisites to use a semi-structured interview, 2) reviewing the literature to critically appraise previous knowledge, 3) developing a preliminary guide, 4) pilot testing the interview guide and prompts prior to 5) presenting the completed interview guide for use [22]. Each of the questions were open-ended and contained prompts for the interviewer that encouraged exploration and expansion of the participant's reflections on their experiences. The participants were made aware of their rights to leave and anonymity of the transcripts before a recording device was turned on and the interview started. The semi-structured interview topic guide used in this study is included in Appendix 2. Demographic information was collected from participants at the commencement of each interview, including age, gender, work experience (years), and rural status. Two primary researchers (PW, AMH) conferred and reflected on the data as interviews progressed. The researchers agreed that sufficient data saturation was achieved after 14 interviews, with replication of data noted and sufficient data available to answer the research question [23].

Qualitative enquiry can be influenced by the researcher's prior assumptions and experiences [21,24]. Reflexivity was undertaken by the primary researcher (PW), a doctoral candidate with a background of exercise, sports, and rehabilitation, who received training in qualitative research and worked closely with a paramedic group throughout their research training. The researcher gained an understanding of the paramedic role prior to the study by talking with paramedics and visiting their places of work. However, they did not have a prior relationship with the participants in the study. Reflective journaling by the researcher throughout the research process, including after each interview, aimed to enhance the trustworthiness and confirmability of the findings [21]. The primary researcher met with a second researcher at intervals to reflect on the research procedure [24]. Employing the concept of bracketing throughout all stages of the research was an ongoing process that assisted the researcher to set aside their pre-conceived beliefs and biases and retain the authenticity of the participants' perceptions and experiences [21,25]. An audit trail was constructed to demonstrate dependability, by clearly detailing all aspects of the research process. Member checking was conducted at the conclusion of each interview, with the researcher summarising the results of the interview from their perspective and asking participants if it reflected their understanding of the interview. The combination of these processes aimed to enhance the trustworthiness of the findings [21,24].

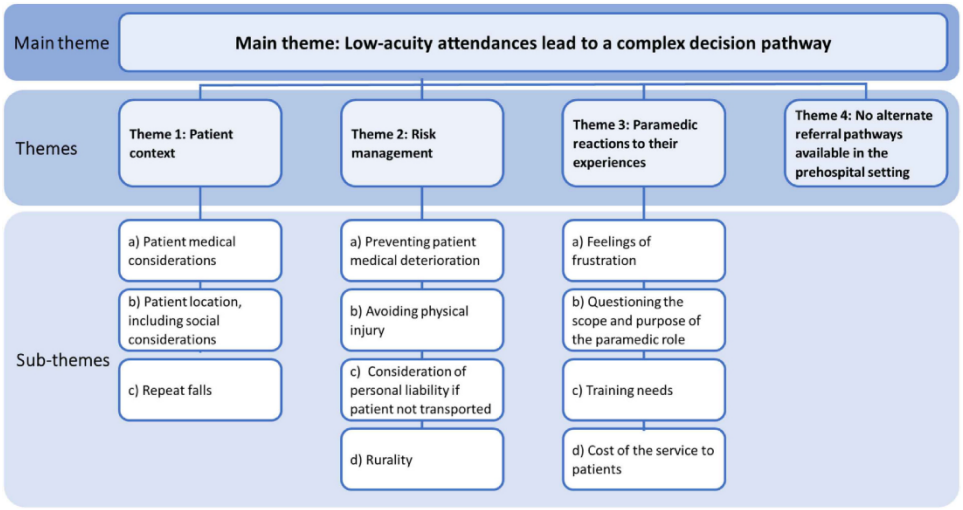

Fig. 1. Thematic map.

Data analysis

Descriptive statistics were used to summarise participant characteristics using STATA (Stata 16 Base Reference Manual, 2019. College Station, TX: Stata Press). Audio recordings were transcribed verbatim and uploaded to NVivo Software (QSR International Pty Ltd, 2020) for management and analysis. The primary researcher (PW) familiarised themselves with the data, by listening to audio recordings, reading the de-identified transcripts multiple times, and recording all potentially interesting items to ensure a thorough understanding of the data set [19]. An inductive approach, whereby a 'bottom up' method of generating and identifying themes, was utilised so that that final themes would be strongly linked to all collected data [19]. The analysis moved through a six-step process and took a 'back and forth' approach throughout. Coding of half the data was completed independently by two researchers (PW, AMH) and examined for thematically interesting items to create initial 'codes' [19]. After coming together to compare and agree on initial codes, coding was conducted by the two researchers to code all data. Initial candidate themes were generated continuously; the themes were refined throughout the data analysis phase, and all coded data pertaining to those initial candidate themes were collated. These initial candidate themes were reviewed, producing an initial thematic map of candidate themes and sub-themes and their relationships. These themes and subthemes were reviewed again alongside the coded data to ensure they were representative of the whole data set. The themes and relationships were reviewed by a third researcher (PB) and final consensus reached after discussion by all three researchers. Once the research team had completed these stages, a final thematic map was created. This thematic map (see Fig. 1) graphically represented the relationships of the main theme, themes, and each sub-theme. Themes were illustrated with original verbatim participant data. To enhance the presentation of the findings in a way that showed the relationships of the themes through time "from call dispatch to final patient discharge from EMS", researchers also used the thematic map to create a graphical flow chart of the results [26].

Ethical considerations

This study received Curtin University human research ethics committee approval (HRE2021–0100) and approval from St John WA Research Governance Committee.

Results

Fourteen paramedics (Participants= P#) were interviewed. Participant characteristics are presented in Table 1. Participants came from the Perth metropolitan region in WA and from rural regions that encompassed northern, eastern, and southern rural WA. The main theme identified that low-acuity attendances lead to a complex decision pathway. Four themes supported this main theme: 1) Patient context, 2) Risk Management, 3) Paramedic reactions to their experiences and 4) the lack of alternate referral pathways available. The main theme, themes, and supporting sub-themes are shown in Fig. 1.

Main theme: low-acuity attendances lead to a complex decision pathway

Paramedics' experiences from receiving the call-out to making a transport decision are presented as a decision-making pathway in Fig. 2. The main theme identified that ambulance-attended patient falls were not always suited to the binary nature of transport decisions (non-transport/transport to hospital). The binary decision pathway was perceived as ineffective because "most falls are only a Priority 3″ (P12) but "we can't really do anything else, like it's leave or take" (P13). Paramedics described a complex decision-making

Table 1
Participant characteristics.

N = 14	
Age Range, (years)	(29 - 49)
Median age [Interquartile range (IQR)], (years)	38 (34 - 42)
Gender, n (%)	
Female	5 (36)
Male	9 (64)
Work experience (years working) Median (IQR)	5.25 [3-6.5]
Virtual interviews via Zoom Yes, n (%)	8 (57)
Rural experience (past or present) Yes, n (%)	4 (29)
Years working	
< = 4.9 years	6 (43)
5-9 years	6 (43)
> = 10 years	2 (14)
Interview duration (minutes) Mean [standard deviation (SD)]	64.2 [23.2]

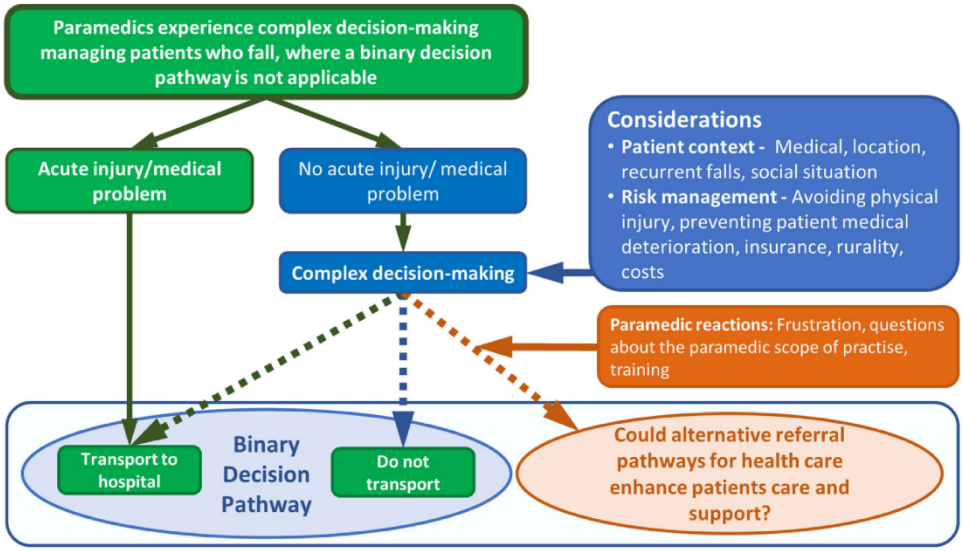

Fig. 2. Flow chart of the decision-making pathway of paramedics when attending patients who fell.

pathway when managing older adults who fell, if they did not present with an injury or acute medical problem (low-acuity) that required emergency transport to hospital. Decision-making in these situations was often experienced as constituting a difficult balance between risk management and patient considerations.

> "If the patient's got a femur fracture, you know you are going through to a resus bay, you know you're going to be moving that patient on to definitive care whereas if you've got a patient who's just had a minor fall with a small head laceration that you might be sitting on the ramp for six hours… trying to keep this dementia patient calm" – P7.

When patients had no apparent injury or acute illness, paramedics' experiences of deciding to transport a patient to hospital or not, following a fall, were described within four themes: 1) patient context, 2) risk management, 3) paramedic reactions to their experiences and 4) no alternate referral pathways available in the prehospital setting.

Theme 1: patient context

When deciding whether an adult with no or minor injuries and no acute medical problems should be transported to hospital, paramedics first prioritised the patient context, with sub-themes identifying a) medical considerations, b) location, including social considerations and c) repeat falls.

a) Patient medical considerations
Paramedics who attended older adults for falls considered circumstances that could indicate medical instability, including, "how long they have been down on the floor, because that can cause its own complications" (P14). Medical considerations could be difficult to evaluate because although transport presented as a safe option, participants commented that "transporting someone to hospital is not always in the best interest of the patient" (P14). Falls were often described as "unwitnessed", where the attending paramedic could not be certain about the fall mechanism, leading paramedics to consider possibilities of developing injuries, such as traumatic brain injury, in their decision-making process. One participant stated, "…she may have just overbalanced, or she may have been dizzy, had a cardiac episode, who knows, and she has obviously impacted her head, however, she's not on any blood thinning or anticoagulant medication" (P5). This meant that if follow-up medical care could not be provided in the community, transport to ED was the only safe option.

b) Patient location, including social considerations
Obtaining an adequate medical history from community-dwelling patients could be challenging, and in that instance RACF were viewed positively. One participant summarised that, RACF "generally have a very good grasp on the patient's medical history, medications, allergies" [14]. Older adults living in RACF also generally had more support, "You often have more people around in a nursing home too, that can help you lift" (P6). However, paramedics noted that decision-making was often impacted by RACF during a call-out, as "Nursing homes have a policy if somebody falls you need to call an ambulance" (P14). Paramedics felt that transport decision-making in those circumstances was not based solely on clinical judgement but rather on the RACF policy, "Even if the patient doesn't appear to have any injuries … they'll be transported purely because it's policy from the nursing home to transport anyone who fell" (P6). Conversely, some RACF presented institutional barriers to EMS responses, "There're some really fantastic facilities … then you go to other facilities, stand at the front door for 15 mins before anyone even comes to let you in, and they don't know who you're there for" (P4).
When family disagreed with policy in RACF it created conflict, "Staff … want her to go, so then it becomes a fight between family and then it's just like hold on a second, who actually has rights here?" (P4). Paramedics who described the problem of ramping, particularly regarding non-acutely injured patients, expressed how they were expected to transport all patients and felt pressured by families, their employing ambulance service and RACF.
Community situations in the older adult's home and the social support available could cause concern and led to difficulty in making decisions regarding transport. Although an older adult

may have had no injury, paramedics sometimes noticed that they were not coping at home, "It's not a safe environment, you think someone needs to go there and give them a hand, you look at the carer, and they just can't do it, they just need that break" (P8).

c) Repeat falls
Paramedics reported attending falls call-outs for the same older adults repeatedly, where no clinical need to transport was identified. This caused concern with one paramedic stating:

> "If we go back within the same night, I always say to them… you're more than welcome to stay at home… we won't kidnap you. I haven't seen anything that we need to treat, but if we do get a second crew come back out tonight… then basically, we'll be asking you to come with us" – P8.

Another paramedic noted that "…there can be something that is causing them to fall quite regularly" (P8). Older adults who had recurrent falls engendered comments such as "…they may need full-time residential care or more than just… community nursing… a couple of times a day" (P14).

