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Research paper

Healthcare costs due to low back pain in the emergency department and inpatient setting in Sydney, Australia

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ABSTRACT

Background: Low back pain is the leading cause of disability worldwide and a common presentation to emergency departments, often resulting in subsequent admissions to hospital. There have been several studies investigating the cost of low back pain to society, but few specific to the emergency department and inpatient setting, especially in Australia. The aim was to describe the cost of low back pain in Australian public hospital emergency departments, and inpatient settings, and explore healthcare costs associated with different care pathways.

Methods: In this retrospective observational study, we explored the costs associated with an episode of care for low back pain in adults that attended three emergency departments in Sydney between 1 July 2014 and 30 June 2019. Systematised Nomenclature of Medicine—Clinical Terms (SNOMED) diagnosis codes were used to identify episodes of care where the patients had been diagnosed with non-specific low back pain or lumbosacral radicular syndromes. Serious spinal pathologies were excluded. We determined the costs for different treatment pathways involving the ambulance service, emergency department and inpatient ward care. Hospital costs were adjusted for inflation to 2019 Australian dollars (AUD).

Findings: There were 12,399 non-serious low back pain episodes of care during the study period. 4006 (32%) arrived by ambulance and 2067 (17%) were admitted for inpatient care. The total costs of inpatient and emergency department care across the 5-year period were AUD\$36.7 million, with a mean of AUD\$2959 per episode of care. The mean cost for a patient who had a non-ambulance presentation to the emergency department and was discharged was AUD\$584. Patients presenting to the emergency department via ambulance and were discharged had a mean cost of AUD\$1022. Patients who presented without the need of an ambulance and were admitted had a mean cost of \$13,137. The most expensive care pathway was for patients arriving by ambulance with subsequent admission, with a mean cost of AUD\$14,949.

Interpretation: The common practice of admitting patients with non-serious low back pain for inpatient care comes at great cost to the healthcare system. In a resource constrained environment, our data highlights the economic need to implement innovative, evidence-based strategies to reduce the inpatient management of these patients.

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Research in Context

Evidence before this study: Low back pain is a leading reason for presentation to the emergency department. Most of these patients have pain of spinal origin that is not serious (e.g., non-specific or radicular low back pain), however up to a third are admitted for inpatient care. Often low back pain care in the emergency department can be considered as low value, with overuse of interventions that have limited evidence of benefit but clear evidence of harm (e.g., opioids). This occurs despite all major guidelines recommending low cost and simple management strategies. The cost of low back pain is significant to society, but the exact costs specifically in the emergency and hospital setting is unknown. We searched PubMed for studies from inception to September 8, 2020 using the search terms “emergency” or “hospital” and “low back pain” and “cost”. Four studies investigated the cost of low back pain in the emergency department or hospital setting from a health funder perspective. These studies were based around estimates (i.e., not actual hospital costs) and did not investigate the cost associated with different care pathways and management options. Furthermore, none of these studies were in Australian hospitals and therefore data on the exact costs specifically in the emergency and hospital setting in Australia are scarce.

Added value of this study: We describe the actual cost of low back pain in the emergency department and hospital setting based on patient level data for 12,399 episodes of care at three large public hospitals in Sydney, Australia. We also describe the costs associated with different care pathways and the cost of frequent management options. The mean hospital cost of a low back pain episode of care is AUD\$2959, which varies substantially if the patient is discharged from emergency (AUD\$584) or admitted to hospital (AUD\$14,949). Estimates suggest non-serious low back pain is costing Australian hospitals approximately AUD\$392.9 million per year. Importantly, although only 17% of these patients were admitted to hospital in our study, these patients are disproportionately contributing to 80% of the total hospital cost.

Implications of all the available evidence: The effectiveness of inpatient care has not been determined and is not recommended in any of the major guidelines for low back pain. In fact, it has been suggested that it can cause harm. This may be due to the risk of hospital acquired complications and the associated bedrest that may delay recovery. Inpatient care continues to be quite prevalent, especially in the Australian context where the rate of hospitalisation for back problems as principle diagnosis was 664 per 100,000 population in 2017–18. Cost-effective implementation strategies may be required to reduce unnecessary low back pain admissions and duration of hospital stays, to reduce the cost burden on the Australian healthcare system. Further research is required to work towards achieving this.

