Smitten Hips: costs, complexities and consequences of hip fracture for 2552 Australian patients hospitalised in 2008–09

Analyses of linked Department of Veterans' Affairs databases

Anthony W Ireland MB BS DipPH FRACP FAChPM

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Sydney Medical School, University of Sydney

Sydney School of Public Health, University of Sydney

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"Hip fracture: a complex illness among complex patients...
In many respects, hip fracture is the quintessential geriatric illness."

Hung WW. Ann Internal Med 2011; 267–268.

"And he [Samson] smote them hip and thigh with a great slaughter..."

Old Testament, Judges 15:8.

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Candidate Statement and Ethics approvals

This document represents original research. The overall concept was prepared and presented by the candidate.

The data used for these studies derives almost exclusively from administrative databases of the Australian Department of Veterans' Affairs. The candidate had no role in the preparation of these data, but was individually responsible for editing, concatenation and linkage of these data sets to create an integrated master file.

In respect of the component research studies the candidate, as principal author, was responsible for study concept and design, access to and collation of all datasets, data analyses and report writing.

Any conclusions or stated opinions within this body of work are entirely those of the candidate and the other contributing authors. They do not necessarily reflect the position of the Department of Veterans' Affairs.

Ethics approval for these studies was granted by the Department of Veterans' Affairs Ethics Committee in December 2010 (E010/30) and renewed in December 2013. The Committee accepted that it was impractical to obtain consent to access medical and personal data in respect of a geographically dispersed population in which many subjects would already have deceased prior to study commencement. Approval was therefore granted under Section 95 of the Privacy Act, 1988.

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The data presented in this document describe experiences of Australians who have served in World War II, the Korean campaign, Vietnam and other theatres of military action, and also those of their widowed spouses. In the centenary year of Gallipoli, the service of these persons is remembered with humility and gratitude.

Abbreviations

Item	Title
ABS	Australian Bureau of Statistics
ACI	Agency for Clinical Innovation (NSW)
AIHW	Australian Institute of Health and Welfare
ANZHFR	Australian and New Zealand Hip Fracture Register
AROC	Australasian Rehabilitation Outcomes Collaboration
DVA	Department of Veterans' Affairs
FIM	Functional Independence Measure
ICD	International Code of Diseases
LOS	Length of (hospital) stay
MBS	Medicare Benefits Schedule
MMSE	Mini-mental state examination (Folstein)
NHFD	National Hip Fracture Database (England)
NHMD	National Hospital Morbidity Database
NICE	National Institute for Clinical Excellence (England)
RAC	Residential Aged Care
SHFA	Scottish Hip Fracture Audit
TPOP	Treatment Population (DVA)
VHC	Veterans' Home Care

Glossary

Name	Description
Admission	The period between initial entry into hospital and the final discharge. May include multiple episodes for different aspects of hospital care, in more than one hospital. Sometimes described as 'episode string.'
Episode	A defined period of hospital care for a single service or period of care. If change of location within or between hospital(s) is required to meet a change in clinical need, the patient is separated from the existing episode and a new episode commences.
Separation	The end point of a hospital admission or episode.
Acute phase	Hospital treatment in a ward or service unit designated as acute care. In the context of this paper the episode of care carries one of the principal diagnosis codes for hip fracture
Hip fracture	Fracture of the upper femur between the head (ball) and the upper 5 cm of the femoral shaft. Fracture of the acetabulum (socket) is not included in this definition.
Comorbidity	The presence of medical diagnoses, recognised at or before the admission or event under consideration, which are deemed to have significance for the current health or prognosis of the patient.
Administrative database	Centralised collection of personal and clinical data items extracted from medical and hospital records following an admission or episode of service provision.
Orthogeriatric	Process of care delivery in which orthopaedic and aged care and/or rehabilitation clinical teams combine resources for hospital care of elderly or frail patients with major fractures. Particularly developed for management of hip fracture.
Treatment population	Department of Veterans' Affairs clients who are eligible for health services at departmental expense. Holders of DVA treatment eligibility cards.
Residential aged care	Facility accredited under the Aged Care Act 1997 to provide High Care ("nursing home") or Low Care ("hostel") accommodation for persons with specified levels of disability as assessed by an Aged Care Assessment Team
Veterans' Home Care	Package of services provided by DVA to eligible clients. Includes personal care, domestic assistance and respite care.
Community patient	Person not identified as living within residential aged care at given point in time.
RAC patient	Person living in residential aged care facility at given point in time. Inclusive of High Care, Low Care and Respite classifications

