Earlier initiation of community-based palliative care is associated with fewer unplanned hospitalisations and emergency department presentations in the final months of life: a population-based study amongst cancer decedents.

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Abstract

Context: While community-based palliative care (CPC) is associated with decreased acute care use in the lead up to death, it is unclear how the timing of CPC initiation affects this association.

Objectives: We aimed to explore the association between timing of CPC initiation and hospital use, over the final 1, 3, 6 and 12 months of life.

Methods: We conducted a retrospective, population-based study in Perth, Western Australia. Linked administrative data including cancer registry, mortality, hospital admissions, emergency department (ED) and CPC records were obtained for cancer decedents from 1 January 2001 to 31 December 2011. The exposure was month of CPC initiation; outcomes were unplanned hospitalisations, emergency department (ED) presentations and associated costs.

Results: Of 28,331 decedents residing in the CPC catchment area, 16,439 (58%) accessed CPC, mostly (64%) in the last three months of life. Initiation of CPC prior to the last six months of life was associated with a lower mean rate of unplanned hospitalisations in the last six months of life (1.4 versus 1.7 for initiation within six months of death); associated costs were also lower ($(A2012) 12,976 versus $13,959, comparing the same groups). However, those initiating CPC earlier did show a trend towards longer time in hospital when admitted, compared to those initiating in the final month of life.

Conclusions: When viewed at a population-level, these results argue against temporally restricting access to CPC, as earlier initiation may pay dividends in the final few months of life in terms of fewer unplanned hospitalisations and ED presentations.

Key Words: Palliative care; Hospital costs; Community health Services; linked administrative data

45 Running title: The timing of community-based palliative care initiation.

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Introduction

The World Health Organization's definition of palliative care, [1] encourages its availability early in the illness course. A 2013 Cochrane review [2] assessing 23 studies found community-based palliative care (CPC) increased the likelihood of death at home, as opposed to in hospital, and reduced symptoms. [4]However, in some settings access to CPC is restricted by expected time until death. For example, expected time until death of three months or less is required in Queensland, Australia, [3] while many insurance plans in the United States, including Medicare, require an expected time to death of six months.[4]

Given an expected increasing need to provide palliative care through alternative non-hospital settings, [5, 6] CPC may appeal to health planners. [7] This is partly because hospital care at the end-of-life also accounts for a disproportionate amount of health spending. [8-10] Cost analysis of the United States, Belgium, Canada, England, Germany, The Netherlands and Norway, shows between 33% and 50% of health-specific purchasing power parity adjusted hospital expenditure in the last six months of life is accounted for in the month prior to death.[11] Previous work has shown a similar scenario amongst cancer patients in Australia,[12, 13] where people are likely to spend time in hospital in the lead up to death, and are most likely to die in hospital. [14] This is despite a preference for dying at home, [15-19] and for receiving out-of-hospital palliative care. [8, 9, 20 10-12]Admission complexity means costs may exceed activity-based funding reimbursements to Australian hospitals. [21, 22 15]

[7, 89]In Perth, Western Australia (WA), CPC is provided by a single non-Government provider free of charge at the point of care. This is an uncapped, home-based, multidisciplinary service available to those with a progressive, life-limiting illness requiring symptom management following medical practitioner referral. In a recent study using data from this service, [22] we found that the use of CPC, relative to no CPC, was associated with an increased odds of cancer decedents dying out of hospital (adjusted odds ratio of 3) and decreased unplanned

hospitalisation (adjusted hazard ratio of 0.94 in the last year of life). Unlike WA, in other health settings a limit is placed on CPC initiation based on expected time to death, to reduce service costs. Considering evidence from other health systems, studies from Canada have found that the initiation of home-base palliative care (CPC) greater than six months prior to death reduced the risk of needing acute care in the last fortnight of life, in a dose-dependent manner, [23] and that end-of-life nursing reduced emergency department (ED) presentations in the subsequent week over the final six months of life. [24]

[5655]If the majority of end-of-life acute care and associated costs are incurred in the immediate lead up to death, an important policy question that has not been adequately explored to date is: what is the added benefit in terms of unplanned hospitalisations and ED presentations, if any, from initiating CPC (i.e. home-based) very much before this time? This is worth exploring, since the cost-effectiveness of CPC, from a health system perspective, is driven by offsetting costs elsewhere is the health system. To date, the majority of research on the impact of specialist palliative care has focused on hospital and hospice-based services. The aims of this study were therefore to: 1) examine the association between timing of initiation of CPC and unplanned hospital use, ED presentations and associated costs, and; 2) assess how this association is affected by the 'end-of-life' period over which these outcomes are measured.

Methods

The reporting of this population-based retrospective study was based on items in the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement (see Appendix 1). [25] The study was approved by the WA Department of Health Human Research Ethics Committee (2013/40), which exempted the study from requiring individual patient consent.

Data sources and linkage

Person-level linked data for WA cancer decedents who died between 1 January 2001 and 31 December 2011 were extracted from the WA Cancer Registry, WA Mortality System, WA Hospital Morbidity Data Collection (HMDC), WA ED Data Collection and CPC records linked and extracted via the WA Data Linkage System. [26]

Description of participants

Only those living within the CPC catchment area in Perth and dying after one month of age were included.

Outcomes, exposure and covariates

Unplanned hospital admissions, ED presentations, length of stay and associated costs (outcomes)

Time prior to death was categorised to several look-back periods: 1, 3, 6 and 12 month(s) prior to the date of death. Hospitalisations were allocated to look-back periods based on the admission date for unplanned hospitalisation or presentation date for ED presentations. The admission status variable in the HMDC data was used to determine if hospitalisations were planned or unplanned. In this study hospitalisations coded as 'emergency' were classified as unplanned. [27]

Episodes of hospitalisation were constructed taking into account inter-hospital transfers to avoid double counting. Transfer adjusted lengths of stay in days [28], for each inpatient hospitalisation were used to calculate: (i) the total number of bed days spent in hospital due to initiation of unplanned admissions to hospital during each look-back, and; (ii) the average length of stay (ALOS) of unplanned admissions to hospital initiated in each look-back period. Deceased on arrival or purely administrative ED presentations (e.g. 'placeholders' for transfers, not presenting) were excluded.

The cost of each episode of care was assigned based on average cost of the Australian Refined Diagnosis Related Group (AR-DRG) code recorded using the National Hospital Cost Data Collections for WA specific to the date of separation of each hospital record. [29, 30] ED presentations were costed using the Urgency Related Group values. [30] These reflect the costs paid to hospitals for admissions by the State Government. All costs were adjusted to 2012 prices, using relevant health price indices [31]. In addition, an expected cumulative length of stay (LOS) was calculated (defined as the average length of stay recorded for the AR-DRG in the relevant national cost data collection table). [30]

Community-based palliative care service (exposure)

CPC service data were used to identify which members of the cohort had accessed CPC (defined as having at least one in-home visit), the date of first access and the number of visits. For those who had "ever" used the service, the timing of first-time service utilisation was categorised in months prior to death ranging from less than one months prior to death, ascending to 12 months or earlier.

The exposure was also dichotomised as initiation before or after each look back period (e.g. within the final three months of life, versus prior to this for the three month look back). In summary, CPC provided by Silver Chain in Perth comprises a multi-disciplinary team providing palliative care services to patients at their 'usual place of residence', which may differ with time. The team is usually comprised of doctors with palliative care training, nurses and other allied health and people to provide non-health-related support (e.g. chaplains). The frequency of visits is based on clinical need and is uncapped.[32]

Socio-demographic data and cancer history (covariates)

Sex, age, marital status, postcode-based residential location and type of cancer causing death were extracted from the WA Mortality system. Postcode-based Socio-economic Index for

Areas (SEIFA) index of relative social disadvantage [33], CPC service catchment area (north, south, east), country of birth, whether more than one cancer was diagnosed, the length of time living with cancer and whether cancer was the cause of death were ascertained using the Cancer Registry. Indigenous status was determined via the WA Data Linkage Branch. [34] Comorbidity was ascertained using the Multipurpose Australian Comorbidity Scoring System (MACSS) [35] in the last 12 months of life using all principal and co-diagnosis codes on the HMDC, with the exclusion of cancer.