Introduction

Low back pain is a significant health concern [1] and the leading cause of disability worldwide [2]. Low back and neck pain is in the top three conditions for highest health care expenditure in the United States [3]. In addition to the high overall costs, there is growing concern that the common management practices for low back pain can be considered low value [4]. That is, when an intervention is not expected to provide benefit when considering the risks of harm, or the added costs of the intervention do not provide equivalently added benefits [5].

Low back pain patients can be a challenge for emergency department (ED) clinicians, often resulting in management that is costly and discordant with guidelines, such as inappropriate imaging referrals, potentially avoidable hospital admissions, and un-

necessary surgical procedures [6,7]. This is concerning, especially since low back pain is a leading reason for presentation to the ED with a recent review reporting that it accounts for 4.4% of all ED presentations worldwide [8]. It is in the top ten reasons for presenting to the ED in Australia [9]. ED costs are significantly higher per visit than primary care [10], but the exact cost burden of low back pain in the Australian ED and hospital setting is unknown. There have been a number of studies describing the overall cost of low back pain from a society perspective [11], but there are only a limited number of studies describing costs specific to the ED or hospital setting [10,12–14], with none in the Australian context. It is also unclear how clinical decisions on sequence of health services or clinical interventions in the ED (or pathways of care), impact overall costs.

It is important to determine cost of illness to assist policy makers in prioritising healthcare resources [15]. This allows for planning of service provision and can help to determine where to allocate resources for more cost-effective care pathways. Therefore, we have aimed to describe the cost of low back pain in an Australian public local health district in the ED and inpatient settings, and explore costs associated with different management strategies and different care pathways.

Methods

This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for the reporting of observational studies [16].

Study design

This was a multi-centre, retrospective, observational study involving a descriptive cost-of-illness analysis for patients who attended the ED for low back pain and their subsequent public hospital admissions. It was a prevalence-based approach, from a health district perspective, estimating the total cost burden for management of low back pain in the ED and inpatient setting across five financial years (from 1 July 2014 to 30 June 2019). Prevalence-based approaches are the most common method of describing the cost of a disease and estimate the costs incurred within a time period [15].

Setting

The setting was three public hospitals in New South Wales (NSW), Australia – Royal Prince Alfred Hospital, Concord Repatriation General Hospital and Canterbury Hospital. We chose these hospitals as they are large metropolitan public hospitals with an ED in the Sydney Local Health District – a network of public hospitals located in the centre and inner west of Sydney and responsible for providing care to more than 670,000 local residents and a large number of people who travel from regional and rural areas in NSW. The hospitals are government funded by a universal healthcare scheme. The study has been approved (X17-0419 & LNR/17/RPAH/631) by the Human Research Ethics Committee of the Sydney Local Health District.

Participants

We explored the costs associated with an ED presentation, or ‘episode of care’, for low back pain. We included the episodes of care of adult patients ≥ 18 years who presented to the participating EDs with low back pain with non-specific cause or low back pain with radicular syndromes (such as sciatica and lumbar spinal stenosis) during the study period. We included these two classifications as guidelines suggest their initial management

should be the same [17]. We considered these two classifications 'non-serious' as they do not include serious spinal pathologies. Codes from the Systematised Nomenclature of Medicine—Clinical Terms—Australian version, ED Reference Set [18] were used to identify non-serious low back pain episodes of care to the EDs (Appendix 1). Low back pain episodes of care related to serious spinal pathologies (such as lumbar fracture, cauda equina syndrome, or spinal infection) were excluded. We excluded diagnosis codes associated with a serious specific cause for pain, as guidelines suggest the management for these patients is different and may require urgent intervention [17].