Theme 2: risk management

Paramedics' experiences when responding to low-priority falls included managing risks to patients and themselves. Four subthemes were identified: a) preventing patient medical deterioration by avoiding risks associated with unnecessary transport and ramping, b) avoiding physical injury to themselves, c) consideration of personal liability in non-transported patients and d) rurality. Some paramedics were concerned about the time spent on low-priority calls and the potential compromise to their services, with one participant stating that "as you got out the van, to come and see this patient, you heard a resus go off just down the road and the nearest crew, you know is 30 min away" (P4). This created challenges for participants as they believed "…we need to be out there dealing with emergencies" (P4).

a) Preventing patient medical deterioration
Paramedics repeatedly stated that "transporting someone to hospital is not always in the best interest of the patient" (P14). They perceived that ramping could be associated with adverse consequences for older patients. One participant stated "… you're probably actually starting the pressure sore process just by being on that bed" (P5). Another participant stated that "our stretchers are not comfortable for oldies, they've got no meat on their bones the stretchers are limited in their positioning…. we'll be looking after someone for up to three-four hours on the ramp" (P8). Another participant described exposure to potentially unnecessary risks. "This lady is elderly and already at risk of picking up any other communicable diseases while she's up there (referring to hospital ramping queue)" (P3). Additional considerations for patients with dementia were reported because "ripping them out of their room at three in the morning because they've fallen over but they have no injuries, is not OK" (P2).

b) Avoiding physical injury
Early to mid-career paramedics had different perspectives about manual handling compared to more experienced paramedics, identifying that "paramedics get injured all the time… everyone, knows someone with a back injury" (P3). These participants challenged existing practice by "doing anything to reduce the manual handling that I have to participate in" (P2). Strategies to avoid physical injury included to: "organise another crew" (P6) and, lifting the adult "once the Emergency Lifting Cushion (ELK) arrives" (P5) although one noted that "the ELK is 4 h away" (P4).

c) Consideration of personal liability if patient not transported
Paramedics follow St John Western Australia Ambulance Service clinical practice guidelines and some participants felt a pressure to transport to address their concerns about personal liability. "I was surprised when I started this job, how many people we don't leave at home… there's nothing wrong with them, but we take them just in case, I think it's the culture" (P9). Another participant explained the concern about liability by describing how transport to hospital meant that the paramedic could transfer responsibility for the patient's outcomes from themselves to the hospital. "Instead of it being a holistic thing where we consider the patient… we're ticking a box to say that we've sent this patient in because it's not my problem anymore" (P6).

d) Rurality
Differences in resource availability between rural and metropolitan WA were identified by paramedics to evoke risk considerations when deciding whether to transport. "In the country, there is no backup crew, or if the backup crew is coming, it's just volunteers, so the scope of practice and abilities is quite less" (P5). Other participants noted that rural hospital resources were not sufficient for timely transport. "If there was a long bone fracture you would bypass and go straight to [regional hospital] because they can't do that here" (P5). When working rurally, absence of timely back up ambulance resources could potentially have a negative impact on the patient's experience and pain management. This was explained by one participant who stated:

> "A long wait is 45 mins for a backup, that's your pain relief exhausted because you've got only two doses. So, you are looking at having someone who potentially is going to be very uncomfortable" – (P8 reflecting on their past experience as a volunteer working in rural WA).

Participants recognized that rural settings had "a lot more of a community feel in itself" (P5), where "there is a very big, aged community" (P5). The smaller settings were viewed as advantageous in certain circumstances. "It's a much easier process, and a kinder process, which leans towards, we'll just take you in because that is easy, and ultimately better for everyone" (P5). This paramedic contrasted the rural experience with the large metropolitan center by saying that transport caused "…less worry of time frames, you could take as long as you wanted (rurally) whereas here (metro) you're like quick quick quick, less time is best time" (P5).
The difference in equipment availability, such as the ELK, was identified by all rurally experienced participants as an important consideration. "There's no fancy tools, there is no ELK, there's no tools for obese patients, it's literally more people, when you can find them" (P5). This was contrasted with metropolitan areas: "In metro you are fortunate because you know there are other ambulances on the road, and they are single responder cars, you know that there are clinical support paramedics, area managers, they are the ones who carry the ELK" (P12).

Theme 3: paramedic reactions to their experiences

Participants' reactions to their experiences of falls call outs were identified in four sub-themes: a) feelings of frustration b) questioning the scope and purpose of the paramedic role c) training-needs and d) cost of the service to patients.

a) Feelings of frustration
Frustration was commonly experienced when attending low priority falls call-outs as "…you spend so much time training on a lot of the higher-acuity jobs, like resuscitation … going out to a low priority patient who's fallen over isn't as exciting" (P2). This perspective created further frustration as "…there's nothing else we can do" (P5). Paramedics felt there was nothing they could do as "…I just don't think that we're given the tools or the guidelines to make a lot of those decisions" (P3). The patient's frustration,

when apparent, impacted paramedics with one stating that they had to witness "…disgruntled displays with themselves (the patient), displays with a system, frustrations at their own lack of mobility or situation" (P11). Paramedics felt frustrated when attending falls call outs at RACF because transport decisions were often based on the RACF policy rather than on their clinical judgement. One participant commented "… it doesn't matter what we do or say or assess, if we're told we have to take a patient in, we have to do it anyway" (P6).
Some participants expressed empathy towards older adults, "they're really enjoyable jobs because I love their old stoic nature" (P11), but overall paramedics concurred with the frustrating and negative emotions expressed when attending low -priority falls call-outs.

> "there's a lot of negative perceptions on the way to falls…. because straightaway it's frustration due to all the things we talked about, lack of pathways, the sadness of them falling and independence being lost and further inequality of life… and then family not helping, or… not enough social support" – P5.

b) Questioning the scope and purpose of the paramedic role
Paramedics questioned the scope of their role, comparing the type of call outs with the scope of practice allowed; "Our options are, take them to hospital or leave them at home" (P9). This was challenging for participants who stated that "…If we leave, we can't take them anywhere else" (P9). One participant reflected that they were doing "a lot of low-acuity work, yet all our training is for high-acuity work, which is literally the same conversation that was happening in paramedicine 11 years ago" (P3). Ramping was viewed as further limiting paramedics' primary purpose as an emergency service provider, when considering older adults who fell and were transported, but were not admitted directly on arrival at ED. "There goes our day we're gonna be on the ramp" (P5).

c) Training needs
Participants felt that their training did not prepare them for the low priority falls call-outs. One participant summarised:

> "It feels like we've moved to this general acceptance that we're a health service… we still just train as an emergency service, so, yeah, we get taught how to lift people up and how to, you know, put him on the stretcher and take him to hospital" – P3.

Another participant stated "…there's not guidelines in place for a lot of these things, so a lot of it is done very ad hoc, which I find leads to depending on who you're working with" (P3). Another participant compared their experience to a previous job. "There are very different approaches to it, whereas when I've come from a service that had quite clear guidelines" (P3). This participant also stated "…I have never done any specific training of this is how you assess someone who's had a fall" (P3).

d) Cost of the service to patients
Paramedics identified that "cost is a big thing" (P8) and patients would tell them, "I can't afford an ambulance" (P8). Some paramedics shared that the cost of their services had become a difficult ethical dilemma in their day-to-day role, including whether or not to transport patients with minor fall related injuries.

> "It's hard, yeah, I mean you're telling people, you know, not to worry so much about the bill and worry more about themselves. The bill is still a very real concern and then a week or two time and they're gonna be receiving, you know, a pretty hefty bill for our actions" – P2.

Theme 4: no alternate referral pathways available in the prehospital setting

Participants' experiences attending low-acuity falls call-outs for older adults led them to strongly concur that alternative referral pathways were required. Participants considered some adults required non-emergency health care (e.g., general practitioners or allied health), but noted that these pathways are not available to paramedics in WA. The absence of alternative clinical pathways available to paramedics for older adults requiring non-emergency care was emphasised by participants with strongly expressed sentiments, such as "alternative pathways, should we have them, yes … nine times out of 10 they don't need an ambulance" (P5). Participants who had previous experience in other EMS services described clear guidelines available, explaining that:

> "I've also come from another service which has a lot more of a focus on safe non-transport or safe referral of patients versus my experience in WA is that there's not guidelines in place for a lot of these things, so a lot of it is done very ad hoc" – P3.

One paramedic described a home environment that could not be appropriately addressed due to the lack of referral options, "we can look around the house so we can say, this is massively hazardous" (P11). Multiple participants suggested that alternative referral pathways could optimise patient care as, "we're so risk averse that we end up taking people to hospital who don't arguably need hospital" (P9). One participant suggested that:

> "We need a few (services) … Then maybe you wouldn't overwhelm one service to the point that they go, No, we're not doing this anymore. And then definitely like a lower-acuity service that could go to these jobs that are triaged….and you know, upgrade if necessary." - P4.

Discussion

This study sought to explore paramedics' experiences and perceptions about attending older adults who have fallen. Overarchingly, paramedics attending falls described how they were often required to negotiate a complex decision-making pathway. The binary decision pathway of transport/non-transport to hospital that was effective for acute presentations, was described as unsuitable for the majority of fall call-outs, as most were low priority in nature. In WA, alternative referral pathways for health care were not available to paramedics. Paramedics were therefore forced to weigh up risks for the patients and themselves when attending patients that had no or minor injuries or other medical problems. This made decision-making complex for paramedics when managing non-acutely injured/unwell patients, who did not require emergency care in a hospital ED. Paramedics identified that alternative health care and referral pathways could potentially provide appropriate care to patients in RACFs, or those who do not require transport to ED and those living rurally who had minor ailments. These findings are supported by other trials that have implemented prehospital referral pathways [15, 27–29]. Pathways such as telephone clinical support, EMS-based screening and health promotion, and a service of extended care paramedics, (who treat patients at home), showed a reduction in avoidable conveyances and ED presentations [15, 27–29].

Paramedics' decision-making was impacted by patient factors, transport options, risk management and the paramedic role, highlighting how the complexity of decision making is intensified by the lack of support and guidelines for paramedics in their role attending falls. These findings are similar to a study in the UK that identified

that the complex-decision making processes for paramedics extended across the prearrival, initial contact, assessment and conveyance decision time [11]. Research suggests that prehospital care should move away from response-based interventions and towards proactive management of patients experiencing repeated falls with no injuries [13,30]. By providing support for paramedics in their decision-making, management and identification of patients, based on the patient's context, i.e., repeat falls, the complexity of decision making could potentially be reduced. Repeatedly attending patients who have recurrent falls was perceived by participants to account for a large proportion of EMS workload. In the UK, lift assist calls have also been found to be time-consuming and alternative solutions have been recommended to reduce the load on EMS [30]. Paramedics' transport decisions were influenced by confidence in the support provided by their ambulance service, similar to other states of Australia where paramedics had a lack of faith in receiving support for their decisions [10]. Ambulance services in England, [3, 11, 31] Canada, [30] and the USA [32] have identified this complex situation, and utilise detailed guidelines to support paramedics through this decision-making process [10].

Paramedics expressed strong feelings of frustration over falls call outs largely because they perceived they had no options for alternative management even though they observed that older patients required more support. Participants' reflections and feelings of frustration regarding patients who fall were also influenced by their perception of what constitutes real paramedic work. Some paramedics viewed their role in the healthcare system as solely delivering life-saving, emergency care to high-acuity patients [10]. This perspective evoked further frustration as they were aware that while attending low-acuity falls call-outs, they were unable to attend high-acuity life-threatening emergencies, similar to findings in Sydney, Australia [10]. They identified that they existed on a spectrum between holistic health service and emergency service, but still received training exclusively in emergency care. Therefore, they felt they could benefit from additional training or specific guidelines for managing low-acuity call-outs for falls. These findings are supported by research reporting that paramedics felt ill-prepared to manage cases involving older fallers [10]. Paramedic instructors believed current training practices for attending older adults who fall are insufficient [10]. Specific training and support for paramedics attending falls could potentially be beneficial given the growing demand for EMS attendances to falls.

Patients who fall and require an ambulance attendance account for a growing proportion of annual EMS workload. Our findings are similar to findings in the UK where lift assist calls have been found to be time-consuming and alternative solutions have been recommended to reduce the load on EMS [30]. Referral to other health care services can potentially be a successful way to manage this group, as shown by a trial in Sydney, Australia that found that subsequent falls attended by an ambulance may be reduced if there is high participant adherence to recommended interventions [33]. Interventions included: physiotherapy, home hazard assessments, optometrists, pharmacy, geriatric specialists, and outpatient assessments which linked patients into existing healthcare services following fall-related paramedic care [33].