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Section I

I (1): Published and completed research studies

1. Ireland AW, Kelly PJ. Total length of stay, costs and outcomes at final discharge for admitted patients with hip fracture: linked episode data for Australian veterans and war widows. Internal Medicine Journal 2013; 43 (12): 1280–1286

2. Ireland AW, Kelly PJ, Cumming RG. Total hospital stay for hip fracture: measuring the variations due to pre-fracture residence, rehabilitation, complications and comorbidities. BMC Health Services Research 2015; 15:17 doi:10.1186/s12913–015–0697–3

3. Ireland AW, Kelly PJ, Cumming RG. Risk factor profiles for early and delayed mortality after hip fracture: Analyses of linked Australian Department of Veterans' databases. Injury 2015; 46(6):1028-1035. doi.org/10/1016/j.injury.2015.03.006

4. Ireland AW, Kelly PJ, Cumming RG. State of Origin: Australian states use different resources for hospital treatment of hip fracture but achieve very similar outcomes. Australian Health Review 2015; http://dx.doi.org/10.1071/AH14181

5. Ireland AW, Kelly PJ, Cumming RG. Rehabilitation after hip fracture is associated with two-year survival but not independent living status: findings from Department of Veterans' Affairs databases for 1724 community-dwelling patients. Journal of Rehabilitation Medicine: under review 30.11.2015

I (2): Abstract

Background

Hip fracture is an injury which requires complex and expensive treatment and which has equally complex and burdensome consequences. As the most serious complication of osteoporosis, hip fracture mostly occurs in persons who are already elderly and have other indicators of frailty. International experience is that one quarter of all victims will not survive one year and more than one third of all survivors will have permanent limitations of physical function and loss of independence. Multi-specialty hospital treatment, a wide range of ongoing medical and supportive services and long-term institutional care for many patients result in a high cost burden, and a severe personal impost for patients and families.

When the work of this Thesis was commenced in 2011, many important details of the treatment, ongoing care and patient outcomes for hip fracture in Australia were unknown or incompletely documented at a national level. [1] In large part this was due to inability to link data for the individual patient both within and between the diverse services required for care of this complex condition. Access to comprehensive patient-linked databases for both hospital and community health services for Department of Veterans' Affairs clients created the possibility of addressing many of these questions.

Objectives

The initial aim was to document the complete hospital admission — its duration, component episodes, costs and both interval and final outcomes. In so doing it was apparent that predictive factors for hospital length of stay (LOS) could also be identified by data linkages within hospital data and by linkages with other datasets.

A detailed examination of mortality rates beyond the initial episode of hospital care was the next objective. Although post-hospital deaths had been described for some localised Australian populations, mortality rates at final hospital discharge, at intervals up to four years thereafter, and also the associated risk factors for mortality were sought.

The question of a relationship between resource expenditure and patient outcomes was then examined. Access to a nation-wide sample allowed comparisons of hospital service elements, length of stay and costs between the Australian states. Rates for mortality, aged care residency and levels of community services both short-term and at one year post-fracture were to be compared.

High rates of hospital episodes for rehabilitation had been identified as a major component of hospital stay and cost. The next objective was an analysis of factors associated with referral to rehabilitation, with shorter or longer stay in rehabilitation units and then a comparison of one-year outcomes for patients with and without hospital rehabilitation.

Finally a context was sought for the findings from these studies by describing the national age-specific prevalence and incidence of hip fracture over the past twenty years and projected caseloads to the middle of this century.