Statistical analysis

The relationship between first-time use of the CPC (in months prior to death, and for initiation before or after the look back period) and the rate of unplanned hospitalisation and ED presentation was evaluated using multivariate negative binomial regression, due to the over dispersed nature of the data. Multivariable exponential Cragg-hurdle models with a lower limit of zero and no upper limit were used for bed days, ALOS and costs. Hurdle model combine two models: (i) a selection model that determines if an individual has an outcome of interest, and; (ii) an outcome model that determines the positive amount of that outcome (i.e. bed days, ALOS or cost). The covariates for the selection model were determined using binary logistic regression with unplanned hospitalisation as the dependent variable. The covariates deemed as significant ($p<0.05$) were used in the hurdle selection model. The Cragg-hurdle outcome model and the negative binomial regression model used the full set of potential covariates as follows: sex, year of death, age at death (<50 years, 50 – 74 years, 75+ years), born in Australia/New Zealand or elsewhere, Indigenous status, partnered at death, multiple cancer diagnoses, time between cancer diagnosis and death (in days), socio-economic status, CPC catchment area, comorbidity recorded on hospitalisations in previous 12 months (yes/no), cancer type causing death and the number of CPC home visits in the last 12 months of life. The inclusion of co-variates was determined based on the effect they had on the model, and reflected those in the

168 administrative data likely to have different distributions for those accessing CPC early and late.
169 The average effect of initiation time was obtained by post estimation of the marginal effects.
170 For the number of unplanned hospitalisations and ED presentations, the marginal estimates
171 were reported as rates per person-time for the relevant lookback period (i.e. only whilst out of
172 hospital were patients considered 'at risk'). For total bed days, ALOS and cost, means at the
173 person-level for each look back period were reported. The mean difference (coefficient)
174 between actual and expected LOS (based on AR-DRG grouping) per person, between initiation
175 before or after the lookback period was estimated using linear regression, adjusted for the above
176 covariates.

177 Those not receiving CPC or with no CPC initiation date were excluded from the analyses,
178 though we did perform a sub-analysis of the negative binomial and Cragg-hurdle modelling for
179 months prior to death, with 'no CPC use' as the reference. Stata SE (Version 14, College
180 Station, Texas) was used to conduct the analyses.

181 **Results**

182 During the study period, 39,247 people died from cancer in WA. Of those, 28,331 (72%)
183 resided in the CPC catchment area at the time of death and had a recorded initiation date. The
184 majority (58%, 16,439) accessed CPC at some time prior to death; differences in characteristics
185 between those accessing and not accessing CPC have been discussed elsewhere. [22] For those
186 who did access CPC, the majority (64%) initiated the service in the last three months of life
187 (Table 1). Only 1,534 (9%) of those using CPC accessed the service earlier than nine months
188 prior to death.

189 Assessing the last 12 months of life, there was not a clear association between the mean rate of
190 unplanned hospitalisations per person-time at risk and the month of initiation prior to death
191 (range 2.1 to 2.8 – Figure 1 a), Appendix 1), or of ED presentations (Figure 1 b), Appendix 2).

For the last 6 months of life, earlier initiation (before 6 months prior to death) of CPC was associated with a lower rate of unplanned hospitalisations and ED presentations; with a similar trend for the last three months of life. Table 2 shows the CPC initiation dichotomised to initiation within or before the look back period. Over each look back period, the mean rate of unplanned hospitalisation and ED presentation was less with earlier initiation.

Over the last year of life, patients who initiated earlier than in the final month of life spent more time in hospital for unplanned admissions (~ 20 – 27 days, Figure 2 a), Appendix 2). Earlier initiation did not seem associated with a lower ALOS (Figure 2 b), Appendix 2). Considering the number of unplanned hospitalisations and mean number of days in hospital for unplanned admissions/ALOS together (Figures 1 and 2), in the last six months of life, there was a lower number of hospitalisations for patients initiating >6 months prior to death, but relatively similar time spent in hospital (Table 2). Table 2 also shows that the mean 'unexpected days' spent in hospital per-person were greater for earlier initiation of CPC.

Figure 3 shows the estimated unplanned hospitalisation (a)) and ED presentations costs (b)). While earlier initiation seems in some cases associated with higher costs, Table 2 shows that broadly for early versus late initiation, there is a trend toward lower associated costs with earlier initiation of CPC.

Appendix 2 contains the marginal estimates used to construct Figures 1 to 3. We also ran the models including patients not initiating CPC and found the trends observed in the main analysis remained.

Discussion

The results of this study suggest an association between earlier initiation of CPC and fewer unplanned hospitalisations and ED presentations and associated costs in the final six months of life, with lower apparent reductions in the final 12 months of life. However, for those patients

initiating CPC earlier, there was an association with greater LOS, in terms of cumulative, average and mean days in excess of that expected based on AR-DRG-related reimbursements to hospitals over the relevant lookback period.

The marginal estimates for unplanned hospital admissions occurring in the last six months of life (Appendix 2) were between 1.2 and 1.9 admissions for the six month period per person-time at risk (time up to six months, as persons were only considered 'at risk' of hospitalisation when not admitted to hospital). Authors of a recent Australian study reported 3.1 hospitalisations per-person in the last six months of life [12]. The discrepancy is likely due to the different study population and that our analysis considered only unplanned hospitalisations. The reason for including only unplanned hospitalisations, was that only admissions to specialist hospital-based palliative care services are coded as "palliative". Thus, to reduce the risk of including admissions with curative intent, we restricted the analysis to only unplanned hospitalisations.

Twenty-five to 34% of estimated unplanned hospitalisation costs in the last six months of life in our study, occurred in the final month of life. The corresponding proportion was 40% in the study by Langton and colleagues [12]. Previous work by Moorin and Holman [36] showed a trend toward more expensive hospital admissions in the final month of life, particularly for patients aged under 85 years. [36] However, the marked peak in hospitalisation costs during the final month of life shown recently by Reeve and colleagues,[13] was not apparent in our study. The costing in our study was based on reimbursement to hospitals, which may under-estimate the actual cost to hospitals, and in part explain the different costing patterns observed. However, the DRG-related costs reflect those incurred by the State Government for hospital admissions.

Previous research has demonstrated a peak in the use of hospital services immediately prior to the transition to palliative care. [37] This may partly explain the increase in hospitalisation in the

final 12 months for those initiating CPC at or around 12 months prior to death. The timing of CPC initiation/non-initiation in relation to time living with cancer (less time with cancer associated with less CPC) may also reflect that less aggressive cancer types/stages facilitate better planning of CPC. More aggressive cancer or cancer diagnosed later may lend itself more to hospital management in the lead up to death. While there is no staging information in the linked administrative data, in addition to type of cancer we adjusted for the number of CPC visits (i.e. intensity of CPC following initiation), presence of multiple cancer types, and the length of time between cancer diagnosis and death.

The use of person-level whole of population linked data reduces issues of recall bias, the single CPC provider in Perth reduces the risk of 'contamination' from other services and the risk of selection bias being reflected in the results is reduced by adjustment for several relevant covariates with potential to differ based on timing of CPC initiation. Though the study period extends to 2011, there have been no local policy changes to CPC access in the areas under study in the intervening period that would limit generalisability to the current day. Our study has several limitations. The assignment of some covariates at death does introduce the risk of changes from the beginning of each look back period. However any changes to modifiable covariates (such as a partnered person marrying in the lead up to death), are unlikely to affect interpretation. Inclusion of only metropolitan cancer decedents limits generalisability to patients palliated for non-cancer reasons, or living in a non-metropolitan area. The effect of potential survival non-equivalence between those accessing CPC at different times – an issue of contention in the literature [38] – increases with increasing time counting backwards from death. Thus, we have not examined the impact of CPC initiation before 12 months prior to date of death. The study of cancer decedents does introduce the risk of studying people prior to a diagnosis of cancer, particularly for aggressive cancer types and for the last 12 months of life, though we adjusted for length of time since cancer diagnosis for all analyses. This can affect

interpretation compared to prospective study forward from a date of diagnosis. [39] Our decision to consider four look back periods, consistent with the approach in a previous study using these data, [22] aimed to assess the robustness of different timing of initiation of unplanned hospitalisation and ED presentation. The adjustment covariates in the model were determined by those likely to be different between people initiating CPC at different times. While there may still be differences, this adjustment makes the comparison as robust as possible given the data available, and the analyses reflect observed trends amongst a large population of 16,439 cancer decedents.