The interviews within this study were conducted between July and December 2021, with prehospital staff working across the state of WA, therefore reflects the absence of any referral pathways. In March 2022, the state ambulance service introduced a clinical practice guideline (CPG) entitled 'Falls prevention guideline'. This directs paramedics to produce a Falls Risk Assessment tool (FRAT) score and deliver it to the attending staff in ED [34]. The publication of this guideline provides opportunity for the further development of specific guidelines that can guide the clinical practice of prehospital staff in their management of patients who fall in WA. [35–37] In October 2022, the WA state ambulance service started a trial to assess an alternative care referral pathway, providing fast in hospital access for older adults at one hospital in Perth, WA, 'The Rapid Access Clinic for the Elderly' [38]. This clinic aims to provide referral to falls prevention services offered for older people in the community and is similar to options available internationally, such as the Falls Decision tree with the London Ambulance service [3] or St John New Zealand's referral to their falls prevention service [4].

Strengths and limitations of the research

Strengths of the research included researcher triangulation in data analysis and using a reflective journal to reduce researcher biases [21]. Participants were noted to be comfortable with online communication during the COVID pandemic period and no differences in coding were found when analysing online compared to face-to-face transcripts. The study was conducted within one state of Australia and hence may not be generalisable to other ambulance services. Providing information regarding the health system in which this study was conducted alongside a transparent analysis of paramedics' experiences within this context aimed to improve the transferability of these findings for other health practitioners in EMS settings [19].

The tertiary qualification and Australian Health Practitioner Regulation Agency (AHPRA) registration required to work as a paramedic in Australia should be considered when contextualising these findings internationally, as education, training and guidelines were themes addressed within the research findings. We did not identify ambulance officer comments due to the small sample and the requirement for confidentiality, and some feedback may reflect a junior practitioner perspective. However, the median work experience of our group of 5.25 years did include the three ambulance officers.

Conclusion

Paramedics reflected that most falls call-outs were not suited to a binary decision pathway but required complex decision-making. Experiences of callouts for older adults who fell but had no or minor injuries, difficulty in deciding who should be transported and managing risk caused strong feelings of frustration among paramedics. and led some to question if the scope of their role was adequate for this patient group. The lack of available, alternative referral pathways for non-emergency health care was viewed as a gap that required addressing. Alternative referral pathways to other health or social care services could potentially support paramedics in their role as first responders, increase access to evidence-based care for older adults who fall, and reduce the number of older adults who are unnecessarily transported to hospital.

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Declaration of Competing Interest

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.auec.2024.01.004.

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7.2 Supplementary Material

Supp Figure 7.1 and Supp Figure 7.2 show the recruitment material used in the exploratory qualitative study to recruit paramedics via email and social media.

Supp Figure 7.1
Recruitment Yammer/Social media Post

Supp Figure 7.2
Recruitment Poster

7.3 Summary of Chapter Findings

This chapter provides a summary of paramedics' experiences when attending and managing patients who fell. After interviewing 14 paramedics, with up to 14 years of experience working in WA, the research team developed a graphical representation for the complex decision-making pathways that paramedics experience every time they attend a patient who had fallen. The main theme identified that low-acuity attendances lead to a complex decision-making pathway. Ambulance-attended patient falls were not always suited to the binary nature of transport decisions (non-transport/transport to hospital). Four themes highlighted that decision-making for low-acuity falls attendances is a complex balance between 1) the patient context, 2) patient and staff risk management, 3) paramedic reactions, and 4) the lack of alternate referral pathways available.

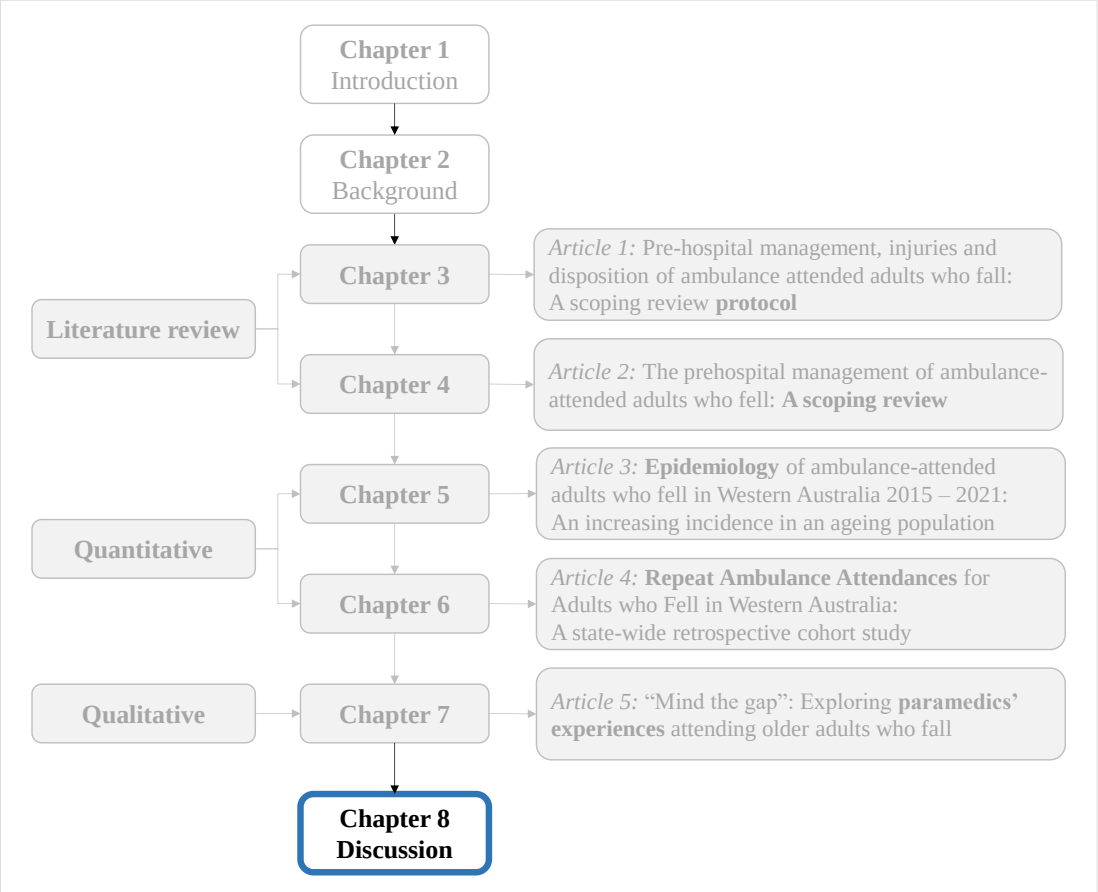
Chapter 8

Discussion

8.1 Overview

Within this chapter, I summarise the key findings of my doctoral research according to the research aim and objectives. I then synthesise these findings in the context of research literature and of local and global guidelines. I discuss the strengths and limitations of my research, and finally my recommendations to inform further research, policy and procedures, as they apply to local and international prehospital systems. This chapter concludes with how my research could support the development and implementation of specific CPGs and alternative referral pathways. This aims to support the improved prehospital management of ambulance-attended adults who have fallen, and the growing demand falls place on ambulance services. To ensure that the findings are relevant to industry, currently available CPGs, the current MPDS version, and alternative referral pathways available to ambulance services in the study settings were reviewed when making recommendations.

Thesis Context



8.2 Summary of findings

The primary aim of my research was to investigate adults (>=18 years) who experienced a fall and were attended by an EMS ambulance, in WA – from an epidemiological and health services perspective – with a view to better inform the prehospital management of patients who fall. The following section provides a summary of my research in relation to each of the four research objectives within this thesis. This research was conducted in a sequential approach, with the findings of each study informing the next.

8.2.1 Scoping Review

Article 1: The Prehospital Management of Ambulance-attended Adults Who Fell

As the first research objective of my thesis was to undertake a scoping review, I first produced a systematic scoping review protocol to ensure a rigorous methodology to guide the conduct of the systematic scoping review. The scoping review sought to explore the published prehospital falls literature to map and synthesise the evidence for the prehospital management of EMS-attended adult patients who fell, identify knowledge gaps and propose recommendations for further research of EMSs management of falls in the prehospital setting. I searched across six electronic databases using pre-set inclusion criteria to explore: ambulance-attended (context), adults (>=18 years) who fell (population), reported injuries sustained, interventions or disposition (transport) data (concept), before narratively synthesising the data. One hundred and fifteen studies were included and reported on patient demographic characteristics, mechanisms and injuries, interventions, and disposition.

The primary gap identified in this scoping review was that prehospital interventions, non-transport of patients and alternative referral pathways were rarely reported. Only 29% of sources reported on interventions provided such as life support, medication, immobilisation and lifts and extractions in the prehospital setting. There were 77 (67%) studies that reported on patients being transported to the hospital and their destination, while only 41 (36%) studies identified non-transport and referral pathways.

8.2.2 Retrospective Cohort Study: Epidemiology of Falls

Article 2: The Epidemiology of Ambulance-attended Adults Who Fall

Following the Scoping Review, I conducted a retrospective cohort study of ambulance-attended falls in WA. The objective was to describe the incidence rate and

characteristics of ambulance-attended falls in WA, including fall-related injuries, prehospital interventions delivered, and disposition (including transport to a hospital or otherwise) using St. John Western Australia (SJWA) ambulance data. An ordinal logistic regression was undertaken to analyse predictors of lower compared to higher transport urgency levels, for those patients transported to the hospital.

Between January 1st, 2015, and December 31st, 2021, there were 188,720 ambulance-attendances to fall incidents across WA. The age-standardised incidence rate for all ambulance-attended adults who fell; all patients with a reported injury; and all older adults >=65 years of age, increased between 2015 and 2021. The highest age-standardised incidence rate was in adult patients 85 years of age and over, increasing from 18,826 per 100,000 person-years in 2015 to 21,423 per 100,000 person-years in 2021. The incidence rate ratio was statistically significant (2015/2021 = 0.7816, p <0.001) and the incidence rate difference (-1:404, 95% CI -1:378, -1:434) between the two rates 2021 (1:88) – 2015 (1:112) was statistically significant (p <0.001).

Following ambulance-attendance, only 1% of patients were transported to the hospital via the highest urgency level, urgency one, a lights and siren ambulance. Most of the falls-related patients could be considered as 'low acuity', given that 62% were transported to hospital with urgency 3 or lower and 21% were not transported at all. Of this cohort, 99 (0.001%) patients were identified to have died at the scene. The ordinal logistic regression found that older, female patients had a higher odds of being transported to ED via a lower urgency.

8.2.3 Retrospective Cohort Study: Repeat Ambulance-attendances

Article 3: The Epidemiology of Ambulance-attended Adults Who Experienced Repeat Falls

After determining that the frequency and incidence of ambulance-attended falls was increasing in WA in the previous cohort study, I examined ambulance-attended adults who sustained repeat falls during the study period. I reported the descriptive epidemiology and mortality outcome of patients who sustained one fall compared to those who sustained repeat falls. Multivariable logistic regression was used to investigate the association between independent variables recorded at a patient's index fall and the likelihood of experiencing a repeat fall within two-time frames: i) within 30 days, and ii) between 31 and 365 days of the index fall. A Kaplan-Meier plot was

used to estimate the time (in days) between consecutive ambulance-attended falls, up to a patients fifth fall.

Of all adults who had ambulance-attendances for a fall-related incident, 29% (n=22,533) sustained repeat falls. These patients who experienced repeat falls, collectively accounted for 58% of all ambulance attendances to fall incidents. Within the cohort of patients who sustained repeat falls, 14% experienced their second fall within 30 days, and 46% within 31-365 days after the index fall. The Kaplan-Meier model results indicated that time between ambulance-attended falls decreased significantly the more falls a patient sustained. The multivariable logistic regression results, when considering data from patients' first ambulance-attended fall, those who were male, older adults, uninjured or not transported at their first fall, were significantly more likely to experience a second ambulance-attended fall within the subsequent 30 and 31 to 365 days.

In patients who experienced repeat falls, 80% were transported at their first fall, and subsequently 48% were subsequently transported to hospital (transported at first and second fall), within 365 days of their first fall. We found that 16% of patients who experienced one single ambulance-attended fall died within 12 months of their only fall. Twelve percent of patients who experienced repeat falls died within 12 months of their first fall, and 29% died within 12 months of their last recorded ambulance-attended fall.

8.2.4 Exploratory qualitative study

Article 4: Paramedics' experiences attending older adults who fall

The fourth study within this thesis was an exploratory qualitative study to ascertain paramedics' views and attitudes towards attending patients who fall, including those older adults who fall repeatedly, and the management of these falls' call-outs in WA. . A purposive sample of 14 paramedics with up to 14 years of experience working in the prehospital setting took part in semi-structured interviews, which were recorded and transcribed. The median work experience of the sample was 5.25 years (IQR: 3-6.5), including five females, and four rurally placed paramedics. The data were inductively thematically analysed.

Key Findings

The main theme of this study identified that paramedics' experiences were positive when attending patients with an acute injury or medical illness following a fall-related event, as binary decision making was appropriate (transport vs non-transport). However, attending patients who have fallen required complex decision-making pathways if the fall was low acuity in nature. Patients who did not present with an injury or acute medical problem (described as low acuity), were not always suited to the binary nature of transport decisions (yes/no) available to WA paramedics. This consideration led paramedics to question the current appropriateness of their scope of practice in attending patients who fall. Four themes contributed to this main theme and highlighted that decision-making for these low-acuity attendances was a complex balance of 1) patient context, 2) risk management, 3) paramedic reactions to their experiences and 4) no alternate referral pathways available in the prehospital setting.