An ongoing objective of the work for this Thesis has been to demonstrate the value of database linkage in the analysis of services and outcomes for complex conditions.

Patients and Methods

Patients were identified from the Department of Veterans' Affairs (DVA) Treatment Population (TPOP) which included all DVA clients entitled to receive all or selected health services at Departmental expense. In December 2008, 92 per cent of TPOP were Gold Card holders with access to all recognised Medical Benefits Schedule health services. In the study year TPOP included 20.5 per cent of all Australians aged 80 years or older (males 26 per cent, females 17.0 per cent). The study year was selected (in 2010) to ensure completeness of the dataset and to provide an adequate period of post-fracture follow-up.

All TPOP beneficiaries hospitalised for hip fracture between I July 2008 and 30 June 2009 were selected. Admissions for a second fracture in the study year were excluded but patients with multiple injuries or malignancy were not.

Data Collection

This is a retrospective cohort study derived from administrative databases. Data describing episodes of service in public and private hospitals, Residential Aged Care (RAC) admissions and date of death were obtained in the first instance. Data for community nursing and Veterans' Home Care (VHC) occasions of service and for hospital readmissions were subsequently added. Patient-level linkage within and between datasets was enabled by the unique identification number assigned by DVA and attached to the record of every health service.

The following variables were included in the dataset: age, sex, fracture type, hospital separation status, surgery, intensive care and rehabilitation episodes, comorbidities and complications. ICD-10-AM codes were used to identify fracture type, rehabilitation episodes, comorbidities and complications. Intensive care was identified by a service item descriptor. Codes for fracture type, procedures, rehabilitation, intensive care and complications were accepted for analysis if they appeared within the episode string for the index admission. Comorbid conditions were identified from primary or secondary diagnoses for all hospital episodes in the study year, up to and including the episode string of the index admission. Complications were identified only from episodes within the index admission.

Data analyses

Student's t-test and Pearson's Chi-squared test were used to assess differences between groups for continuous and binary outcomes respectively. Linear, logistic and negative binomial regression models were employed as appropriate with checking for high correlation or interaction between variables. Mortality was assessed with Kaplan-Meyer survival curves and log-rank testing, and Cox Proportional Hazards regression models.

Formulae were derived for the age-sex standardisation of mortality rates between populations with different demographic profiles, for distinguishing between high and low risk sub-groups for relevant outcomes and for defining levels of dependency following discharge from the index hospital admission.

Results

The study population numbered 2552. The mean age was 86.6 years (range 54-100 years), 37.6 per cent of patients were men and 27.7 per cent of patients were living in residential aged care (RAC) at the time of admission.

Mean length of acute phase care was 13.4 days and of total hospital stay was 30.8 days. 43 per cent of all days were in acute care, 37 per cent in rehabilitation and the remaining 20 per cent was for management of comorbid conditions, complications or subacute care awaiting discharge. The main factors influencing hospital stay were prior aged care residency and referral to rehabilitation. Complications arising in hospital, especially sepsis, were associated with longer stay whereas individual comorbid conditions had limited effect.

Mortality in this elderly sample was 11 per cent at 30 days, 34 per cent at one year and 47 per cent at two years. Prior RAC residence was the strongest determinant for mortality. Males from RAC had one-year mortality of 72 per cent while for females from the community the rate was 19 per cent. Cancer, cardiac failure, stroke and renal failure were associated with 20 per cent to 60 per cent increased mortality risk during the first year. Hip fracture patients had mortality rates in excess of those for a reference population for at least four years.

Despite lack of significant difference in patient characteristics between the Australian States, there were substantial and significant differences in hospital utilisation profiles for hip fracture management. Acute phase LOS ranged from

9.4 to 14.6 days and total LOS was between 25 and 36 days. The highest mean total cost was 51 per cent greater than the lowest value. One year after the index fracture there were no significant differences in rates for mortality, RAC residence or living at home without defined community services.