Our approach uses readily available data, similar to that available to health policy makers, and yields useful insights into patterns of CPC and unplanned hospital use. A previous study, also conducted in Perth [40] evaluated the effect of early (between 91 and 365 days before death) versus no or late admission (i.e. no admission or within 90 days of death). These authors found a reduced number of ED presentations in the 3 months before death. [40] However, evaluating timing of access in terms of early versus non/late access as undertaken in these authors' study does not allow the effect of early versus late access to be differentiated, as those using CPC have been found to have differing characteristics to those who do not. [22] Analyses from Canada have found that the initiation of home-base palliative care (CPC) greater than six months prior to death reduced the risk of needing acute care in the last fortnight of life, in a dose-dependent manner, [23] and that end-of-life nursing reduced emergency department (ED) presentations in the subsequent week over the final six months of life. [24] These results are consistent with these findings. Our study adds to these findings by analysing data from a different health system, and by assessing timing of initiation by month of initiation prior to death and with different lookback periods.

The important implications of this study are for health systems where CPC initiation is restricted to a certain time prior to death, as is the case for the United States' Medicare

program.[4] While it is simplistic to consider hospitalisation at the end of life a 'problem', [41] there is a strong body of evidence indicating the hospital use at the end of life is resource intensive, [11] and as populations age strategic planning of palliative care will be important to ensure quality and sustainability.

In conclusion, earlier CPC initiation (with more than six months to live) was associated with fewer unplanned hospitalisations in the last six months of life. Though we cannot suggest causation, these findings support a hypothesis that initiation of CPC at >6 months prior to death can reduce the number of unplanned hospitalisations at a population-level in the six months before death. Other considerations, such as patient preference are important,[42] but will require alternate study designs.

Authors' contributions: RM and DY conceived the study; RM and CW conducted the analyses and modelled the data; RM, DY and CW interpreted the data analysis; RM wrote the draft manuscript; CW revised the paper; RM, DY and CW critically appraised the manuscript for important intellectual content.

Disclosures

Associate Professor Rachael Moorin was employed as Principal Investigator at the Silver Chain Group which delivers the community based palliative care service evaluated in this study at the time the study was conducted.

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References

1. World Health Organisation. WHO Definition of Palliative Care. http://www.who.int/cancer/palliative/definition/en/ (2015, accessed 11 August 2017).
2. Gomes B, Calanzani C, Curiale V, McCrone P and Higginson I. Effectiveness and cost-effectiveness of home palliative care services for adults with advanced illness and their caregivers. *Cochrane Database Syst Rev*. 2013: DOI: 10.1002/14651858.CD007760.pub2.
3. Sunshine Coast Hospital and Health Service, Queensland Health. Specialist Palliative Care Service, https://www.health.qld.gov.au/sunshinecoast/community/pal-care (2017, accessed 11 August 2017).
4. National Cancer Institute. Hospice care fact sheet, https://www.cancer.gov/about-cancer/advanced-cancer/care-choices/hospice-fact-sheet (2012, accessed 3 November 2017).
5. Australian Government, Department of Health and Ageing. Primary Health Care Reform in Australia: Report to Support Australia's First National Primary Health Care Strategy, http://catalogue.nla.gov.au/Record/4699071 (2009, accessed 11 August 2017).
6. Gomes B and Higginson IJ. Where people die (1974--2030): past trends, future projections and implications for care. *Palliat Med*. 2008; 22: 33-41.
7. Rabow M, Kvale E, Barbour L, et al. Moving upstream: A review of the evidence of the impact of outpatient palliative care. *J Palliat Med*. 2013; 16: 1540-9.
8. Goldsbury D, O'Connell D, Girgis A, et al. Acute hospital-based services used by adults during the last year of life in New South Wales, Australia: a population-based retrospective cohort study. *BMC Health Serv Res*. 2015; 15.

9. Rosenwax LK, McNamara BA, Murray K, McCabe RJ, Aoun SM and Currow DC. Hospital and emergency department use in the last year of life: a baseline for future modifications to end-of-life care. *Med J Aust*. 2011; 194: 570-3.
10. Langton J, Blanch B, Drew A, Haas M, Ingham J and Pearson S. Retropective studies of end-of-life resource utilization and costs in cancer care using health administrative data: A systematic review. *Palliat Med*. 2014; 28: 1167-96.
11. Bekelman JE, Halpern SD, Blankart CR, et al. Comparison of Site of Death, Health Care Utilization, and Hospital Expenditures for Patients Dying With Cancer in 7 Developed Countries. *JAMA*. 2016; 315: 272-83.
12. Langton JM, Reeve R, Srasuebkul P, et al. Health service use and costs in the last 6 months of life in elderly decedents with a history of cancer: a comprehensive analysis from a health payer perspective. *Br J Cancer*. 2016; 114: 1293-302.
13. Reeve R, Srasuebkul P, Langton JM, et al. Health care use and costs at the end of life: a comparison of elderly Australian decedents with and without a cancer history. *BMC Palliat Care*. 2017; 17.
14. McNamara B and Rosenwax L. Factors affecting place of death in Western Australia. *Health Place*. 2007; 13: 356-67.
15. Currow D, Burns C and Abernethy A. Place of death for people with noncancer and cancer illness in South Australia: a population-based survey. *J Palliat Care*. 2008; 24: 144-50.
16. Foreman L, Hunt R, Luke C and Roder D. Factors predictive of preferred place of death in the general population of South Australia. *Palliat Med*. 2006; 20: 447-53.
17. Holdsworth L and Fisher S. A retrospective analysis of preferred and actual place of death for hospice patients. *Int J Palliat Nurs*. 2010; 16: 424-30.

18. Hays JC, Galanos AN, Palmer TA, McQuoid DR and Flint EP. Preference for place of death in a continuing care retirement community. *Gerontologist*. 2001; 41: 123-8.
19. Townshend J, Frank A, Fermont D, et al. Terminal cancer care and patients' preference for place of death: a prospective study. *Br Med J*. 1990; 301: 415-7.
20. Higginson I and Sen-Gupta G. Place of Care in Advanced Cancer: A Qualitative Systematic Literature Review of Patient Preferences. *J Palliat Med*. 2000; 3: 287-300.
21. Cassal JB, Kerr KM, Kalman NS and Smith TJ. The business case for palliative care: Translating research into program development in the US. *J Pain Symptom Manage*. 2015; 50: 741-9.
22. Youens D and Moorin R. The Impact of Community-Based Palliative Care on Utilization and Cost of Acute Care Hospital Services in the Last Year of Life. *J Palliat Med*. 2017.
23. Seow H, Barbera L, Howell D and Dy SM. Using more end-of-life homecare services is associated with using fewer acute care services: a population-based cohort study. *Med Care*. 2010; 48: 118-24.
24. Seow H, Barberra L, Pataky R, et al. Does increasing home care nursing reduce emergency department visits at the end of life? A population-based cohort study of cencer decedents. *J Pain Symptom Manage*. 2016; 51: 204-12.
25. Benchimol EI, Smeeth L, Guttmann A, et al. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement. *PLoS Med*. 2015; 12: e1001885.
26. Holman CDAJ, Bass AJ, Rouse IL and Hobbs MST. Population-based linkage of health records in Western Australia: development of a health services research linked database. *Aust N Z J Public Health*. 1999; 23: 453-9.