Following clinical assessment of the patient, the patients' context was paramedics' first priority when deciding if the patient required transport. The patients' location and social considerations contributed to the decision-making process, specifically rurality, community dwelling or residential aged care facility status. Paramedics reported that attending the same patient repeatedly raised concerns about the lack of alternative options for health care, referral pathways or patients are being connected to needed support services. Paramedics were concerned that transporting low acuity patients could lead to patients having unnecessary discomfort and risk as they could experience long wait times on the ramp waiting to be admitted to ED. Considerations for personal liability if the patient wasn't transported highlighted how paramedics felt pressure to transport patients to hospital, regardless of their professional clinical decision making. Differences in resource availability between metropolitan and rural WA highlighted challenges for paramedics. Paramedics reported less support and resources rurally to conduct their role. Paramedics also reported that patients could experience longer wait times rurally, due to fewer paramedics on road.

Paramedics commonly experienced feelings of frustration when attending low-acuity patients who fell. When caring for low-acuity patients, paramedics questioned the scope and purpose of their role when forced to cope with lack of alternative referral pathways. This included considerations for their training in the management of falls

and what guidelines are required for the management of falls in the prehospital setting. The cost of their service made for difficult experiences when a patient would say "I can't afford an ambulance" (Participant 8). Paramedics experiences attending low-acuity falls call-outs, particularly to older adults, led them to concur that alternative referral pathways were required. Paramedics emphasised the need for these pathways, as in their experience, most older adults who fall, would utilise and benefit from alternative referral pathways. Participants with experience working in other EMS, outside of WA, highlighted how safe non-transport and specific guidelines supported their decision making in those settings, as opposed to WA where they perceived these services were not available.

8.3 Discussion of Findings in the Context of Research Literature

8.3.1 Defining Falls

More than 50 articles provided over 100 varying falls definitions, as shown in Figure 4.1. Given this plethora of falls definitions, a few select recently published sources have been expanded on here to provide examples of how these definitions could be categorised. In the prehospital literature, falls could be defined by distance fallen, mechanism of a fall, by demographic group (i.e., older adults), by high-risk group (i.e., repeat fallers), by context (i.e., from ladder), or by CPG's definitions of prehospital diagnosis, i.e., traumatic, or medical fall.

A common method of defining falls was based on meters fallen, particularly in adults less than 65 years of age.(57, 74) A Netherlands-based study defined a fall from low height as <2 meter and a fall from medium height as between 2 and 5 meters.(57) Studies out of the Netherlands and Switzerland both provided a definition for a fall from high height, although the Switzerland-based study defined it as >2 meters (74) and the Netherlands study defined it as a fall from >=5 meters or from >=3 times body length.(57) Prehospital assessment keywords were used to define ambulance-attended falls, specifically injurious falls in China (85) and a collapse as the cause of falling in Canada.(65) The Canadian study also defined falls contextually, using dropped or unspecified, or by defining a slip, trip or slide as a fall from low height.(65) It is important for researchers to use the term unspecified, when reporting ambulance-attended falls as not all falls are witnessed, and the cause of a fall is not always able to be determined. Two studies, one from the USA (39) and the other from Australia (8) further defined a high-risk group within the cohort of older adults, as those who

experienced repeat falls.(8, 39) Ultimately, there are a plethora of falls definitions in prehospital literature, and while the lack of unifying definitions can make collating prehospital literature challenging, it speaks to the highly variable and unpredictable nature of falls and their prehospital management.

8.3.2 Incidence

An increase in the frequency and incidence of falls requiring medical attention has been observed globally.(8, 21, 161, 162) Across Western Europe in 2017, 13,840 older adults per 100,000 population obtained medical treatment to manage fall-related injuries.(5) This ranged greatly from 7,594 per 100,000 in Greece to 19,796 per 100,000 in Norway.(5) In the US, one in four older adults fall each year, with 3 million older adults treated in ED.(163) The prevalence of falls across the global population of older adults has also been observed across Australia.(4, 8, 50, 164)

Australia's ageing population is contributing in part to the increased incidence of falls. An important consideration as, by 2066 older adults are projected to account for 23% of the Australian population.(19) In Victoria, Australia, findings consistent with that of my retrospective cohort study, on the epidemiology of EMS-attended falls, found an increase in the incidence of EMS-attended falls, specifically within the population of older adults.(8) As an increasing proportion of the population are becoming older adults, the increasing demand on EMS to attend falls is expected to continue increasing, as it has been shown to, between 2015 and 2021 in WA, in Chapter 5.

The increasing demand for the management of falls has been impacting the whole health care sector. In England, 2,100 per 100,000 people aged 65 years of age and over had an emergency hospital admission due to a fall, and was identified to be 5,311 per 100,000 in people aged 80 plus years of age.(165) In New Zealand, older adults 80 to 89 years of age were also found to have the highest number of falls requiring hospitalisation.(166) In WA, the age-standardised incidence rate of ED attendances and hospitalisations was 1,535.4 and 1,053.4 per 100,00 people, respectively, due to a fall-related incident.(3) The age-standardised rate of fall-related hospitalisations in WA increased steadily from 960.7 per 100,000 in 2017.(3) Chapters 5 and 6 present the findings of state-wide studies, and confirm the increasing frequency, incidence and demand of falls on the health sector of WA.

The demand for EMS that falls place is not only increasing due to the increasing incidence of falls, but also by the high proportion of ambulance-attendances attributed

to repeat falls. Similar to my findings in WA, nearly 50% of all ambulance-attendances to falls in Victoria, Australia were attributed to the same 54,765 patients experiencing repeat falls.(8) A comparable pattern of EMS-attended repeat falls has been reported internationally. More than 1 in 6 EMS transports in North Carolina, USA, were followed by a repeat transport of the same patient within 30 days; and falls were identified as the second leading dispatch complaint in this cohort.(134) Patients who experienced a fall in this cohort were 7% more likely to experience a repeat transport within 30 days, adjusting for dispatch complaint, incident location, ethnicity and age.(134) A study of a UK ambulance service found that older adults requiring an ambulance attendance following a fall had a re-contact rate of 37% within one month and 71% within six months.(161) The findings of my retrospective cohort study on repeat falls are consistent with the published literature globally, indicating that attending adults with repeat falls contribute to a significant proportion of EMS workload. It is crucial that older adults who experience or are at risk of repeated ambulance-attended falls are able to be identified in the prehospital setting, hospital ED, general practitioner or allied health. This would allow the patients to be appropriately directed to alternative referral pathways, fall prevention groups or allied health providers.

8.3.3 Prehospital Management

The predominant cause of trauma in older adults are falls.(44, 152) Older adults, most frequently females, experience ambulance-attended falls across Australia, as shown from our findings in WA,(164) by Cox et al., in Victoria,(8) and Simpson et al., in New South Wales.(4) The age and sex of ambulance-attended adults who fall is well established, and further research may benefit from exploring other patient characteristics, i.e., comorbidity, socioeconomic status or ethnicity.

Differences in the availability of ambulance services between metropolitan and rural communities for people who fall, has been identified. In Victoria, Australia, the limited health care services available for ambulance-attended adults who fall within regional, rural and remote communities have been reported.(152) A recent scoping review identified two studies reporting similar findings on the current scope of practice of paramedics managing older adults who fall in rural and remote areas.(160) The review reported how a duty of care must be upheld through the promotion of equity, regarding resource allocation and responsivity between metropolitan and rural areas.(160) The first of these studies, Shah et al., 2006 reported a control trial of fire

department paramedic protocols including screening for falls and environmental hazards, with a focus on patient and paramedic education.(167) The second of these studies, Shah et al., 2010 reported a paramedic protocol for screening medication management, falls and depression, with a focus on in-home assessments and referral to government social services.(168) Differences were identified in paramedics' experiences attending and managing falls between metropolitan and rural WA settings, identified in chapter seven. Research has found that the method of patient referrals in metropolitan compared to rural settings, was identified to impact on referral pathways effectiveness, particularly paper-based forms, as they may be insufficient in managing older adults who fall in rural environments due to the lack of health resources available.(160, 167, 168) Further exploration of protocols and available health services could support metropolitan and rural health settings equity.

Decision-making about patient management in the prehospital setting is complex in nature, due to multiple influencing factors. Resources, patient factors and social situations, consequences of decisions, and paramedic factors all impact on paramedics' decision-making.(154) Specific guidelines, clinical support and training can facilitate how paramedics manage these highly variable factors and situations.(154) A prehospital program in the USA called the Community-centred Fall Intervention Team (Community-Fit), aimed to reduce the frequency of ambulance-attended lift assists, fall attendances and transports to hospital using scheduled community paramedic teams to conduct home assessments and falls prevention interventions.(155) Community-FIT provided an alternative to transport to hospital for patients who were considered frail and vulnerable, but did not require urgent medical attention, the alternative being the home assessment, prevention interventions and treatment.(155)

8.3.4 Patient Disposition

Transport

Following an ambulance attendance, patients can be transported to a hospital ED, and when necessary, transferred through to a trauma centre. While the majority of ambulance attendances in Ontario, Canada resulted in transport to hospital, the notable exception was fall-related events, of which a third were treated at home by home care providers.(151) A patient who experienced a fall and subsequently an injury, pain or who had been on the floor for a long time prior to the ambulance-attendance, were

identified as experiencing positive predictors of transport to hospital.(145) In events such as this, clinical decision tools are used by prehospital staff in the UK to assess if a patient requires urgent transport.(129) In chapter five, I present that in WA, older female patients had a higher odds of being transported via a lower urgency. Using this information moving forward, clinical decision tools could potentially be reviewed to ensure sensitivity, being able to identify high acuity patients accurately, and specificity, being able to identify low acuity patients who did not sustain injury, accurately. This would support paramedics' clinical decision making in the identification of high acuity patients and how urgently they require transport to hospital.

Non-transport to hospital was common amongst older adults in WA (22%), with some experiencing no or minor injuries, some treated on scene, and in some cases the patient refused transport, following a fall. In the USA, falls in public locations, people who have fallen previously, patients with no illness or injury,(23) males, older age groups, and Hispanic/Latino patients,(149) had a significantly increased odds of non-transport. A common consequence of non-transport was ambulance re-attendance or future health service use, often in older adult populations.(153) Considering non-transported patients, the highest mortality in Finland EMS was observed in patients who had experienced two or three ambulance attendances in the year prior; within this cohort, falls were the third most common dispatch complaint.(148) While some patients who fall may not require EMS transport or in hospital care, prehospital staff need to be provided with alternatives to mitigate the risks associated with non-transport.(148)

Although ambulance-attended adults who fall are commonly transported to ED, not all patients require in-hospital care. In Finland, low-acuity patients transported to hospital ED during night time (20:00 – 08:00) did not receive medication or diagnostic tests until the next morning.(150) Kasvi et al., suggested further exploration into alternative care pathways for managing older adults who fell and were transported at night.(150) Time of transport is important when considering patients with comorbidities, as patients experiencing complications such as dementia are identified as a group at high-risk of falling, longer on scene times, were generally frailer, and incurred more ambulance-attendances.(158) The prevalence of dementia in older adult populations is increasing and associated with high ambulance use per person.(158) Tohira et al., suggested a need for the development of alternatives to ED transport for people with dementia.(158)

Alternative referral pathways

Alternative referral pathways vary in type and availability between ambulance services, prehospital staff and country. Alternative prehospital health care staff include extended care paramedics in New Zealand, who have additional specific training and the ability to refer patients to other health and social care professionals, where appropriate.(121) Prehospital staffing teams can include paramedics, extended care paramedics, emergency care technicians, emergency care practitioners, ambulance officers, specialist nurses, non-clinical or non-emergency crews, specialist falls response paramedics, volunteer ambulance officers or a combination of these professionals.(121, 128, 134, 143, 161, 169) The objectives and levels of care provided vary from home falls risk assessments to advanced life support.(121, 128, 134, 143, 161, 169) Prehospital practitioners were less likely to transport patients who had fallen to ED, and further research is required to explore the occurrence of subsequent EMS use and appropriateness of decision making.(170) The use of computerised clinical decision support on hand held devices has been demonstrated as a cost-effective and safe method to support paramedics to decide if a patient who has fallen requires transport to ED or a combination of non-transport and referral to a falls service.(169)

The decision not to transport a patient, has the potential to result in subsequent EMS or health care use. Non-transport resulting from informal and non-guideline-based assessment, coupled with a lack of alternative referral pathways, is associated with poor health outcomes and repeat use of ambulance services.(4, 171) A falls rapid response service in England, has been shown to be clinically effective, although highlighted that recontact rates required further research in the population of older adults.(146) In-home risk assessments in Taiwan, have been found to be an efficient and cost-effective method of assessment, as prehospital staff have a unique opportunity to view patients in their home environment.(147) Research in the UK has demonstrated that the referral of patients from the prehospital setting to quick response community-based multidisciplinary fall prevention programs significantly decreased subsequent ambulance-attended falls.(81)

At the time that this doctoral research was being conducted, there were no alternative referral pathways available in the WA prehospital setting. In 2021, the parliament of WA conducted an inquiry into the delivery of ambulance services in

WA. The following 2022 state government's response to said inquiry, proposed specific actions to incentivise efforts to divert patients to clinically appropriate alternative care pathways.