Among 1724 community patients with similar demographics and comorbidity profiles, patients who received hospital-based rehabilitation had lower one-year and two-year mortality. There were no significant differences in post-fracture residential status or receipt of community services attributable to rehabilitation in adjusted models. Number and costs of hospital admissions in the year following the index fracture were not different. Older age, subtrochanteric fractures, and dementia were associated with lower rates of rehabilitation referral while patients treated surgically and those with complicating anaemia, urinary or wound infection were more frequently referred. Rehabilitation added more than 14 days to total hospital stay and over $14,000 to hospital costs in this sample.

The age-standardised incidence of hip fracture for the general Australian population peaked just before 2000 and had fallen by 16 per cent for women and 8 per cent for men by 2012–13. The greatest rates of decline in age-specific incidence were in the age range 75–84 years for both men and women. Despite declining incidence the estimated total number of hip fractures had increased from 11,400 to 18,600 in the period between 1993–94 and 2012–13, when 50 per cent of hip fractures were in persons aged 85 years or older.

By 2051, a 50 per cent increase in the Australian population to 38 million, of which 4.2 per cent would be aged 85 years or older would see hip fracture numbers increase to approximately 44,000 if the fall in incidence over the past 15 years were replicated. Patients aged 85 years or older would contribute 60 per cent of the total.

Conclusions

New information has been provided on hospital utilisation, costs and long-term patient outcomes for hip fracture in a large national sample.

Predictors for these outcomes have been examined in multivariable models. Patients from RAC had significantly shorter total hospital stay and higher mortality than community patients. Mortality rates at intervals up to four years have been calculated and the principal predictors have been demonstrated. Across Australia, hospital utilisation differed between states, but with no resultant differences in patient outcomes for mortality or restored independence. In-hospital rehabilitation was associated with increased hospital LOS and costs, and with lower immediate and one-year mortality, but not with improved markers for independence. Numbers of hip fractures are projected to continue increasing sharply due to the expansion and ageing of the population despite falling age-specific incidence.

Changing processes of care delivery in hospitals are likely to mitigate the cost burden. Full understanding of the care of this complex condition requires linkage of information from multiple data sources.

Section II. The context of hip fracture

II (1). Definition, significance, epidemiology, history

1(i): Definition

Hip fracture describes any fracture of the femoral head, neck or trochanters, and the upper femoral shaft immediately distal to the greater trochanter. Fractures of the acetabulum are classified as pelvic fractures. Hip fractures are usually classified as cervical, trochanteric (or intra-trochanteric) and subtrochanteric. Cervical fractures, involving the head and neck of the femur, lie within the capsule of the hip joint and are also described as intracapsular fractures. Fractures of the greater or lesser trochanter and the sub-trochanteric femoral shaft are extracapsular. These classifications are illustrated below in Figure II-1. [2]

The great majority of hip fractures in the elderly are the result of low impact trauma events, almost exclusively due to falls, in persons with pre-existing osteoporosis. The term "minimal trauma fracture" is sometimes used.

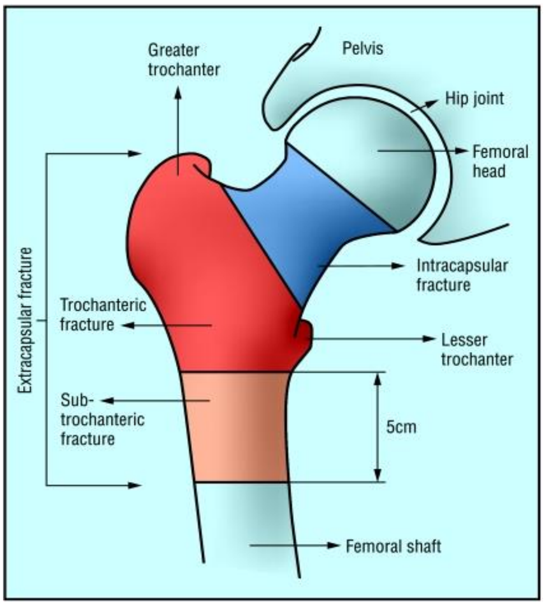

Figure II-1. Classification of hip fractures. Fractures in the blue area are intracapsular and those in the red and orange areas are extracapsular.