27. Government of Western Australia: Department of Health. Hospital Morbidity Data System: HMDS reference manual, http://www.health.wa.gov.au/healthdata/docs/Hospital_Morbidity_Data_System_Reference_Manual.pdf (2014, accessed 10 November 2017).
28. Smith TJ, Temin S, Alesi ER, et al. The integration of palliative care into standard oncology care. *J Clin Oncol*. 2012; 30: 880-7.
29. Australian Government, Department of Health and Ageing. National Hospital Cost Data Collection Hospital Reference Manual: Western Australia 2010-2011, https://www.ihpa.gov.au/sites/g/files/net636/f/publications/rd15-nhcdc-cost-report-2010-11.pdf (2013, accessed 11 August 2017).
30. Independent Hospital Pricing Authority. National Hospital Cost Data Collection Cost Report 2011-2012, Round 16, https://www.ihpa.gov.au/publications/nhcdc-australian-public-hospitals-cost-report-2011-2012-round-16 (2014, accessed 11 August 2017).
31. Australian Institute of Health and Welfare. Health expenditure Australia 2010-11, http://www.aihw.gov.au/publication-detail/?id=10737423009 (2012, accessed 11 August 2011).
32. Silver Chain Group. Palliative Care, https://www.silverchain.org.au/health-care/palliative-care-2/ (2017, accessed 3 November 2017).
33. Australian Bureau of Statistics. Census of Population and Housing: Socio-Economic Indexes for Areas (2001, 2006 & 2011). Canberra: Australian Bureau of Statistics, 2001, 2006, 2011.
34. Christensen D, Davis G, Draper G, et al. Evidence for the use of an algorithm in resolving inconsistent and missing Indigenous status in administrative data collections. *Australian Journal of Social Issues* 2014; 49.

35. Holman CDAJ, Preen DB, Baynham NJ, Finn JC and Semmens JB. A multipurpose comorbidity scoring system performed better than the Charlson index. *J Clin Epidemiol*. 2005; 58: 1006-14.
36. Moorin RE and Holman CD. The cost of in-patient care in Western Australia in the last years of life: a population-based data linkage study. *Health Policy*. 2008; 85: 380-90.
37. Obermeyer Z, Makar M, Abujaber S, Dominici F, Block S and Cutler D. Association Between the Medicare Hospice Benefit and Health Care Utilization and Costs for Patients With Poor-Prognosis Cancer. *Journal of the American Medical Association*. 2014; 312: 1888-96.
38. Luckett T, Davidson PM, Lam L, Phillips J, Currow DC and Agar M. Do community specialist palliative care services that provide home nursing increase rates of home death for people with life-limiting illnesses? A systematic review and meta-analysis of comparative studies. *J Pain Symptom Manage*. 2013; 45: 279-97.
39. Bach PB, Schrag D and Begg CB. Resurrecting treatment histories of dead patients: a study design that should be laid to rest. *JAMA*. 2004; 292: 2765-70.
40. McNamara B, Rosenwax L, Murray K and Currow D. Early admission to community-based palliative care reduces use of emergency departments in the ninety days before death. *J Palliat Med*. 2013; 16: 774-9.
41. Robinson J, Gott M, Gardiner C and Ingleton C. The 'problematisation' of palliative care in hospital: an exploratory review of international palliative care policy in five countries. *BMC Palliat Care*. 2016; 15: 64.
42. Alonso-Babarro A, Bruera E, Varela-Cerdeira M, et al. Can this patient be discharged home? Factors associated with at-home death among patients with cancer. *J Clin Oncol*. 2011; 29: 1159-67.

Table 1. Characteristics of decedents according to broad timing of first-time use of the community palliative care service.

Characteristic		Initiation of community based palliative care in last year of life												
		Up to 1 month		> 1 to 3 months		> 3-6 months		> 6-9 months		> 9 to 12 months		At 12 months or earlier		
Median number of visits (IQR)		9 (4 – 17)		21 (12 – 36)		37 (22- 64)		53 (31 -89)		60 (35 – 107)		67 (38 – 118)		
		n	Percent[a]	n	Percent[a]	n	Percent[a]	n	Percent[a]	n	Percent[a]	n	Percent[a]	p-value[b]
Sex	Male	2,933	59.4	3,167	57.4	1,714	55.7	686	50.2	259	48.6	481	48.1	<0.0001
Age at Death	Under 50 years	407	8.2	441	8.0	268	8.7	116	8.5	29	5.4	85	8.5	<0.465
	50-74 years	2,470	50.0	2,816	51.0	1,550	50.3	710	52.0	285	53.5	509	50.8	
	75+ years	2,061	41.7	2,265	41.0	1,261	41.0	540	39.5	219	41.1	407	40.7	
Marital status at death	Partner recorded	3,126	63.3	3,292	59.6	1,834	59.6	794	58.1	309	58.0	539	53.8	<0.0001
Socio-economic status	Highest disadvantage	790	16.0	837	15.2	475	15.4	229	16.8	83	15.6	156	15.6	0.926
(at death)	High disadvantage	932	18.9	1,038	18.8	556	18.1	265	19.4	95	17.8	199	19.9	
	Moderate disadvantage	986	20.0	1,088	19.7	621	20.2	264	19.3	118	22.1	188	18.8	
	Less disadvantage	877	17.8	1,030	18.7	573	18.6	237	17.3	105	19.7	175	17.5	
	Least disadvantage	1,353	27.4	1,529	27.7	854	27.7	371	27.2	132	24.8	283	28.3	
Time living with cancer responsible for death	Less than 1 year	2,781	56.3	2,773	50.2	1,319	42.8	517	37.8	165	31.0	47	4.7	<0.0001
	1-5 years	1,541	31.2	2,003	36.3	1,302	42.3	603	44.1	263	49.3	689	68.8	
	More than 5 years	616	12.5	746	13.5	458	14.9	246	18.0	105	19.7	265	26.5	
Multiple cancers diagnosed	Yes	1,123	22.7	1,197	21.7	634	20.6	302	22.1	111	20.8	198	19.8	<0.0001
Type of cancer[c]	Female Breast	358	7.2	364	6.6	192	6.2	119	8.7	60	11.3	146	14.6	<0.0001
	Prostate	202	4.1	284	5.1	221	7.2	120	8.8	35	6.6	104	10.4	<0.0001
	Colorectal	588	11.9	707	12.8	412	13.4	172	12.6	76	14.3	123	12.3	0.364
	Lung, bronchus and Trachea	1,043	21.1	1,293	23.4	711	23.1	317	23.2	117	22.0	169	16.9	<0.0001
	Melanoma	231	4.7	284	5.1	129	4.2	38	2.8	14	2.6	15	1.5	<0.0001
Total in exposure group[d]		**4,938**	**30.0**	**5,522**	**33.6**	**3,079**	**18.7**	**1,366**	**8.3**	**533**	**3.2**	**1,001**	**6.1**	

n = Number of decedents, IQR = interquartile range

a) Percent is percentage of total decedents in the exposure category having the characteristic specified. Totals may not add to 100 due to rounding.
b) Chi-squared test, comparing percentage in each category for each time period.
c) Selected cancer types shown in this table. Thus, total percentage does not add to 100. P-values compared proportion with to without that cancer type, by time period.
d) Percent is calculated as the percentage of the entire cohort (i.e. used the service at some time in the last 12 months, N = 16,439, 58% of total 28,331 decedents in cohort). Totals may not add to 100 due to rounding.

Table 2. Acute care rate and associated cost for cancer decedents enrolled with community-based palliative care (CPC) at some prior to death, by initiation of CPC before or after the lookback period.[a]