8.4 Discussion Of Findings in the Context of Local and Global Guidelines

The prehospital management of adults who fall in WA has undergone policy and practice changes since 2022. Local changes in WA have included an inquiry by the state parliament, a response report by the State government Department of Health and policy changes within the WA ambulance service guided by the Department of Health's report.

As older adults experience falls most frequently, focused guidelines for this high-risk group were required for the consistent, evidence-based management of falls globally. Guidelines such as step safely (WHO) and, the world guidelines for falls prevention and management for older adults, have provided guidelines to provide global equity for the availability of information regarding the global management of falls.

This section provides a discussion of the changes that have occurred in WA regarding the management of falls, how the Government of WA's, Department of Health is involved in the state-wide management of falls, and how the globally guidelines for falls are evolving.

8.4.1 Changes in Falls management in WA

The interviews conducted in the exploratory qualitative study were conducted between July and December 2021, with prehospital staff working across the state of WA. In March 2022, the state ambulance service introduced a CPG entitled 'Falls prevention guideline'.(32) This directs paramedics to produce a Falls Risk Assessment tool (FRAT) score and deliver it to the attending staff in ED. The publication of this guideline provides opportunity for the development of specific guidelines that can guide the clinical practice of prehospital staff in their management of patients who fall in WA.

In October 2022 the state ambulance service (SJWA) started a trial to assess an alternative care referral pathway, providing fast in-hospital access for older adults at one hospital in Perth, WA, Joondalup health campus, known as 'The Rapid Access Clinic for the Elderly'.(172) The trial provides options for older, low-acuity patients, when transported from prehospital setting to ED. While this trial is not specifically

target to patients who fall, it focuses on low-acuity older adults, and as chapter five demonstrated, 61% of ambulance attendances to adults who fell were low acuity (urgency 3 - 5) in nature and 78% of ambulance attendances to falls, were to older adults. This trial currently includes alert and orientated patients with nil or minor injuries, and excludes falls preceded by any other medical event – e.g., chest pain, dizziness, shortness of breath, stroke symptoms. Following this trial, further exploration of specific guidelines, and referrals from the prehospital setting, for the prehospital management of patients who fall could be beneficial.

The WA Virtual Emergency Medicine (VEM) service, implemented in 2021, is shown to reduce patient wait times and improve ambulance and ED flow.(173) This program was run in one hospital in Perth, WA, the Fiona Stanley Hospital. This has since been expanded and the WA Virtual Emergency Department (WAVED) was launched on the 11th of September 2023. It is located at SJWA State Operations Centre and comprises a team of medical, nursing, and clerical staff.(174) This gives patients the option of being seen virtually at home through a virtual consultation with an emergency clinician, rather than waiting in ED. This provides patients with a clinically appropriate alternative option to an ED attendance, if it is clinically appropriate for the patient.

8.4.2 Government of Western Australia, Department of Health

While my research was being conducted in WA and published between 2021-2024, the WA Department of Health (DOH) published their Response to the Legislative Council Standing Committee on Public Administration 'Critical Condition: Inquiry into the Delivery of Ambulance Services in WA'.(175) Eleven actions were published in this report as targets to improve emergency access across the state, of which, Action 4 and Action 8 are of particular relevance to my research findings. Action 4 includes the establishment of The Ministerial Taskforce on Ambulance Ramping to explore alternative care pathways through the Emergency Access Response Program. As identified in chapter four, my scoping review identified a lack of evidence regarding alternative referral pathways globally. I identified in chapter seven, in the exploratory qualitative study that, paramedics reported that attending low-acuity call-outs for falls was often frustrating, stressful and required complex decision-making, especially given that there were no CPGs or alternative referral pathways available in WA at the time, to guide the management of ambulance-attended patients who fell. Action 8 involved the DOH incentivising efforts to divert

patients to clinically appropriate alternative care pathways. This incentive has the potential to address the increasing demand being placed on the WA ambulance service. This increasing demand is shown by the increasing incidence and frequency of low-acuity ambulance-attendances to fall incidents, as highlighted in chapter five, the epidemiology of ambulance-attended falls. The demand placed on the ambulance service by repeated ambulance-attendances to individual patients is highlighted in chapter six. The findings of my research align with the proposed actions put forward by the WA DOH, in that both recommend the development and implementation of specific referral pathways for patients where clinically appropriate.

8.4.3 Global Guidelines for Falls

The World Health Organizations' (WHO) falls guideline, referred to as Step Safely, provides strategies for preventing and managing falls.(176) Step Safely recommends that a focus on the equitable provision of prehospital services between low and middle-income countries and high-income countries is needed. While transport to hospital following an ambulance-attended fall is a critical step in any prehospital setting, this report reinforces the importance of locally tailored prehospital protocols. Locally tailored referral protocols can be helpful in ensuring that people who have fallen and require an ambulance are connected with the appropriate and relevant local services.

The world guidelines for falls prevention and management for older adults, developed by 96 multidisciplinary experts who form the World Falls Task Force,(14) made specific recommendations towards falls prevention and management. These included recommendations that high risk older adults should be offered comprehensive falls risk assessments, and the implementation of multidomain personalised interventions.(14) The prehospital management of adults who fall was not addressed in the world falls guidelines, although reference was made to the necessity for severe falls to be followed up with a prompt visit to the ED.(14) In this context, a severe fall was defined as: a fall with severe enough injuries to require consultation with a doctor; the person was subsequently laying on the ground without the ability to get up for one hour or more; or the patient lost consciousness.(14) The framework of the guidelines is structured around four main areas: fall risk stratification, assessment, management and interventions, and use of an assessment and treatment algorithm, ultimately facilitating a patient centred approach to the delivery of individualised interventions.(14) Although

prehospital staff have not been considered in this model, the world guidelines do highlight that their recommendations require flexible implementation that consider local context, resources and the country's needs.(14) Given that the world falls guidelines suggest the identification of high risk groups and the implementation of interventions for the management of falls, it is recommended that updates to the world falls guidelines consider the role of prehospital staff in the identification and management of older adults who fall.

The world falls guidelines suggest the identification of high-risk groups, similarly to my recommendations in the retrospective cohort study on repeat falls. This could be considered when WA EMS policy and practice is being updated to create specific guidelines for the prehospital management of falls. The world falls guidelines recommendation regarding the implementation of interventions for the management of falls aligns with the WA DOH actions to improve emergency access across the state by exploring alternative care pathways. This recommendation also aligns with my exploratory qualitative research findings, suggesting that the development and implementation of specific CPGs and alternative referral pathways would support the improvement of the prehospital management of ambulance-attended adults who fall.

8.5 Strengths And Limitations

Within this section I discuss the strengths and limitations of the thesis as a whole and each of the studies

8.5.1 Strengths

The research presented in this thesis show novel findings which have not previously been explored or reported on in WA, such as the epidemiology of ambulance-attended falls and repeat falls, as well as paramedics' experiences attending and managing patients who experienced falls.

The inclusion of quantitative and qualitative published works in this multi-methods thesis by compilation, aimed to provided well rounded context of the prehospital management of ambulance-attended falls. The multi-methods design is defined as two or more research methods, each conducted rigorously and complete within themselves in individual projects.(177) These results were synthesised to form a complete piece of work, producing a multi-methods thesis.(177)

I am confident that all efforts have been made to identify all falls cases attended by SJWA between 2015 and 2021; through a combination of manual searching by multiple researchers (PMW, HT, PB, DM), machine learning and natural language processing for data identification. By having a lead-in and follow-up period and accounting for deaths within the retrospective cohort study focused on repeated ambulance-attended falls, every effort has been made to accurately identify all repeat falls within the data set. Given the long latency period between a first and second ambulance-attended fall, having seven years of retrospective data allowed for accurate analysis of time between falls. Given that both retrospective cohort studies were population based of all fall-related ambulance-attendances by a state ambulance service in rural and metropolitan locations, I was able to present data at a state-wide level. The projects within this thesis have enabled an ongoing relationship with local government stakeholders, Injury Matters, and the reporting of state-wide findings in annual Falls Reports.(3, 24)

8.5.2 Limitations

As the cohort studies were retrospective, I was not able to collect information other than what was initially collected. I therefore had to present the pre-collected data available. All population based retrospective cohort studies were conducted across the state of WA, therefore may not be applicable or generalisable to other locations or regions given the sprawled nature of the state's population and vast land mass. Socioeconomic, disability, and comorbidity status were not recorded in the ePCR or CAD and therefore, were not included in these studies. Routine medications being taken by the patient were also not recorded. Time and fiscal restraints prevented access to linked hospital data for the cohort of ambulance-attended patients. Therefore, patient in-hospital management, hospital diagnosis or hospital disposition outcomes were not able to be reported (although mortality outcomes were reported).

Acknowledging the limitations of the research that forms my thesis, I have outlined my recommendations for policy, practice, and research below. These are based on the primary outcomes and findings of my research.

8.6 Recommendations

Within this section I discuss the recommendations for policy and practice based on my research findings. I also recommend several areas for future research to explore.

8.6.1 Recommendations for Policy and Practice

1. I identified that no alternative referral pathways or falls-related specific CPGs existed in WA at the time my studies were conducted. Therefore, the health and ongoing health care needs of older adults who fall should be considered when updating CPGs to support paramedics' decision making in the prehospital setting to accurately determine which patients require transport to hospital and who can be adequately cared for at home. All updates to transport decision tools must ensure that they take into account the patient's wishes.
2. The development of alternative referral pathways for non-transported patients and then specific CPGs to direct patients to the appropriate referral pathways is recommended, given that 22% of ambulance-attended adults who fell were not transported to hospital and the lack of alternative referral pathways for non-transported patients meant that paramedics only had two options to choose from, namely, transport to hospital or leave at home.
3. The Ministerial Taskforce on Ambulance Ramping (WA Department of Health) which are currently exploring alternate care pathways through the Emergency Access Response Program, could potentially consider the role of prehospital staff in the identification and referral of patients who fall and are at risk of subsequent ambulance use, i.e., repeat falls. This is supported by the finding that patients who experience repeat ambulance-attended falls, account for nearly 60% of all ambulance attendances to fall incidents.
4. Inclusion of the prehospital setting in the world guidelines for falls prevention and management for older adults: a global initiative, could improve the holistic and multidisciplinary care of older adults who fall.
5. As St John WA Ambulance service has developed a 'Falls prevention guideline' in their CPGs, additional tools for paramedics in this guideline could support their clinical decision making. This addition would be particularly useful for paramedics as I identified that low-acuity patients contribute to the complexity of paramedic's decision-making.
6. Further exploration of EMS organisational structures globally that currently work effectively with referral pathways, could assist in diversifying strategies to approach the development of prehospital alternative referral pathways in WA. It is particularly important to look to other services as many have explored cost effective and efficient ways of managing the prehospital care of older adults who fall.

8.6.2 Recommendations for Future Research

1. Eighty-three percent of studies included in the literature review were conducted in Australia, the USA, UK and Ireland, although 80% of deaths from falls globally are in low and middle-income countries.(2) Efforts should be made to focus research on areas with high mortality rates from falls such as in low and middle-income countries.
2. Intervention studies exploring the safety, feasibility, effectiveness and cost-effectiveness of alternative referral pathways for falls management in the WA prehospital system are recommended.
3. Investigating the epidemiology and specific needs for ambulance-attended adults who fall in rural and remote locations in WA, compared to metropolitan settings, to determine the impact on patients is recommended given that resource availability has been highlighted as different between metropolitan and non-metropolitan settings.
4. Investigating the role that paramedics and prehospital staff play in the identification of patients who have fallen and would benefit from alternative referral pathways would inform future practice.
5. Investigate the impact of prehospital staff who have extended qualifications and skills on the prehospital management of adults who fall.
6. Exploration of patients who refuse to be transported to hospital could be beneficial in exploring high risk sub-groups of patients who fall and require an ambulance. Exploring this patient cohort could allow for targeted treatment, referral, and discharge protocols and linkages to other community or hospital services.