Data sources

We used patient-level costing data calculated for funding purposes by Sydney Local Health District. These costing data are calculated as part of the NSW District and Network Return, which then forms part of the State's submission to the Independent Hospital Pricing Authority for the National Hospital Cost Data Collection. The calculations are made in accordance with the NSW Health Cost Accounting Guidelines [19]. The cost is calculated using the reported clinical and administrative activity received by each patient during their hospital visit. This is done using a top down approach. The Sydney Local Health District Targeted Activity and Reporting System (STARS) [20] was used to access and link costing data across multiple datasets, allowing us access to patient level costing data, but also demographics of the patients and nature of their episodes of care.

Variables

The study measured the direct healthcare costs associated with hospital care for non-serious low back pain. We calculated the total cost per year, average cost per episode of care, and average cost per episode of care according to different patient care pathways. We based these pathways around what we observed to be common sequence of health services or clinical interventions received by patients with low back pain in our health district. The patient care pathways we explored were:

- 1 Pathway 1 (non-ambulance presentation, emergency care, community discharge): where patients presented direct from the community via a method other than ambulance, were managed in the ED, and were discharged back into the community (that is, not admitted to the hospital).
- 2 Pathway 2 (ambulance, emergency care, community discharge): where patients were brought into the ED via ambulance, were managed in the ED, and were discharged back into the community (that is, not admitted to the hospital).
- 3 Pathway 3 (non-ambulance presentation, emergency care, hospital admission): where patients presented direct from the community via a method other than ambulance, were managed in the ED, and then were subsequently admitted to a hospital ward for ongoing management.
- 4 Pathway 4 (ambulance, emergency care, hospital admission): where patients were brought into the ED via ambulance, were managed in the ED, and then were subsequently admitted to a hospital ward for ongoing management.

Non-ambulance presentation refers to any method of arrival other than ambulance, for example a public transport, private car, walked in, or accompanying by a friend or family member.

We did not include ambulance costs as they are funded differently, and our interest was in the health district costs. The cost components used to calculate the patient level data were categorised as follows:

- 1 Clinical costs: nursing, medical, and allied health wages, and clinical costs related to operating room care and critical care.
- 2 Diagnostic imaging costs: plain radiographs, computed tomography, and magnetic resonance imaging, as well as radiology wage related costs.
- 3 Pathology test costs: laboratory tests, such as blood or bodily fluid tests, as well as pathology wage related costs.
- 4 Medication costs: medicines administered during the ED and/or inpatient stay, as well as pharmacy wage related costs.
- 5 Other: hospital overhead-costs, costs associated with facility maintenance, non-clinical and administration costs, surgical equipment and prostheses, ward supplies, ED supplies, average cost of all depreciation, staff leave, insurance cost and interest.

Statistical analysis

The statistical analyses are descriptive in nature. Results are expressed using means and \pm standard deviations (SD). We added a post-hoc analysis to determine if mean costs differed based on age groups (<65 versus \geq 65 years), and gender using *t*-test. Differences in mean costs between pathways were established by using a post-hoc one-way analysis of variance (ANOVA). Since differences in pathways could be confounded by age, we also added a two-way ANOVA to explore the difference in mean costs between the older and younger age groups by pathway. Costs are expressed in Australian dollars (AUD), adjusted for inflation using the Health Consumer Price Index for the financial year 2018–19, as published by the Australian Bureau of Statistics [21]. 1 AUD = 0.75 United States Dollars (USD) on average in 2018–19 [22]. STATA version 14 (StataCorp LP, College Station, TX, USA) was used for all analyses.

Role of funding source

Nil funding was received to complete this study.

Results

A total of 12,399 eligible low back pain episodes of care (10,691 unique patients) were included in the study. The characteristics of the episodes of care are shown in Table 1. The total cost for low

Table 1
Characteristics of the episodes of care.