	Mean rate of unplanned hospitalisations per person-time at risk (95% CI)[b]	Mean rate of emergency department presentations per person-time at risk (95% CI)[b]	Mean cumulative length of stay in days, per person (95% CI)[b]	Average length of stay in days, per person (95% CI)[b]	Mean difference in actual versus expected length of stay in days (95% CI)[b, c], per person	Mean cost of unplanned hospitalisations in 2012 Australian dollars, per person (95% CI)[a]	Mean cost of emergency department presentations in 2012 Australian dollars, per person (95% CI)[b]
1. Last month of life							
Initiation within last month	0.8 (0.8 – 0.8)	0.6 (0.6 – 0.7)	3.5 (3.3 – 3.7)	3.0 (2.8 – 3.1)	Ref	3,851 (3,703 – 3,998)	216 (208 – 224)
Initiation prior to last month	0.5 (0.5 – 0.6)	0.4 (0.4 – 0.4)	3.6 (3.4 – 3.7)	3.2 (3.1 – 3.4)	1.30 (1.1 – 1.5)	3,834 (3,706 – 3,963)	208 (201 – 214)
2. Last 3 months of life							
Initiation within last 3 months	1.4 (1.3 – 1.4)	1.1 (1.0 – 1.1)	10.3 (10.0 – 10.7)	6.6 (6.4 – 6.8)	Ref	9,311 (9,055 – 9,567)	511 (498 – 524)
Initiation at or prior to last 3 months	1.0 (1.0 – 1.0)	0.8 (0.7 – 0.8)	10.7 (10.3 – 11.1)	7.3 (7.1 – 7.6)	3.4 (2.9 – 3.9)	9,026 (8,753 – 9,299)	467 (453 – 480)
3. Last 6 months of life							
Initiation within last 6 months	1.7 (1.7 – 1.8)	1.4 (1.4 – 1.4)	16.1 (15.6 – 16.5)	8.3 (8.1 – 8.5)	Ref	13,959 (13,641 – 14,277)	761 (745 – 778)
Initiation at or prior to last 6 months	1.4 (1.3 – 1.5)	1.1 (1.0 – 1.2)	15.7 (14.9 – 16.5)	8.8 (8.5 – 9.2)	4.4 (3.5 – 5.2)	12,976 (12,433 – 13,519)	708 (681 – 734)
4. Last 12 months of life							
Initiation within last 12 months	2.3 (2.2 – 2.4)	1.8 (1.7 – 1.8)	21.2 (20.7 – 21.7)	8.9 (8.7 – 9.1)	Ref	18,642 (18,250 – 19,034)	1,040 (1,019 – 1,060)
Initiation at or prior to last 12 months	2.0 (1.9 – 2.2)	1.7 (1.6 – 1.9)	20.3 (18.7 – 22.0)	9.1 (8.6 – 9.7)	6.8 (5.1 – 8.5)	17,236 (16,037 – 18,436)	1,001 (939 – 1,062)

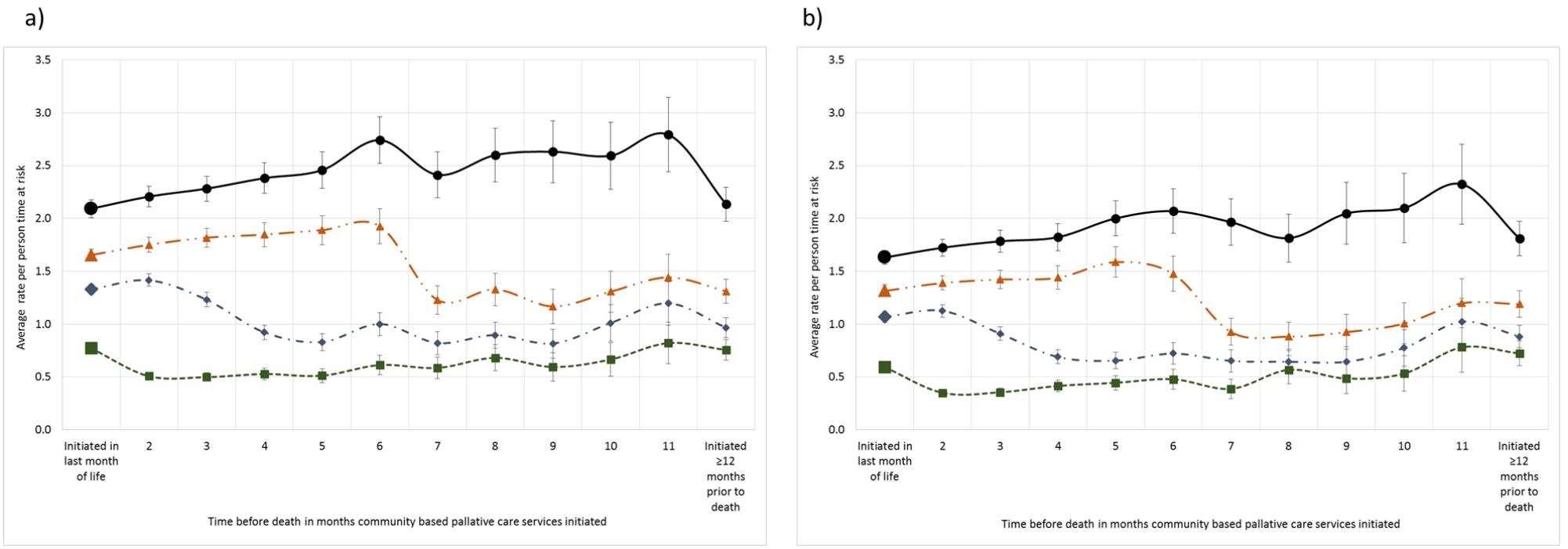
CI = confidence interval

a) For each look back period (1 – 4, highlighted in grey) initiation prior to the lookback (i.e. for 1. Initiation before the final month of life) is compared to initiation after the lookback (i.e. for 1. Initiation within the final month of life).

b) Adjusted for, sex, year of death, age at death (<50 years, 50 – 74 years, 75+ years), born in Australia or New Zealand (yes/no), Indigenous (yes/no), partner at death (yes/no), multiple cancer diagnoses (yes/no), time between cancer diagnosis and death (in days), socio-economic status, CPC service centre (north, east or south), comorbidity recorded on hospitalisations in previous 12 months (yes/no), cancer type causing death (dummy variables for Bladder/urinary tract, Breast, Unknown, Cervix, Colorectal, Kidney, Laryngeal, Leukaemia, Liver, Lung/Bronchial, Lymphoma, Melanoma, Mesothelioma, Myeloma, Oesophageal, Ovarian, Prostate, Stomach, Testicular, Thyroid, Uterine, Pancreas versus 'other' not entered into model), and the number of CPC home visits in the last 12 months of life.

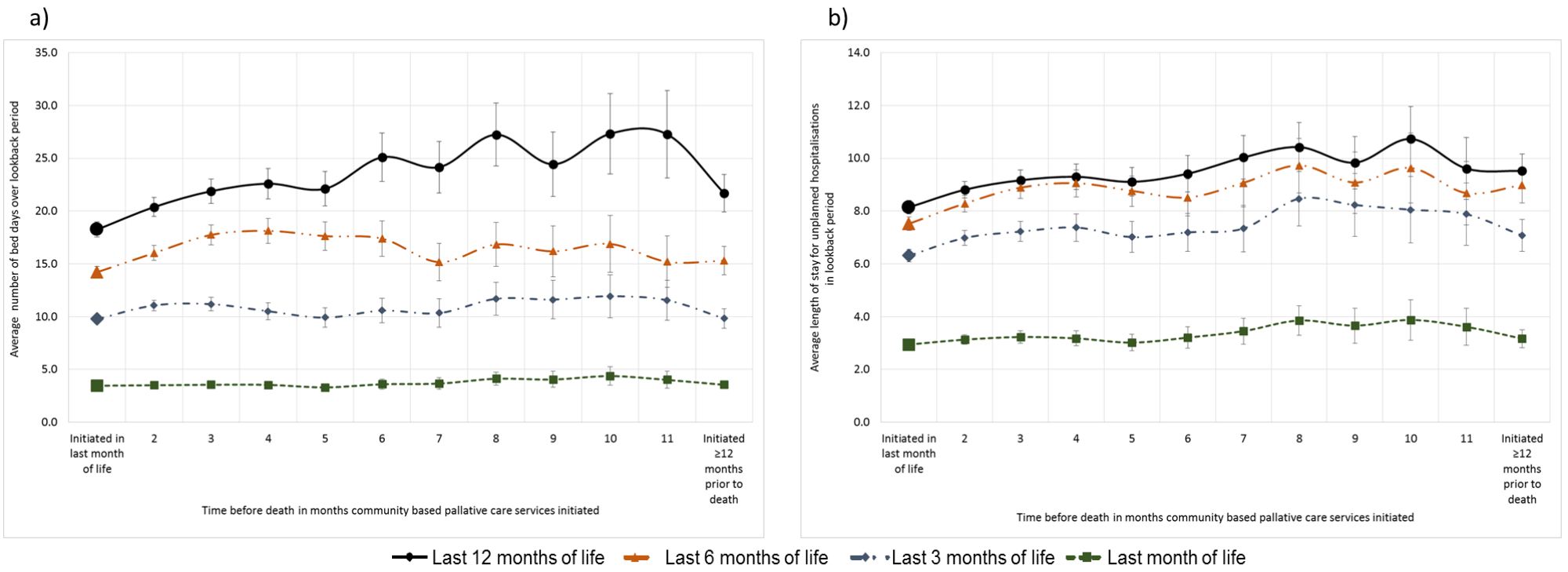
c) Coefficients represent the difference in actual versus expected stay in hospital based on diagnostic reference groupings, a positive coefficient indicates a greater positive difference (i.e. more unexpected days in hospital), with data modelled using linear regression adjusted for the covariates in b, only for patients admitted to hospital during the last 12 months of life.