8.7 Concluding Remarks

In this thesis, I explored the epidemiology and paramedics' perspectives of ambulance-attended adults who fell in WA with a view to better inform the prehospital management of patients who fall. I found that the frequency and incidence of ambulance-attended falls are increasing in WA. While 19% of patients were attended via a priority 1, lights and siren ambulance, only 1% were transported to the hospital via the highest urgency. This drew attention to the low acuity nature of this cohort. Nearly 30% of all patients attended by an ambulance for a fall, experienced repeat falls, and collectively accounted for nearly 60% of all ambulance attendances to fall incidents. Paramedics working in WA expressed how the available binary transport to

hospital options (yes/no) in the prehospital setting led to complex decision-making experiences, particularly when attending patients with low acuity fall-related incidents.

Considering these findings, I suggest that ambulance-attended falls present a growing challenge for the WA health system. Specifically, the local ambulance service who are facing an increasing demand attending to the State's ageing population. This compounding issue has flow-on effects, increasing the burden throughout the health care system. The continued development of communication pathways between the prehospital ambulance service and hospitals, allied health, and general practitioners could support the inclusion of alternative referral pathways from the prehospital setting. Considerations of a holistic patient-centred approach, engaging the prehospital system in alternative referral pathways, and specific guidelines to support paramedic decision-making, could potentially support this growing cohort of patients. With an increasing and ageing population, combined with the lack of referral options for the prehospital setting, the development of specific guidelines and alternative referral options for the improved prehospital management of ambulance-attended adults who fall is needed.

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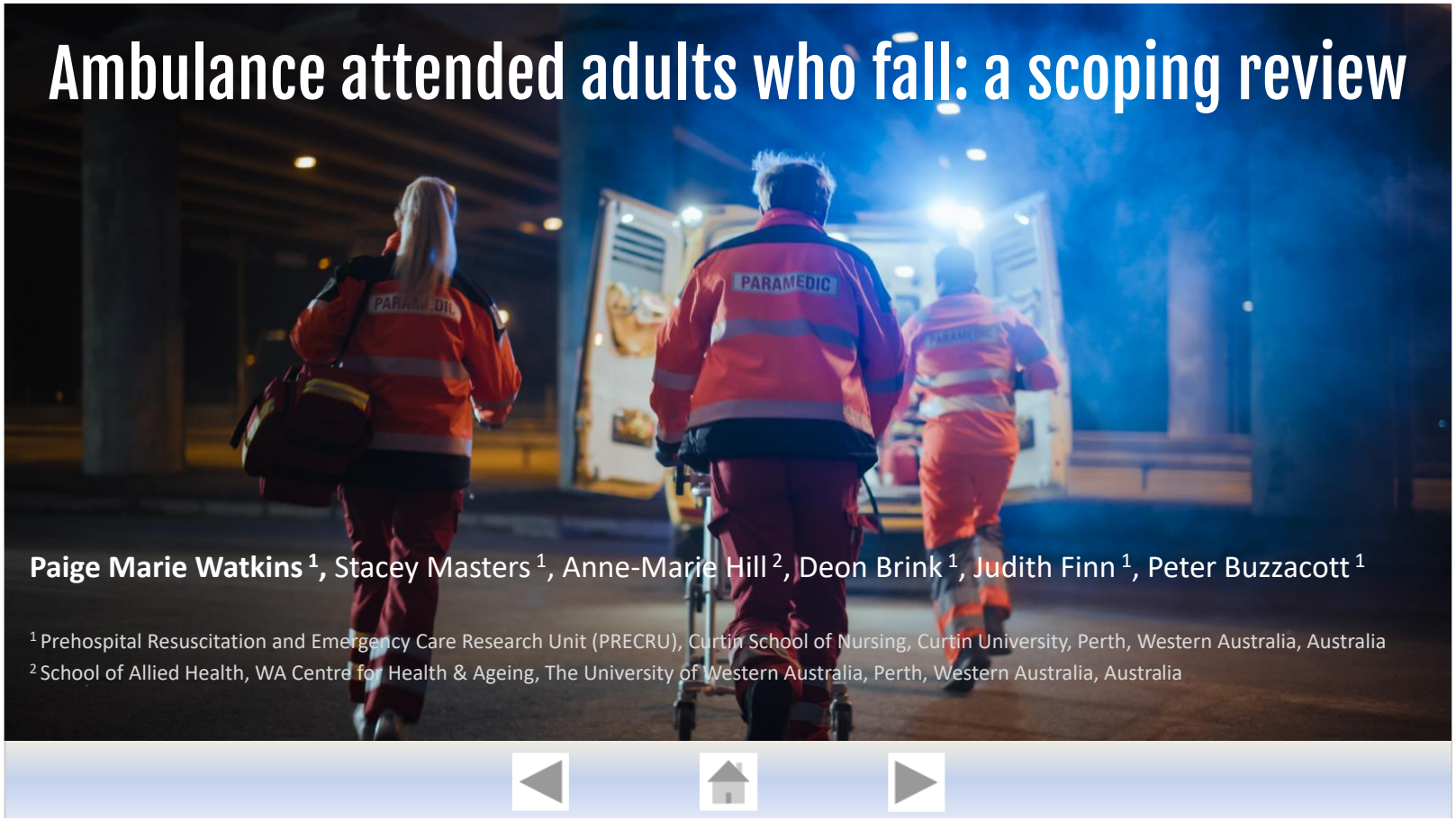
APPENDICES

Appendix A

Poster: Ambulance Attended Adults Who Fall: A Scoping Review



Ambulance attended adults who fall: a scoping review

Paige Marie Watkins [1] (paige.watkins@postgrad.curtin.edu.au), Stacey Masters [1], Anne-Marie Hill [2], Deon Brink [1], Judith Finn [1], Peter Buzzacott [1]

[1] Prehospital Resuscitation and Emergency Care Research Unit (PRECRU), Curtin School of Nursing, Curtin University, Perth, Western Australia, Australia; [2] School of Allied Health, WA Centre for Health & Ageing, The University of Western Australia, Perth, Western Australia, Australia.

Background: The concurrent increase in frequency and incidence of ambulance attended falls, with an increasingly ageing population, is resulting in a growing demand for Emergency Medical Services (EMS) attendances.

Aim: To map and synthesise the evidence for the prehospital management of EMS attended adult patients who fall.

Methods: The Joanna Briggs Institute methods for systematic scoping reviews were used. Six databases (Medline, Scopus, CINAHL, Cochrane, EMBASE, ProQuest) were searched (August 2021).
Data were narratively synthesised.
Included sources reported:

- **Context:** Ambulance attended.
- **Population:** Adults (>18 years) who fell.
- **Concept:** Demographic data, reported injuries sustained, interventions or disposition (transport) data.
- **Source type:** peer-reviewed published literature in English

Interventions were the least reported with only 29% of sources reporting on **life support**, **medication**, **immobilisation** and **lifts and extractions** in the prehospital setting.

Results: A total of 115 research sources met the inclusion criteria. Most studies used a cohort design, and were published in Australia, UK or USA, between 2010-2019.

- **EMS interventions** for falls, transport decisions and alternative care pathways for fall management was limited.
- **Adults <65** years were less likely than older adults (>65 years) to be attended repeatedly and/or not transported to hospital.
- **Older adults who fell** and required lift assistance, were commonly not transported, and commonly experienced repeat attendances.
- **Being male, falling from height and sustaining severe injuries** were associated with transport to major trauma centres, while older females falling from standing/low height with minor injuries were less likely to be transported.

Search update 22nd September 2023: Using the same inclusion criteria and search strategy, 16 additional sources that meet these criteria were found. Updated search literature has identified these patients with a high risk of future health service use, and interventions to facilitate EMS management of patients who fall are needed.

Conclusions: Evidence about EMS management of patient falls in prehospital settings was limited. Definitions of falls and mechanisms of injury were inconsistent.

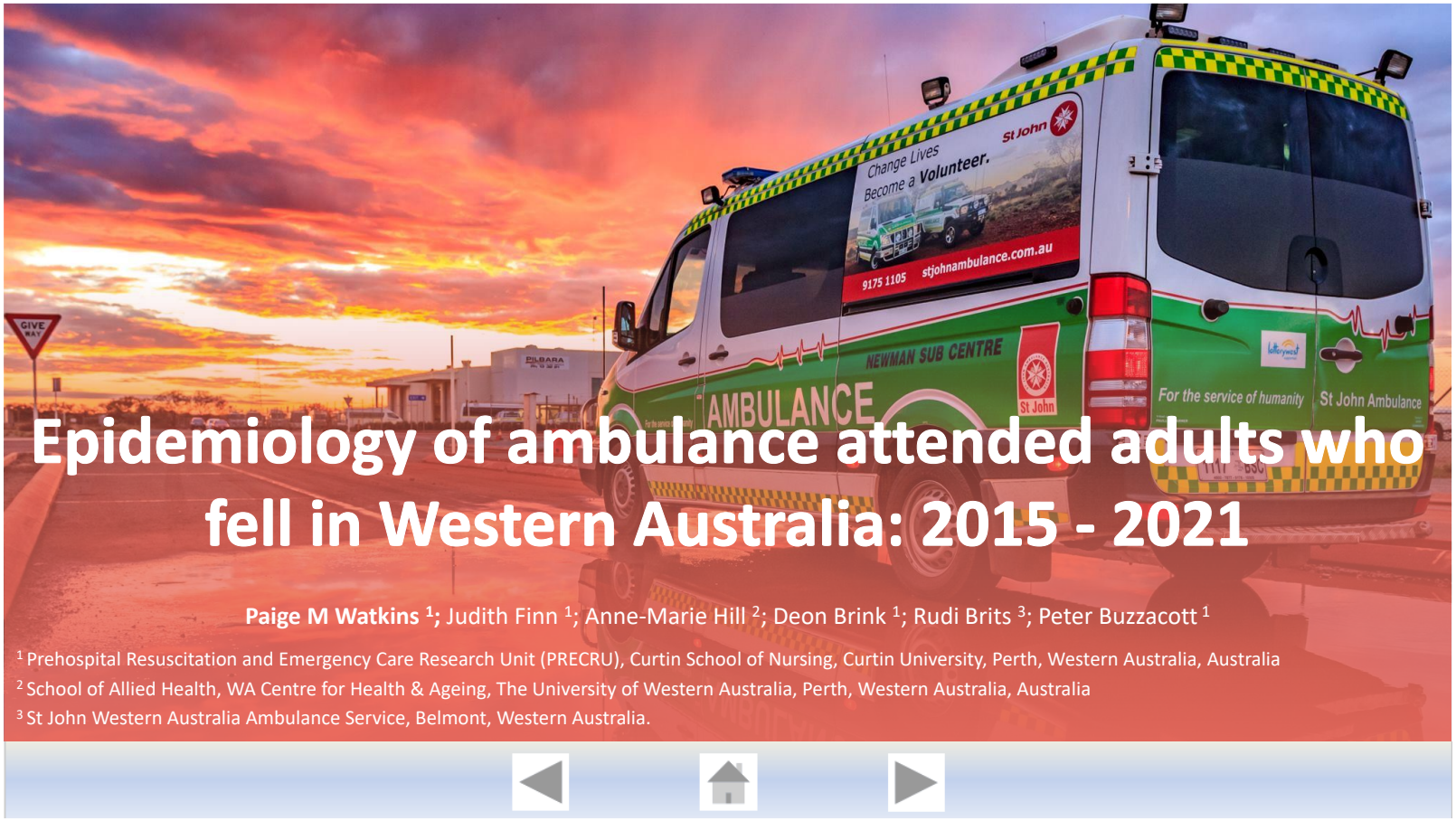
Finding consensus in the classification of falls in prehospital literature could support collating research to inform practice.

Australia and New Zealand Falls Prevention Society & World Falls Congress 2022 JOINT CONFERENCE

PRECRU

Appendix B

Poster: Epidemiology of Ambulance Attended Adults Who Fell in Western Australia: 2015 - 2021



Epidemiology of ambulance attended adults who fell in Western Australia: 2015 – 2021

Paige Marie Watkins [1] (paige.watkins@postgrad.curtin.edu.au), Judith Finn [1]; Anne-Marie Hill [2]; Deon Brink [1]; Rudi Brits [3]; Peter Buzzacott [1]

[1] Prehospital Resuscitation and Emergency Care Research Unit (PRECRU), Curtin School of Nursing, Curtin University, Perth, Western Australia, Australia; [2] School of Allied Health, WA Centre for Health & Ageing, The University of Western Australia, Perth, Western Australia, Australia; [3] St John Western Australia Ambulance Service, Belmont, Western Australia.