Characteristics	Values (n = 12,399)
Age, years – mean (SD)	52.3 (20.2)
Gender, male – no. (%)	6246 (50.4%)
Mode of arrival – no. (%)	
Ambulance	4006 (32.3%)
Non-ambulance	8393 (67.7%)
Triage category – no. (%)§	
Emergency	226 (1.8%)
Urgent	4517 (36.4%)
Semi-urgent	7343 (59.2%)
Non-urgent	313 (2.5%)
Low back pain categories – no. (%)‡	
Non-specific	11,097 (89.5%)
Radicular	1301 (10.5%)
ED length of stay, hours – mean (SD)	4.0 (2.7)
Disposition mode – no. (%)	
Admitted to hospital	2067 (16.7%)
Discharged to community	10,332 (83.3%)
Inpatient length of stay, days – mean (SD)†	9.7 (12.4)

ED – Emergency department, SD – Standard deviation.

§ Triage categories are based on the Australasian Triage Scale (ATS). There were no low back pain episode of cares in the ATS category 'life threatening'.

‡ Primary diagnosis codes were categorised into non-specific back pain and radicular back pain.

† Inpatient length of stay is based on the 2067 patients that were admitted to hospital.

Reference: 1. The Australasian Triage Scale. Emergency medicine (Fremantle, WA). 2002;14(3):335–6.

Table 2
Average and total costs by cost components.

Cost components	Cost per episode of care (mean, SD)	Total cost over 5 years (n = 12,399)	Average cost per year
Clinical			
Medical	\$491 (1095)	\$6,082,100	\$1,216,420
Nursing	\$820 (2657)	\$10,172,641	\$2,034,528
Allied Health	\$174 (679)	\$2,157,940	\$431,588
Critical care	\$35 (1147)	\$438,855	\$87,771
Surgery	\$60 (631)	\$746,205	\$149,241
Total	\$1581 (4708)	\$19,597,741	\$3,919,548
Imaging	\$156 (501)	\$1,937,771	\$387,554
Pathology	\$112 (397)	\$1,391,592	\$278,318
Medication	\$52 (377)	\$642,936	\$128,587
Other	\$1058 (3202)	\$13,117,704	\$2,623,541
Total	\$2959 (8642)	\$36,687,744	\$7,337,549

Costs are in AUD, SD – standard deviation.

back pain for 12,399 episodes of care in the three study hospitals, over the five years studied, was AUD\$36,687,744. The mean (SD) cost per episode of care was AUD\$2959 (8642) made up of AUD\$1581 (4708) on clinical costs, AUD\$156 (501) on imaging costs, AUD\$112 (397) on pathology costs, AUD\$52 (377) on medication costs, and AUD\$1058 (3202) on other costs. The total costs and average costs per year by cost components are presented in Table 2. There was a statistically significant difference in mean costs between the older (\$6101) and younger (\$1575) age groups (mean difference \$4527, 95% CI \$4206 to \$4847; $p < 0.001$). Similarly, there was a statistically significant difference in mean costs between male (\$3393) and female (\$2518) sexes (mean difference \$875, 95% CI \$571 to \$1179; $p < 0.001$).

The characteristics of the episodes of care by clinical care pathways are presented in Appendix 2. The mean (SD) cost per episode of care varied from AUD\$584 (539) to AUD\$14,949 (18,495) when patients underwent different clinical care pathways (Table 3). A one-way ANOVA revealed these differences to be statistically significant ($F [3, 12,395] = 2163.9, p < 0.001$). However, there was a significant interaction between age groups and clinical pathways on costs ($F [3, 12,391] = 66.8, p < 0.001$), with presentations for older patients costing more than younger patients across all clinical care pathways (Appendix 3). Cost component contributions to each pathway is summarised in Fig. 1.

Discussion

This study provides a comprehensive estimate of the cost to the health district of non-serious low back pain episodes of care in three urban Australian hospitals over a 5-year period with a total cost of AUD\$36.7 million. The mean direct hospital cost of a low back pain episode of care is AUD\$2959. This cost substantially increases if the patient is admitted, for example, on average costing AUD\$584 if they attend ED only compared to AUD\$14,949 if

they are admitted to hospital. Those who are admitted are older and stay hospitalised for an average of eight days if they have a non-ambulance presentation, and 10 days if they present via ambulance.