Figure 1. Time of initiation of community based palliative care services by the mean rate per person-time at risk of a) unplanned hospitalisations, and; b) emergency department presentations in the last year of life.



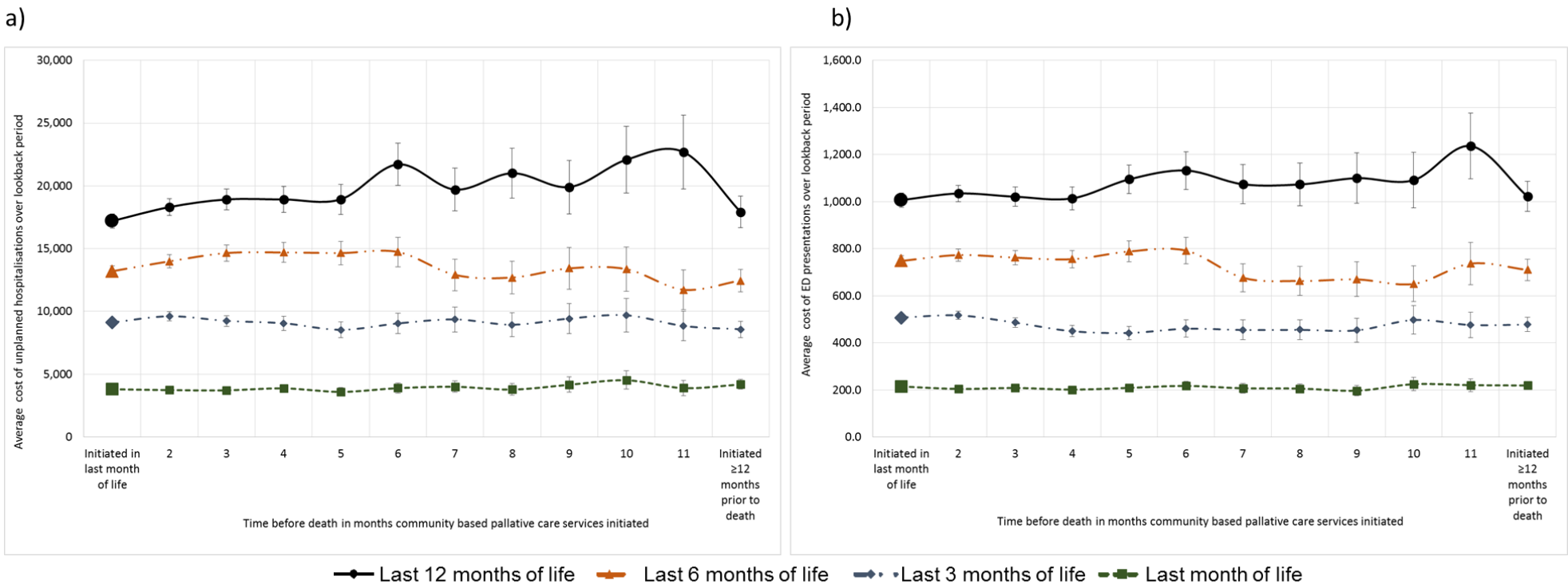
Adjusted for, sex, year of death, age at death (<50 years, 50 – 74 years, 75+ years), born in Australia or New Zealand (yes/no), Indigenous (yes/no), partner at death (yes/no), multiple cancer diagnoses (yes/no), time between cancer diagnosis and death (in days), socio-economic status, CPC service centre (north, east or south), comorbidity recorded on hospitalisations in previous 12 months (yes/no), cancer type causing death (dummy variables for Bladder/urinary tract, Breast, Unknown, Cervix, Colorectal, Kidney, Laryngeal, Leukaemia, Liver, Lung/Bronchial, Lymphoma, Melanoma, Mesothelioma, Myeloma, Oesophageal, Ovarian, Prostate, Stomach, Testicular, Thyroid, Uterine, Pancreas versus 'other' not entered into model), and the number of CPC home visits in the last 12 months of life.

Figure 2. Time of initiation of community based palliative care services by: a) mean per-person total number of days spent in hospital, and; b) per-person average length of stay (in days) for unplanned admissions in the last year of life (note different scales).



Adjusted for, sex, year of death, age at death (<50 years, 50 – 74 years, 75+ years), born in Australia or New Zealand (yes/no), Indigenous (yes/no), partner at death (yes/no), multiple cancer diagnoses (yes/no), time between cancer diagnosis and death (in days), socio-economic status, CPC service centre (north, east or south), comorbidity recorded on hospitalisations in previous 12 months (yes/no), cancer type causing death (dummy variables for Bladder/urinary tract, Breast, Unknown, Cervix, Colorectal, Kidney, Laryngeal, Leukaemia, Liver, Lung/Bronchial, Lymphoma, Melanoma, Mesothelioma, Myeloma, Oesophageal, Ovarian, Prostate, Stomach, Testicular, Thyroid, Uterine, Pancreas versus 'other' not entered into model), and the number of CPC home visits in the last 12 months of life.

Figure 3. Time of initiation of community based palliative care services by the mean per-person cost (A$2012) of: a) unplanned hospitalisations, and; b) emergency department presentations (note different scales).



Adjusted for, sex, year of death, age at death (<50 years, 50 – 74 years, 75+ years), born in Australia or New Zealand (yes/no), Indigenous (yes/no), partner at death (yes/no), multiple cancer diagnoses (yes/no), time between cancer diagnosis and death (in days), socio-economic status, CPC service centre (north, east or south), comorbidity recorded on hospitalisations in previous 12 months (yes/no), cancer type causing death (dummy variables for Bladder/urinary tract, Breast, Unknown, Cervix, Colorectal, Kidney, Laryngeal, Leukaemia, Liver, Lung/Bronchial, Lymphoma, Melanoma, Mesothelioma, Myeloma, Oesophageal, Ovarian, Prostate, Stomach, Testicular, Thyroid, Uterine, Pancreas versus 'other' not entered into model), and the number of CPC home visits in the last 12 months of life.

Appendix 1. The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	Described in title and abstract.	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract.	1.1 Title and in abstract/ 1.2 Title and abstract. 1.3 Abstract.

				RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction.		
Objectives	3	State specific objectives, including any prespecified hypotheses	End of introduction.		
Methods					
Study Design	4	Present key elements of study design early in the paper	Methods section.		
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Methods section.		

Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants	Retrospective study with outcome of unplanned hospital/ED use and associated cost, with exposure of month of CPC initiation prior to death. Cohort defined at death (i.e. a study of decedents).	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the	6.1 Data linkage used described in 'data sources and linkage' section of method. 6.2 Appropriate references cited in the methods section. 6.3. Data linkage used described in 'data sources and linkage' section of method.

		(b) Cohort study - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case		number of individuals with linked data at each stage.	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	Defined in methods section.	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Defined in methods section and again, in detail, below Figures 1, 2 and 3.
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement).	Described in the methods section.		

		Describe comparability of assessment methods if there is more than one group			
Bias	9	Describe any efforts to address potential sources of bias	Adjustment described in the 'statistical analysis' part of the methods.		
Study size	10	Explain how the study size was arrived at	Population-based study, so all eligible records included (>16,000 patients).		
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	Described in the 'statistical analysis' part of the methods.		

Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	Described in the 'statistical analysis' part of the methods.		

Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	12.1 Data linkage used described in 'data sources and linkage' section of method. 12.2 Described in the methods section, when defining people to be included in the analysis.
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and	12.3 Linkage described in the 'data sources and linkage section',

				methods of linkage quality evaluation should be provided.	person-level data used.
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram	Described in the first part of the results section, with further detail in a previous study referenced.	RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.*, study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	13.1 Described in the first part of the results section, with further detail in a previous study referenced.
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders	Described in the first part of the results section, with further detail in a previous study referenced.		