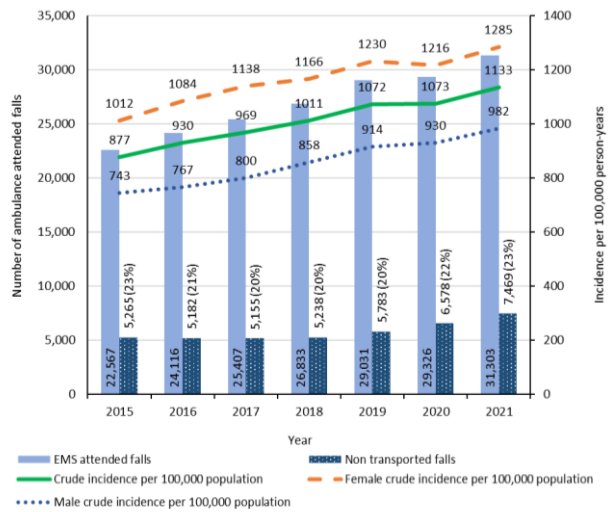
Background: Emergency Medical Services (EMS) are attending an increasing number of adults who fall.

Aim: To describe the incidence, patient characteristics, treatments and disposition of ambulance attended adult patients who fell in Western Australia (WA).

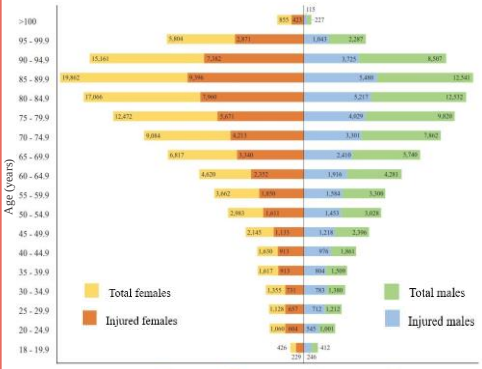
Methods: An ordinal logistic regression (STATA) was conducted in this retrospective cohort study, analysing predictors of lower compared with higher transport urgency levels. Participants were adults (>18 years) who fell and required ambulance attendance in WA between 1st January 2015 – 31st December 2021.

Results: A total of 188,720 patients (female = 57%) were attended by ambulances after falls, (median age= 80 years [IQR 67-87]).

- **19% of patients were attended via priority one** (n= 36,113), while the majority (n= 99,681, 53%) were via priority two.
- **The age-standardised incidence rate** of ambulance attended falls increased from 115 cases/100,000 person-years to 161 cases/100,000 person-years between 2015-2021.
- **A total of 89,140 (47%) patients had an injury** recorded by paramedics, most often lacerations or suspected fractures.
- **N= 50,044** (26.5%) patients received medication.
- **148,050 (78%) patients were transported** to hospital with the following urgency levels: 2,371 (2%) via urgency one; 27,882 (19%) via urgency two, 93,447 (63%) via urgency three and 22,584 (15%) via urgency four and five (<1% unknown urgency).
- **Positive predictors of lower transport urgency** levels (1 vs. 2,3,4&5; 1,2 vs. 3,4&5; 1,2,3 vs. 4&5) to hospital included being female and older than 65 years of age.



Number of ambulances attended adult patients who fell in WA, and crude incidence per 100,000 person-years, by calendar year



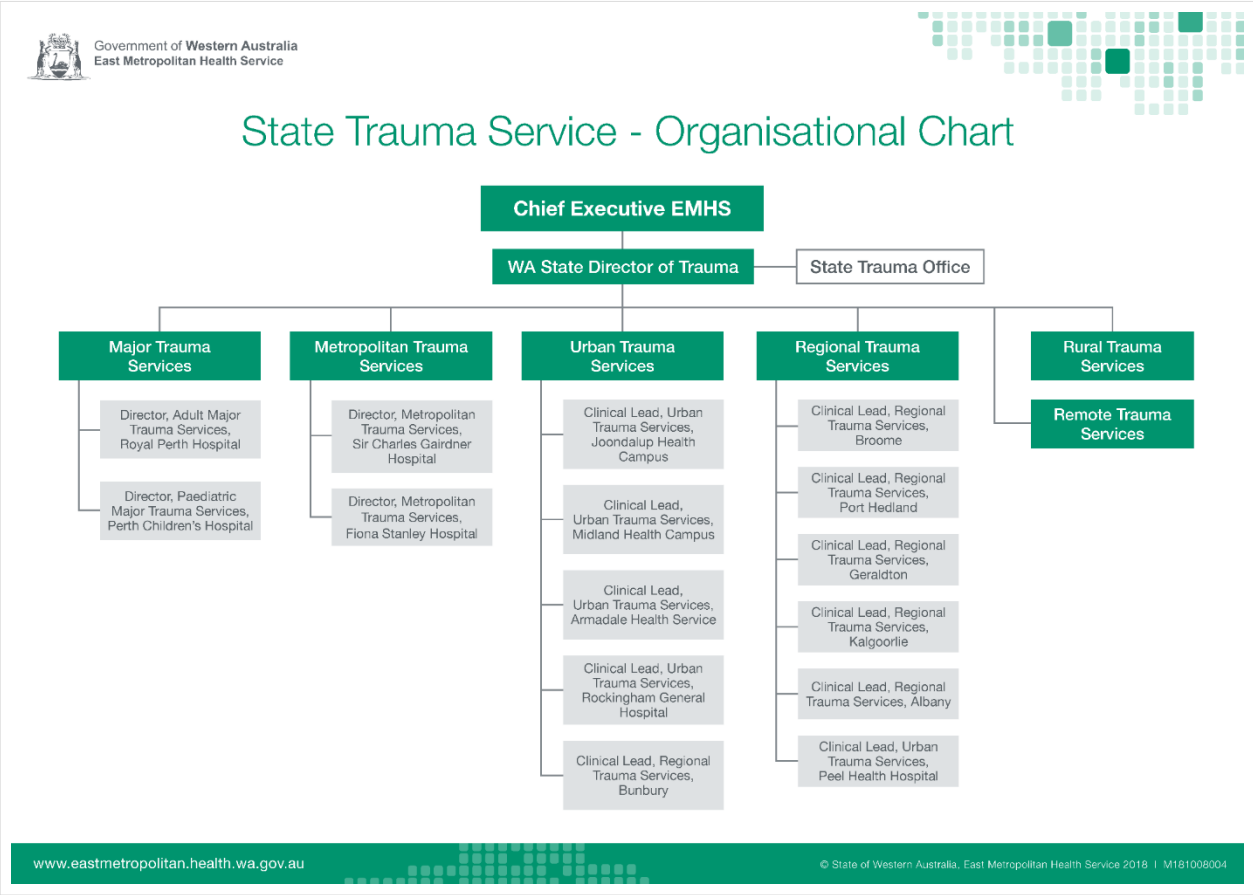
Butterfly chart of all ambulance attended adults in WA 2015-2021 by age and sex

Conclusions: The incidence rate of falls requiring ambulance attendance has increased in recent years, increasing the annual demand on EMS.

While 19% of patients were attended via a priority one dispatch, only 1% were transported to hospital via urgency one. Older, female patients had a higher odds of being transported via a lower urgency.

Appendix C

Appendix C State Trauma Service Organisational Chart

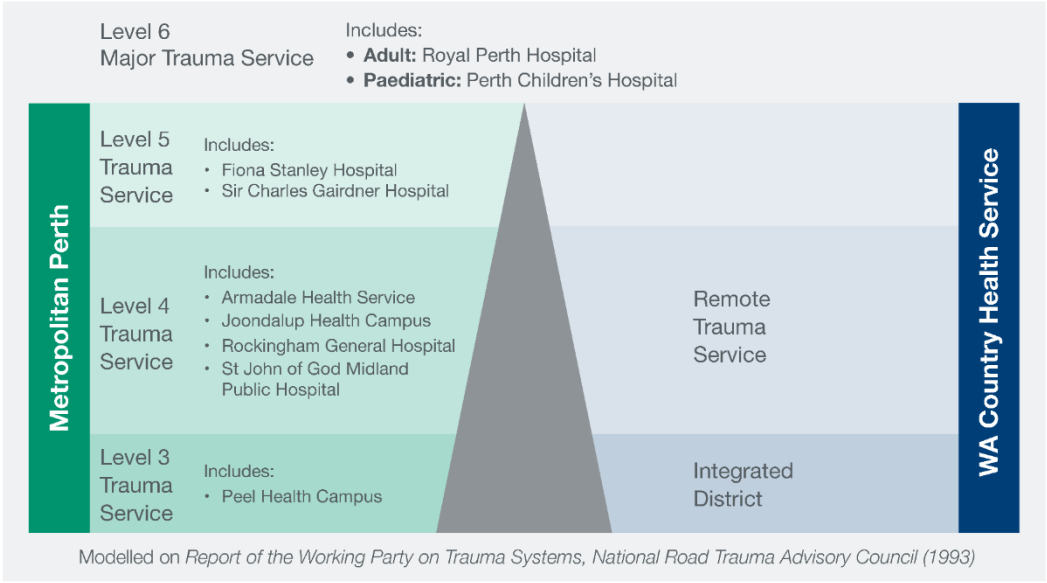


Appendix D

Appendix D State Trauma System Role Delineation

Government of Western Australia
East Metropolitan Health Service

Western Australian Trauma System – role delineation



Modelled on *Report of the Working Party on Trauma Systems, National Road Trauma Advisory Council (1993)*

Appendix E

Ethics Approvals

E.1 Ethics Approval for Phd Candidate to be Listed as a Co-investigator for the Project Western Australian Pre-hospital Care Record Linkage Project

Curtin University

Research Office at Curtin

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
Facsimile +61 8 9266 3793
Web research.curtin.edu.au

21-Feb-2020

Name: Judith Finn
Department/School: School of Nursing, Midwifery and Paramedicine
Email: Judith.Finn@curtin.edu.au

Dear Judith Finn

RE: Amendment approval
Approval number: HR128/2013

Thank you for submitting an amendment request to the Human Research Ethics Office for the project **Western Australian Pre-hospital Care Record Linkage Project**.

Your amendment request has been reviewed and the review outcome is: **Approved**

The amendment approval number is HR128/2013-69 approved on 21-Feb-2020.

The following amendments were approved:
Addition of project personnel:
Watkins, Paige

Any special conditions noted in the original approval letter still apply.

Standard conditions of approval

1. Research must be conducted according to the approved proposal
2. Report in a timely manner anything that might warrant review of ethical approval of the project including:
   - proposed changes to the approved proposal or conduct of the study
   - unanticipated problems that might affect continued ethical acceptability of the project
   - major deviations from the approved proposal and/or regulatory guidelines
   - serious adverse events
3. Amendments to the proposal must be approved by the Human Research Ethics Office before they are implemented (except where an amendment is undertaken to eliminate an immediate risk to participants)
4. An annual progress report must be submitted to the Human Research Ethics Office on or before the anniversary of approval and a completion report submitted on completion of the project
5. Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
6. Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
7. Changes to personnel working on this project must be reported to the Human Research Ethics Office
8. Data and primary materials must be retained and stored in accordance with the Western Australian University Sector Disposal Authority (WAUSDA) and the Curtin University Research Data and Primary Materials policy
9. Where practicable, results of the research should be made available to the research participants in a timely and clear manner
10. Unless prohibited by contractual obligations, results of the research should be disseminated in a manner that will allow public scrutiny; the Human Research Ethics Office must be informed of any constraints on publication
11. Ethics approval is dependent upon ongoing compliance of the research with the Australian Code for the Responsible Conduct of Research, the National Statement on Ethical Conduct in Human Research, applicable legal requirements, and with Curtin University policies, procedures and governance requirements
12. The Human Research Ethics Office may conduct audits on a portion of approved projects.

Should you have any queries regarding consideration of your project, please contact the Ethics Support Officer for your faculty or the Ethics Office at hrec@curtin.edu.au or on 9266 2784.

Yours sincerely

Signature Redacted

Amy Bowater
Ethics, Team Lead

E.2 Ethics Approval for Retrospective Cohort Studies

Curtin University

16-Jun-2023

Research Office at Curtin

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
Facsimile +61 8 9266 3793
Web research.curtin.edu.au

Name: Judith Finn
Department/School: Curtin School of Nursing
Email: Judith.Finn@curtin.edu.au

Dear Judith Finn

RE: Amendment approval
Approval number: HR128/2013

Thank you for submitting an amendment request to the Human Research Ethics Office for the project **Western Australian Pre-hospital Care Record Linkage Project**.

Your amendment request has been reviewed and the review outcome is: **Approved**

The amendment approval number is HR128/2013-100 approved on 16-Jun-2023.

The following amendments were approved:
The addition of a sub-study titled "Epidemiology and Prehospital Management of Ambulance Attendance Falls in WA."

Any special conditions noted in the original approval letter still apply.

Standard conditions of approval

1. Research must be conducted according to the approved proposal
2. Report in a timely manner anything that might warrant review of ethical approval of the project including:
   - proposed changes to the approved proposal or conduct of the study
   - unanticipated problems that might affect continued ethical acceptability of the project
   - major deviations from the approved proposal and/or regulatory guidelines
   - serious adverse events
3. Amendments to the proposal must be approved by the Human Research Ethics Office before they are implemented (except where an amendment is undertaken to eliminate an immediate risk to participants)
4. An annual progress report must be submitted to the Human Research Ethics Office on or before the anniversary of approval and a completion report submitted on completion of the project
5. Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
6. Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
7. Changes to personnel working on this project must be reported to the Human Research Ethics Office
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11. Ethics approval is dependent upon ongoing compliance of the research with the Australian Code for the Responsible Conduct of Research, the National Statement on Ethical Conduct in Human Research, applicable legal requirements, and with Curtin University policies, procedures and governance requirements
12. The Human Research Ethics Office may conduct audits on a portion of approved projects.