There is limited literature on the cost of non-serious low back pain in inpatient and emergency care settings. Jorgensen [12] investigated the cost of chronic low back pain in an ED in Maine, United States. They found the mean cost for chronic low back pain presentations was USD \$576 in 2002 (approximately 2019 USD \$770). They concluded that the ED is a costly venue for the care of chronic low back pain and questioned the cost-effectiveness of care in this setting, but did not investigate the cost of these patients if they were admitted to a hospital ward. Itz et al. [13] investigated the cost of medical specialist care and hospital care for low back pain in the Netherlands. They found the mean cost per patient to be €2410 in 2008 (approximately 2019 USD \$3080) and suggested that hospital costs for low back pain contribute the largest amount to totals costs in the Netherlands. A recent study by Rampersaud et al. [10] explored direct costs associated with spinal conditions over outpatient and hospital settings in Ontario, Canada. However, they used an algorithm to estimate costs, whereas our study was able to report actual cost to the healthcare system. They found the cost of spinal management in 2013–14 was much higher in the ED than in primary care, estimating C\$215 (Canadian dollars) per visit in ED compared with C\$36 in primary care (approximately 2019 USD\$30 and \$160 respectively). They also found hospital inpatient costs accounted for 71% of total cost for spinal injuries. Carregaro et al. [14] found inpatients care costs contributed to 58% of total cost of spinal disorders in Brazil. Our study supports that ED care is costly and even more so when including a subsequent hospital admission. This is important to note, especially in the Australian context when admission rates from ED are high (17%) [23] when compared to other high-income countries. For example, in Canada where it has been reported as 2.5% [24] and the US where it has been reported as 2.2% [25]. More studies are needed to explore admission rates, appropriateness of admissions, as well as ED and inpatient costs in low to middle income countries.

The 'Clinical' cost component contributes the most cost per episode of care. When exploring the costs within the 'Clinical' cost component, 'Nursing' contributes the most, on average at \$820 per episode of care. The relatively high 'Nursing' costs are likely due to the costs associated with admission and time the patient spends on a ward. This may be due to the increased care needs required by the patient, for example, patients may need the nurses to assist with activities of daily living or medication administration. However, without further research into why patients are being admitted, what care is provided during admissions and the necessity or appropriateness of this care remains unclear. Interestingly, 'Imaging', 'Medication' and 'Pathology' costs only contribute to about 11% of the total average cost per episode of care. The Lancet low back pain series [4] discussed concerns with high use of imaging and medications, such as opioids in non-specific low back pain;

Table 3
Total costs by clinical care pathway (n = 12,399).

Clinical pathway	No. (%)	Age, years (mean, SD)	ED length of stay, hours (mean, SD)	Hospital length of stay, days (mean, SD)	Cost per episode of care (mean, SD)*
Pathway 1†	7597 (61.3)	47.3 (18.4)	3.3 (1.8)	–	\$584 (539)
Pathway 2‡	2735 (22.1)	54.8 (19.5)	4.2 (2.5)	–	\$1022 (922)
Pathway 3§	796 (6.4)	62.4 (19.5)	6.5 (3.8)	8.5 (10.3)	\$13,137 (14,569)
Pathway 4¶	1271 (10.3)	70.4 (18.8)	6.6 (4.2)	10.4 (13.5)	\$14,949 (18,495)

Costs are in AUD, SD – standard deviation, ED – emergency department.

† Non-ambulance presentation, receives emergency care, discharged to community.

‡ Presents via ambulance, receives emergency care, discharged to community.

§ Non-ambulance presentation, receives emergency care, admitted to hospital.

¶ Presents via ambulance, receives emergency care, admitted to hospital.