		(b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)			
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures	Described in the results section, Figures 1- 3, Tables 1 – 3, Appendix 2 and 3.		
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted	Described in the results section, Figures 1- 3,		

		estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Tables 1 – 3, Appendix 2 and 3.		
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	Described in the last sentence of the results section.		
Discussion					

Key results	18	Summarise key results with reference to study objectives	Discussed in the first paragraph of the discussion.		
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Study limitations have been described in the discussion section.	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	19.1. Discussed in strengths and limitations section that single service provider reduces bias; some limitations also described in this section.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Conclusions drawn in discussion, taking into account study limitations.		

Generalisability	21	Discuss the generalisability (external validity) of the study results	Addressed in the study limitations section.		
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.		
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Appendices provided, code is available upon request.

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

Appendix 2. Marginal estimates of: (a) mean rate per person-time at risk of unplanned hospital admissions; (b) mean rate per person-time at risk of ED presentations; (c) mean per-person total number of days spent in hospital; (d) per-person average length of stay (in days) for unplanned admissions; (e) mean per-person cost (A$2012) of unplanned hospitalisations, and; (f) mean per-person cost (A$2012) of emergency department presentations.

a) mean rate per person-time at risk of unplanned hospital admissions [a]

	Last month of life			Last 3 months of life			Last 6 months of life			Last 12 months of life		
Initiation of community palliative care (months before death)		**Lower 95% CI**	**Upper 95% CI**		**Lower 95% CI**	**Upper 95% CI**		**Lower 95% CI**	**Upper 95% CI**		**Lower 95% CI**	**Upper 95% CI**
1	0.8	0.7	0.8	1.3	1.3	1.4	1.7	1.6	1.7	2.1	2.0	2.2
2	0.5	0.5	0.5	1.4	1.4	1.5	1.7	1.7	1.8	2.2	2.1	2.3
3	0.5	0.5	0.5	1.2	1.2	1.3	1.8	1.7	1.9	2.3	2.2	2.4
4	0.5	0.5	0.6	0.9	0.9	1.0	1.8	1.7	2.0	2.4	2.2	2.5
5	0.5	0.4	0.6	0.8	0.7	0.9	1.9	1.8	2.0	2.5	2.3	2.6
6	0.6	0.5	0.7	1.0	0.9	1.1	1.9	1.8	2.1	2.7	2.5	3.0
7	0.6	0.5	0.7	0.8	0.7	0.9	1.2	1.1	1.4	2.4	2.2	2.6
8	0.7	0.6	0.8	0.9	0.8	1.0	1.3	1.2	1.5	2.6	2.3	2.9
9	0.6	0.5	0.7	0.8	0.7	1.0	1.2	1.0	1.3	2.6	2.3	2.9
10	0.7	0.5	0.8	1.0	0.8	1.2	1.3	1.1	1.5	2.6	2.3	2.9
11	0.8	0.6	1.0	1.2	1.0	1.4	1.4	1.2	1.7	2.8	2.4	3.1
≥12	0.8	0.7	0.9	1.0	0.9	1.1	1.3	1.2	1.4	2.1	2.0	2.3

a. Adjusted for: age at death, sex, number of hospice visits in last 12 months of life, year of death, place of birth (Australia/New Zealand, or elsewhere), Indigenous status, marital status, multiple cancer diagnoses (coded as yes/no), time between cancer diagnosis and death (in days), socioeconomic status, community palliative care catchment area (north, east or south), comorbidity recorded in previous 12 months (coded as yes/no) and cancer type causing death ((Bladder/urinary tract, Breast, Unknown, Cervix, Colorectal, Kidney, Laryngeal, Leukaemia, Liver, Lung/Bronchial, Lymphoma, Melanoma, Mesothelioma, Myeloma, Oesophageal, Ovarian, Prostate, Stomach, Testicular, Thyroid, Uterine, Pancreas) versus Other).
b. CI = confidence interval

b) mean rate per person-time at risk of ED presentations [a]

	Last month of life			Last 3 months of life			Last 6 months of life			Last 12 months of life		
Initiation of community palliative care (months before death)		**Lower 95% CI**	**Upper 95% CI**		**Lower 95% CI**	**Upper 95% CI**		**Lower 95% CI**	**Upper 95% CI**		**Lower 95% CI**	**Upper 95% CI**
1	0.6	0.6	0.6	1.1	1.0	1.1	1.3	1.3	1.4	1.6	1.6	1.7
2	0.3	0.3	0.4	1.1	1.1	1.2	1.4	1.3	1.5	1.7	1.6	1.8
3	0.4	0.3	0.4	0.9	0.8	1.0	1.4	1.3	1.5	1.8	1.7	1.9
4	0.4	0.4	0.5	0.7	0.6	0.8	1.4	1.3	1.5	1.8	1.7	2.0
5	0.4	0.4	0.5	0.7	0.6	0.7	1.6	1.4	1.7	2.0	1.8	2.2
6	0.5	0.4	0.6	0.7	0.6	0.8	1.5	1.3	1.6	2.1	1.9	2.3
7	0.4	0.3	0.5	0.7	0.5	0.8	0.9	0.8	1.1	2.0	1.7	2.2
8	0.6	0.4	0.7	0.6	0.5	0.8	0.9	0.7	1.0	1.8	1.6	2.0
9	0.5	0.3	0.6	0.6	0.5	0.8	0.9	0.8	1.1	2.0	1.8	2.3
10	0.5	0.4	0.7	0.8	0.6	0.9	1.0	0.8	1.2	2.1	1.8	2.4
11	0.8	0.5	1.0	1.0	0.8	1.2	1.2	1.0	1.4	2.3	1.9	2.7
≥12	0.7	0.6	0.8	0.9	0.8	1.0	1.2	1.1	1.3	1.8	1.6	2.0

a. Adjusted for: age at death, sex, number of hospice visits in last 12 months of life, year of death, place of birth (Australia/New Zealand, or elsewhere), Indigenous status, marital status, multiple cancer diagnoses (coded as yes/no), time between cancer diagnosis and death (in days), socioeconomic status, community palliative care catchment area (north, east or south), comorbidity recorded in previous 12 months (coded

as yes/no) and cancer type causing death ((Bladder/urinary tract, Breast, Unknown, Cervix, Colorectal, Kidney, Laryngeal, Leukaemia, Liver, Lung/Bronchial, Lymphoma, Melanoma, Mesothelioma, Myeloma, Oesophageal, Ovarian, Prostate, Stomach, Testicular, Thyroid, Uterine, Pancreas) versus Other).

b. CI = confidence interval

c) mean per-person total number of days spent in hospital [a]

Initiation of community palliative care (months before death)	Last month of life			Last 3 months of life			Last 6 months of life			Last 12 months of life		
		Lower 95% CI	Upper 95% CI		Lower 95% CI	Upper 95% CI		Lower 95% CI	Upper 95% CI		Lower 95% CI	Upper 95% CI
1	3.5	3.3	3.6	9.8	9.4	10.2	14.2	13.7	14.8	18.2	17.5	18.9
2	3.5	3.3	3.7	11.1	10.6	11.6	16.0	15.3	16.7	20.4	19.5	21.3
3	3.6	3.3	3.8	11.2	10.5	11.8	17.8	16.8	18.7	21.9	20.7	23.0
4	3.6	3.2	3.9	10.5	9.7	11.3	18.1	16.9	19.3	22.6	21.1	24.1
5	3.3	3.0	3.7	9.9	9.0	10.8	17.6	16.3	19.0	22.1	20.5	23.7
6	3.6	3.1	4.1	10.6	9.4	11.7	17.4	15.7	19.1	25.1	22.8	27.4
7	3.7	3.1	4.2	10.3	9.0	11.7	15.2	13.4	16.9	24.2	21.7	26.6
8	4.1	3.5	4.7	11.7	10.1	13.2	16.8	14.8	18.9	27.2	24.2	30.2
9	4.1	3.3	4.8	11.6	9.8	13.4	16.2	13.8	18.6	24.4	21.4	27.5
10	4.4	3.5	5.3	11.9	9.9	14.0	16.9	14.2	19.6	27.3	23.5	31.2
11	4.0	3.2	4.8	11.6	9.6	13.5	15.2	12.8	17.6	27.3	23.1	31.4
≥12	3.6	3.2	3.9	9.8	8.9	10.8	15.3	14.0	16.6	21.7	19.9	23.5

a. Adjusted for: age at death, sex, number of hospice visits in last 12 months of life, year of death, place of birth (Australia/New Zealand, or elsewhere), Indigenous status, marital status, multiple cancer diagnoses (coded as yes/no), time between cancer diagnosis and death (in days), socioeconomic status, community palliative care catchment area (north, east or south), comorbidity recorded in previous 12 months (coded as yes/no) and cancer type causing death ((Bladder/urinary tract, Breast, Unknown, Cervix, Colorectal, Kidney, Laryngeal, Leukaemia, Liver, Lung/Bronchial, Lymphoma, Melanoma, Mesothelioma, Myeloma, Oesophageal, Ovarian, Prostate, Stomach, Testicular, Thyroid, Uterine, Pancreas) versus Other).