Yours sincerely

Signature Redacted

Professor Sharyn Burns
Chair, Human Research Ethics Committee

E.3 Ethics Approval for Exploratory Qualitative Study

Curtin University

Research Office at Curtin

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 7863
Facsimile +61 8 9266 3793
Web research.curtin.edu.au

09-Mar-2021

Name: Peter Buzzacott
Department/School: Faculty of Health Sciences
Email: Peter.Buzzacott@curtin.edu.au

Dear Peter Buzzacott

RE: Ethics Office approval
Approval number: HRE2021-0100

Thank you for submitting your application to the Human Research Ethics Office for the project **Paramedic's views and attitudes towards patients who fall and the management of falls in Western Australia**.

Your application was reviewed through the Curtin University Low risk review process.

The review outcome is: **Approved**.

Your proposal meets the requirements described in the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research (2007)*.

Approval is granted for a period of one year from **09-Mar-2021** to **08-Mar-2022**. Continuation of approval will be granted on an annual basis following submission of an annual report.

Personnel authorised to work on this project:

Name	Role
Watkins, Paige	Student
Buzzacott, Peter	CI
Hill, Anne-Marie	Supervisor
Finn, Judith	Supervisor

Approved documents:

Document

Standard conditions of approval

1. Research must be conducted according to the approved proposal
2. Report in a timely manner anything that might warrant review of ethical approval of the project including:
   - proposed changes to the approved proposal or conduct of the study
   - unanticipated problems that might affect continued ethical acceptability of the project
   - major deviations from the approved proposal and/or regulatory guidelines
   - serious adverse events
3. Amendments to the proposal must be approved by the Human Research Ethics Office before they are implemented (except where an amendment is undertaken to eliminate an immediate risk to participants)
4. An annual progress report must be submitted to the Human Research Ethics Office on or before the anniversary of approval and a completion report submitted on completion of the project
5. Personnel working on this project must be adequately qualified by education, training and experience for their role, or supervised
6. Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, that bears on this project
7. Changes to personnel working on this project must be reported to the Human Research Ethics Office
8. Data and primary materials must be retained and stored in accordance with the Western Australian University Sector Disposal Authority (WAUSDA) and the Curtin University Research Data and Primary Materials policy
9. Where practicable, results of the research should be made available to the research participants in a timely and clear manner
10. Unless prohibited by contractual obligations, results of the research should be disseminated in a manner that will allow public scrutiny; the Human Research Ethics Office must be informed of any constraints on publication
11. Approval is dependent upon ongoing compliance of the research with the Australian Code for the Responsible Conduct of Research, the National Statement on Ethical Conduct in Human Research, applicable legal requirements, and with Curtin University policies, procedures and governance requirements
12. The Human Research Ethics Office may conduct audits on a portion of approved projects.

Special Conditions of Approval

It is the responsibility of the Chief Investigator to ensure that any activity undertaken under this project adheres to the latest available advice from the Government or the University regarding COVID-19.

This letter constitutes low risk/negligible risk approval only. This project may not proceed until you have met all of the Curtin University research governance requirements.

Should you have any queries regarding consideration of your project, please contact the Ethics Support Officer for your faculty or the Ethics Office at hrec@curtin.edu.au or on 9266 2784.

Yours sincerely

Amy Bowater
Ethics, Team Lead

Appendix F

Approval for Inclusion of Published Journal Articles in Thesis

F.1 Approval for Article 1 (Chapter 3)

Re: Approval - Published work in PhD thesis

Rob Garner <Rob.Garner@paramedics.org>
Tue 16/01/2024 11:45

To:Paige Watkins (Student) <paige.watkins@postgrad.curtin.edu.au>;Jemma Altmeier <jemma.altmeier@paramedics.org>;Lea Cowdrey <Lea.Cowdrey@paramedics.org>

Hi Paige,

Very sorry for the delay - not sure where it originally landed, but it's not in my inbox. Apologies for the hold-up. Yes, you're welcome to use it for your thesis. I wish you all the very best with it!

Kind regards,

Rob Garner
Publications and Content Manager
Australasian College of Paramedicine

The College is trialling a four-day work week. My working days are: Mon-Thur, 9am-5pm (AEST).
For urgent matters on a Friday, please email urgent@paramedics.org
M: +61 (0)499 053 356 | E: rob.garner@paramedics.org
P: 1300 730 450 (AU) or 0800 730 450 (NZ) | W: https://paramedics.org
A: Level 3, 478 George Street, Sydney NSW 2000 | ABN 39 636 832 061 | ACN 636 832 061

From: Paige Watkins (Student) <paige.watkins@postgrad.curtin.edu.au>
Sent: Tuesday, 16 January 2024 1:28 PM
To: Rob Garner <Rob.Garner@paramedics.org>; Jemma Altmeier <jemma.altmeier@paramedics.org>; Lea Cowdrey <Lea.Cowdrey@paramedics.org>
Subject: Fw: Approval - Published work in PhD thesis

To whom it may concern,

I'm following up on this email I sent last year requesting permission to include an article I published with you in my thesis by publication.

I published some of my thesis work in the Australasian Journal of Paramedicine, "Pre-Hospital Management, Injuries and Disposition of Ambulance Attended Adults who Fall: A Scoping Review Protocol" and am seeking approval to have this work presented in my thesis, as it is published with your journal.

Thank you

Kind Regards,

Paige Marie Watkins

BSc (Exercise, Sports & Rehabilitation) Hons
PRECRU PhD Candidate
School of Nursing
Health Sciences

Email | paige.watkins@student.curtin.edu.au
Phone | 9266 0048

Curtin University

All people have an equal right to live free from violence, discrimination and stigma.

I wish to acknowledge the traditional custodians of the land we are on, the **Whadjuk** (Perth region) people. I wish to acknowledge and respect their continuing culture and the contribution they make to the life of this city and this region.

From: Paige Watkins (Student)
Sent: 08 December 2023 13:18
Cc: editor@paramedics.org <editor@paramedics.org>; advocacy@paramedics.org <advocacy@paramedics.org>; info@paramedics.org <info@paramedics.org>
Subject: Approval - Published work in PhD thesis

To whom it may concern,

I am a PhD candidate, and I'm preparing to submit my thesis for examination. I published some of my thesis work in the Australasian Journal of Paramedicine, "Pre-Hospital Management, Injuries and Disposition of Ambulance Attended Adults who Fall: A Scoping Review Protocol" and am seeking approval to have this work presented in my thesis, as it is published with your journal.

Thank you

Kind Regards,

Paige Marie Watkins

BSc (Exercise, Sports & Rehabilitation) Hons
PRECRU PhD Candidate

School of Nursing
Health Sciences

Email | paige.watkins@student.curtin.edu.au
Phone | 9266 0048

Curtin University

All people have an equal right to live free from violence, discrimination and stigma.

I wish to acknowledge the traditional custodians of the land we are on, the **Whadjuk** (Perth region) people. I wish to acknowledge and respect their continuing culture and the contribution they make to the life of this city and this region.

F.2 Approval for Article 2 (Chapter 4)

Re: Published article to include in phd thesis [231208-008291]

Permissions Helpdesk <permissionshelpdesk@elsevier.com>
Mon 11/12/2023 13:18
To:Paige Watkins (Student) <paige.watkins@postgrad.curtin.edu.au>

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RE: The prehospital management of ambulance-attended adults who fell: A scoping review, Australasian Emergency Care, Volume 26, Issue 1, 2023, Pages 45-53, Watkins et al.

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Regards,

Permissions Helpdesk

From: Paige Watkins
Date: Friday, December 08, 2023 05:28 AM GMT

To whom it may concern,

I published "The Prehospital Management of Ambulance-attended Adults Who Fell: A Scoping Review" in your journal and am preparing to submit my thesis. I am seeking permission to present this article in my thesis.

F.3 Approval for Article 3 (Chapter 5)

Re: permission for article to be in thesis [231208-008760]

Permissions Helpdesk <permissionshelpdesk@elsevier.com>
Mon 11/12/2023 13:20
To:Paige Watkins (Student) <paige.watkins@postgrad.curtin.edu.au>

Dear Paige Watkins

We hereby grant you permission to reprint the material below at no charge in your thesis subject to the following conditions:

RE: Epidemiology of ambulance-attended adults who fell in Western Australia 2015 – 2021: An increasing incidence in an ageing population, Injury, Volume 54, Issue 12, 2023, Watkins et al.

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Regards,

Permissions Helpdesk

From: Paige Watkins
Date: Friday, December 08, 2023 05:48 AM GMT

To whom it may concern,

I published "Epidemiology of ambulance-attended adults who fell in Western Australia 2015 – 2021: An increasing incidence in an ageing population " in your journal [Injury] and as part of my Phd thesis, I am requesting permission for the publication to be presented in my thesis document.

Thank you

Paige Watkins

F.4 Approval for Article 5 (Chapter 7)

Re: AUEC_650

Ramon Shaban (Editor in Chief | AUEC) <editor@cena.org.au>
Fri 19/01/2024 08:46

To:Paige Watkins (Student) <paige.watkins@postgrad.curtin.edu.au>
Cc:Ramon Shaban (Editor in Chief | AUEC) <editor@cena.org.au>

Dear Paige,

Thank you for your patience. Your request is approved, and I grant you permission to include AUEC_650 presentec within your thesis.

All the best for the examination and career ahead, and thank you for publishing with Australasian Emergency Care.

Kind regards,
Ramon

Professor Ramon Z. Shaban FCENA
Editor-in-Chief
www.ausemergcare.com

Senior Administrative Officer and Executive Assistant: Mrs Trishna Pokharel Dhital | Email: office.professor-shaban@sydney.edu.au

AUEC Australasian Emergency Care

CENA College of Emergency Nursing Australasia Ltd

From: "Paige Watkins (Student)" <paige.watkins@postgrad.curtin.edu.au>
Date: Tuesday, 16 January 2024 at 2:23 pm
To: AUEC EIC <editor@cena.org.au>
Subject: Re: AUEC_650

Hello Ramon,

Thank you, I'm very excited about this being published with Australasian Emergency Care.

I'm completing a thesis by publication and looking to put PDF copies of the published article in my thesis.

I look forward to hearing from you,

Kind Regards,

Paige Marie Watkins

BSc (Exercise, Sports & Rehabilitation) Hons
PRECRU PhD Candidate

School of Nursing

Health Sciences

Email | paige.watkins@student.curtin.edu.au

Phone | 9266 0048

Curtin University

All people have an equal right to live free from violence, discrimination and stigma.

I wish to acknowledge the traditional custodians of the land we are on, the **Whadjuk** (Perth region) people. I wish to acknowledge and respect their continuing culture and the contribution they make to the life of this city and this region.

From: Ramon Shaban (Editor in Chief | AUEC) <editor@cena.org.au>
Sent: 16 January 2024 11:19
To: Kathirreshan, Mahalakshmi (ELS-CHN) <m.kathirreshan@elsevier.com>; Paige Watkins (Student) <paige.watkins@postgrad.curtin.edu.au>
Subject: RE: AUEC_650

Dear Paige,

Thank you for your email and congratulations on having it accepted, and also congratulations on nearing the completion of your PhD.

I approved production proof copy of your paper earlier today, which means is it published.

It has been allocated to Volume 27 Issue 3 for 2023, but has been allocated a DOI and is published.

In terms of permission to include in your thesis, in what format are you seeking this permission?

Kind regards,
Ramon

Professor Ramon Z. Shaban FCENA
Editor-in-Chief
www.ausemergcare.com

Senior Administrative Officer and Executive Assistant: Mrs Trishna Pokharel Dhital | Email: office.professor-shaban@sydney.edu.au

From: Kathirreshan, Mahalakshmi (ELS-CHN) <m.kathirreshan@elsevier.com>
Sent: Tuesday, 16 January 2024 2:03 PM
To: Ramon Shaban <ramon.shaban@sydney.edu.au>
Cc: paige.watkins@postgrad.curtin.edu.au
Subject: AUEC_650

Dear Prof Ramon,

Good day to you.

Please see the below mail from the author of the article AUEC_650 ["Mind the gap": An exploratory qualitative study of paramedics' experiences attending older adults who fall in Western Australia]:

My recently accepted article (article reference AUEC650) is being prepared for publication. I am seeking permission to have this article presented in my PhD thesis (thesis by publication).

Could you please assist the author (copied here) with his query?

Thank you in advance.

Regards,

Maha

Mahalakshmi Kathirreshan
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