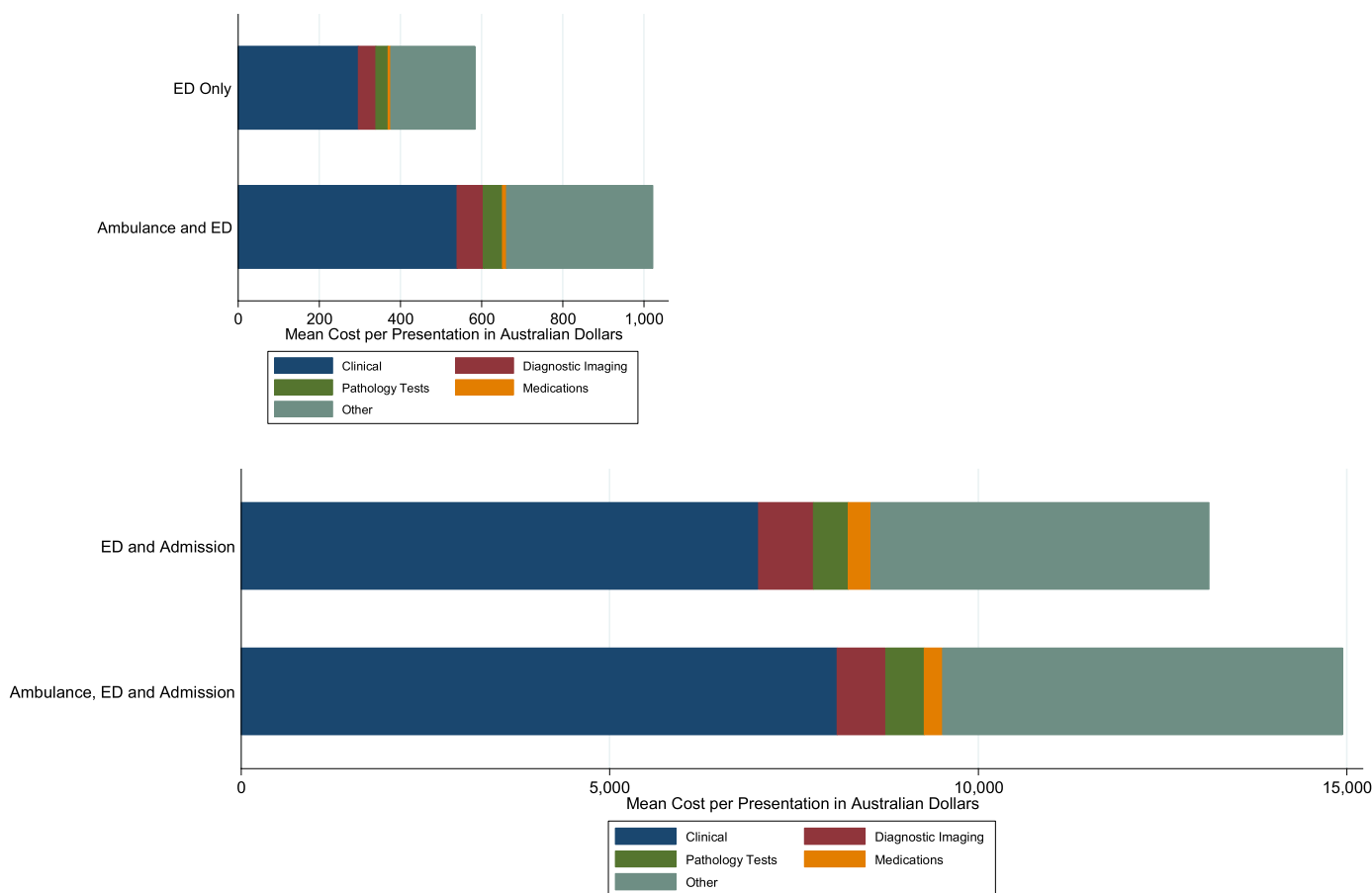


Fig. 1. Cost component contributions by care pathway.

Costs are in AUD, ED – emergency department.

ED only: Non-ambulance presentation, receives emergency care, discharged to community, $n = 7597$

Ambulance and ED: Present via ambulance, receives emergency care, discharged to community, $n = 2735$

ED and Admission: Non-ambulance presentation, receives emergency care, admitted to hospital, $n = 796$

Ambulance, ED and Admission: Presents via ambulance, receives emergency care, admitted to hospital, $n = 1271$.

but the concerns were about harms and triggering unnecessary subsequent care, not the initial costs. Although we found only a small cost to imaging and medications, our study does not explore the downstream costs and consequences of these practices. Further research into the appropriateness and effectiveness of ED and inpatient management practices for low back pain is warranted, as well as the downstream harms of these practices and how they impact on societal costs.