b. CI = confidence interval

d) per-person average length of stay (in days) for unplanned admissions [a]

Initiation of community palliative care (months before death)	Last month of life	Lower 95% CI	Upper 95% CI	Last 3 months of life	Lower 95% CI	Upper 95% CI	Last 6 months of life	Lower 95% CI	Upper 95% CI	Last 12 months of life	Lower 95% CI	Upper 95% CI
1	2.9	2.8	3.1	6.3	6.1	6.5	7.5	7.3	7.8	8.1	7.9	8.4
2	3.1	2.9	3.3	7.0	6.7	7.3	8.3	8.0	8.6	8.8	8.5	9.1
3	3.2	3.0	3.5	7.2	6.8	7.6	8.9	8.5	9.3	9.2	8.8	9.6
4	3.2	2.9	3.5	7.4	6.9	7.9	9.1	8.5	9.6	9.3	8.8	9.8
5	3.0	2.7	3.3	7.0	6.4	7.6	8.8	8.2	9.3	9.1	8.6	9.7
6	3.2	2.8	3.6	7.2	6.5	7.9	8.5	7.8	9.2	9.4	8.7	10.1
7	3.4	3.0	3.9	7.3	6.5	8.2	9.1	8.2	10.0	10.0	9.2	10.9
8	3.8	3.3	4.4	8.5	7.4	9.5	9.7	8.7	10.8	10.4	9.5	11.4
9	3.7	3.0	4.3	8.2	7.0	9.4	9.1	7.9	10.2	9.8	8.8	10.8
10	3.9	3.1	4.6	8.1	6.8	9.3	9.6	8.3	11.0	10.7	9.5	12.0
11	3.6	2.9	4.3	7.9	6.7	9.1	8.7	7.5	9.9	9.6	8.4	10.8
≥12	3.2	2.8	3.5	7.1	6.5	7.7	9.0	8.3	9.7	9.5	8.9	10.2

a. Adjusted for: age at death, sex, number of hospice visits in last 12 months of life, year of death, place of birth (Australia/New Zealand, or elsewhere), Indigenous status, marital status, multiple cancer diagnoses (coded as yes/no), time between cancer diagnosis and death (in days), socioeconomic status, community palliative care catchment area (north, east or south), comorbidity recorded in previous 12 months (coded

as yes/no) and cancer type causing death ((Bladder/urinary tract, Breast, Unknown, Cervix, Colorectal, Kidney, Laryngeal, Leukaemia, Liver, Lung/Bronchial, Lymphoma, Melanoma, Mesothelioma, Myeloma, Oesophageal, Ovarian, Prostate, Stomach, Testicular, Thyroid, Uterine, Pancreas) versus Other).

b. CI = confidence interval

e) mean per-person cost (A$2012) of unplanned hospitalisations [a]

Initiation of community palliative care (months before death)	Last month of life			Last 3 months of life			Last 6 months of life			Last 12 months of life		
		Lower 95% CI	Upper 95% CI		Lower 95% CI	Upper 95% CI		Lower 95% CI	Upper 95% CI		Lower 95% CI	Upper 95% CI
1	3,816	3,669	3,964	9,117	8,815	9,419	13,197	12,763	13,632	17,203	16,633	17,773
2	3,752	3,569	3,934	9,607	9,251	9,963	13,989	13,472	14,506	18,311	17,626	18,996
3	3,733	3,510	3,955	9,237	8,807	9,667	14,647	13,998	15,296	18,919	18,070	19,768
4	3,890	3,602	4,178	9,047	8,487	9,608	14,695	13,892	15,499	18,920	17,877	19,963
5	3,609	3,297	3,922	8,527	7,893	9,162	14,645	13,712	15,578	18,932	17,735	20,129
6	3,907	3,501	4,313	9,036	8,234	9,837	14,734	13,561	15,907	21,718	20,018	23,418
7	4,016	3,556	4,476	9,356	8,363	10,349	12,902	11,657	14,147	19,705	17,997	21,413
8	3,794	3,345	4,243	8,931	7,979	9,883	12,691	11,393	13,989	21,007	19,030	22,984
9	4,175	3,563	4,787	9,424	8,226	10,622	13,428	11,763	15,092	19,908	17,783	22,034
10	4,535	3,812	5,258	9,687	8,355	11,019	13,364	11,591	15,137	22,082	19,434	24,730
11	3,908	3,295	4,522	8,833	7,658	10,008	11,720	10,150	13,290	22,691	19,747	25,634
≥12	4,200	3,829	4,571	8,572	7,920	9,223	12,451	11,544	13,359	17,914	16,651	19,178

a. Adjusted for: age at death, sex, number of hospice visits in last 12 months of life, year of death, place of birth (Australia/New Zealand, or elsewhere), Indigenous status, marital status, multiple cancer diagnoses (coded as yes/no), time between cancer diagnosis and death (in days), socioeconomic status, community palliative care catchment area (north, east or south), comorbidity recorded in previous 12 months (coded as yes/no) and cancer type causing death ((Bladder/urinary tract, Breast, Unknown, Cervix, Colorectal, Kidney, Laryngeal, Leukaemia, Liver, Lung/Bronchial, Lymphoma, Melanoma, Mesothelioma, Myeloma, Oesophageal, Ovarian, Prostate, Stomach, Testicular, Thyroid, Uterine, Pancreas) versus Other).

b. CI = confidence interval

f) mean per-person cost (A$2012) of emergency department presentations [a]

Initiation of community palliative care (months before death)	Last month of life			Last 3 months of life			Last 6 months of life			Last 12 months of life		
		Lower 95% CI	Upper 95% CI		Lower 95% CI	Upper 95% CI		Lower 95% CI	Upper 95% CI		Lower 95% CI	Upper 95% CI
1	215	207	222	507	492	523	748	726	770	1,006	976	1,037
2	204	195	213	516	499	534	773	747	799	1,034	999	1,069
3	208	197	219	486	466	506	762	732	792	1,021	980	1,062
4	201	189	213	450	425	474	755	719	791	1,014	964	1,063
5	209	195	223	442	414	470	788	744	832	1,094	1,033	1,156
6	217	199	235	460	423	497	791	735	848	1,132	1,052	1,212
7	207	186	227	455	413	497	677	618	736	1,073	991	1,156
8	206	186	225	456	412	499	663	601	725	1,073	981	1,164
9	197	175	219	453	403	503	670	597	743	1,100	993	1,206
10	224	196	252	497	437	557	651	575	727	1,091	974	1,208
11	220	193	247	476	422	530	737	646	827	1,236	1,096	1,376
≥12	219	204	234	478	447	508	710	665	755	1,021	958	1,085

a. Adjusted for: age at death, sex, number of hospice visits in last 12 months of life, year of death, place of birth (Australia/New Zealand, or elsewhere), Indigenous status, marital status, multiple cancer diagnoses (coded as yes/no), time between cancer diagnosis and death (in days), socioeconomic status, community palliative care catchment area (north, east or south), comorbidity recorded in previous 12 months (coded as yes/no) and cancer type causing death ((Bladder/urinary tract, Breast, Unknown, Cervix, Colorectal, Kidney, Laryngeal, Leukaemia, Liver, Lung/Bronchial, Lymphoma, Melanoma, Mesothelioma, Myeloma, Oesophageal, Ovarian, Prostate, Stomach, Testicular, Thyroid, Uterine, Pancreas) versus Other).

b. CI = confidence interval