ED episodes of care associated with hospital admissions incur a considerably larger cost than those that do not. Admissions for non-serious low back pain are controversial and there have been suggestions that they may be unnecessary [26]. However, details about reasons for admission for non-serious low back are not well explored. In fact, none of the pathways in our study (i.e. ambulance, ED and inpatient care) are suggested in the major guidelines [17,27] for the management of non-serious low back pain. Guidance on how to manage patients who seek ambulance and hospital care is quite scarce in the literature, creating a significant challenge for clinicians. ED patients may be different to their primary care counterparts, [28] however, it is still not clear in the literature exactly how. It has been suggested that they have poorer prognostic risk factors [29] and a differing clinical course [30]. It is likely that the complexity of these patients relates to co-morbidities and psychosocial factors, but further research is required to understand this completely. It would be useful to explore barriers and enablers of ambulance, ED and inpatient care from a patient and clinician

perspective. These views would give valuable insight into these costly management strategies. This will assist in creating more specific guidelines for this setting, assist in determining whether new cost-effective models of care should be implemented, and whether savings can be achieved without negatively impacting patient care.

This study has several strengths. There was a large sample of 12,399 episodes of care for low back pain over a 5-year period. Presentation level costing data were used from hospital reporting purposes and, therefore, the actual cost to the public healthcare system is reported. Past studies report estimated costs [10,12–14]. This study also explored costs associated with different care pathways, giving insight into what management practices are the most costly. This will more accurately allow policy makers to make informed decisions about funding, care model implementation and allocation of resources.

There are some limitations to this study. The patient care pathways we explored were what we observed to be common sequence of health services or clinical interventions received by patients with low back pain in our health district. In order to reduce bias, a specialist panel may have been more appropriate to define these pathways, although our data were sourced directly from participating hospitals and, therefore, may represent what actually happens within our healthcare system. Although it was not the aim, we were not able to report indirect costs or actual cost of the ambulance encounter. In NSW, 51% of the cost for the ambulance encounter is charged to the patient and the government subsidises

the rest of the cost. As of July 2020, NSW residents are charged a call out fee of AUD\$401 plus AUD\$3.62 per kilometre [31]. We are unable to guarantee diagnostic coding accuracy as this is done by clinicians and hospital coders. The results may not be generalisable to all settings as the three hospitals were from metropolitan Sydney and from the public healthcare system. Although the hospital catchments area represents a wide range of socioeconomic status, the costs may not translate to hospitals in the private sector, rural areas, or in other countries with different healthcare systems.

This study presents novel data on hospital costs for low back pain to EDs and inpatient wards. In Australia, there were 132,769 low back pain presentations to EDs in the financial year 2018–19 [9], which based upon on our study findings will incur an estimated cost of AUD \$392.9 million to the Australian healthcare system each year. Episodes of care associated with hospital admission were approximately 20 times more costly than those discharged to the community. This study can assist policy makers in prioritising healthcare resources and provides evidence for the urgent need to evaluate the appropriateness of inpatient care for these patients. Further research is required into the cost-effectiveness of admitting patients with low back pain and the development of new models of care to better manage these patients in an attempt to reduce the burden of admissions.

Author Contributions

All authors contributed substantially to conception and design, acquisition, and interpretation of the data. GCM and DMC had full access to all the data and takes responsibility for the accuracy of the data analysis. DMC drafted the manuscript. All authors participated substantially in the critical revision of the manuscript for important intellectual content. Study supervision was conducted by CGM and GCM.

Data sharing statement

Due to information governance restrictions imposed by organisations governing data access, we are unable to share the study data unless applicants secure the relevant permissions.

Declaration of Interests

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.lanwpc.2020.100089.

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