1(ii): Significance

At a personal level hip fracture is regarded as one of the most serious consequences of increasing age and frailty and osteoporosis in particular. It results in increased risk of death, with 25 to 30 per cent mortality within 12 months of injury, and functional limitation for the great majority of survivors, at least one-quarter of which require transfer into supported accommodation. [2,3,4]

The number of hip fractures worldwide was approximately 1.6 million in 2000, with an anticipated increase to perhaps four times this number by the middle of this century. [5] Loss of disability adjusted life years in Europe alone exceeds 2 million, a greater burden than that of every individual cancer diagnosis except for carcinoma of the lung. [6]

At a community level, the management of hip fracture involves high cost hospital care and prolonged post-hospital care in most cases. Total one-year health costs have been assessed at over $50,000 in Canada (2010 $CAD) and more than $US70,000 for US veterans with about three-quarters of these costs directly attributable to the hip fracture. [7,8]

1(iii): Epidemiology

The personal risk factors for hip fracture have been well understood for two centuries. Female gender and increasing age in the presence of osteoporosis are the dominant causative factors to the extent that this injury has been named "the widows' disease". In most large series females outnumber males by at least 2.5:1 and the incidence for persons aged 85 years or older exceeds that of persons aged 70–74 years by a factor of 10. Family history of osteopenia, reduced oestrogen levels, vitamin D deficiency and low calcium intake increase fracture risk as do physical inactivity and low body weight in the elderly. [9] At a population level, the incidence of hip fracture increases with increasing distance from the equator and is higher in more affluent societies. [10] Denmark has the highest (age-standardised) fracture incidence, Australia is in the lower 40 per cent and South Africa the lowest of nations excepting Nigeria. [10]

1(iv): History

In his 1823 publication "A treatise on dislocations and fractures of the joints" British surgeon Sir Astley Cooper [11] provided detailed clinical and pathological descriptions of the three main types of hip fracture (cervical, trochanteric, and sub-trochanteric) as recognised today. He emphasised the important differences for bone union of fractures within or external to the joint capsule, recognising the significance of interrupted vascular supply to the femoral head for subsequent healing and function. He also described "...how bones sometimes become soft from age and disease and from the absorption of their phosphate of lime..." and the increased prevalence of this condition in females, and with age and immobility. Although providing this exquisite description of osteoporosis, a term which already existed in French literature, it was not seen in English usage before the 20th century. [12]

Fractures of the femoral neck or trochanter have been identified in archaeological specimens from late Neolithic times. The existence of osseous reaction at the fracture sites testified to some instances of prolonged survival. [13] The first death of a known person as a result of hip fracture was that of Charles IV, King of Bohemia in 1378. The skeleton showed a recent intracapsular fracture and contemporary records attributed death to a “mischievous fever” — probably hypostatic pneumonia. [14] The first clinical description of femoral neck fracture was recorded by Ambroise Paré in 1575. [15]

1(v): History of treatment

The first successful internal fixation of a femoral neck fracture was performed by König in 1875, by aseptic percutaneous insertion of a gimlet. [16] Prior to this date von Langenbeck had performed a similar procedure. The patient eventually died from sepsis, but healing of an extracapsular fracture was found at autopsy. An alternative surgical treatment was excision of the proximal fragment, practised by Theodor Kocher with occasional long-term successful healing.[16] Joint excision was in common practice for patients with severe arthritis in the latter half of the 19th century.[17] This period and the early years of the 20th century saw attempts at internal fixation of cervical fractures with pegs of bone, ivory or wood. Non-surgical treatment by manipulation and immobilisation in plaster achieved bony union in about one-quarter of patients.[18]

The year 1925 saw the introduction of fixation with a flanged nail by a team lead by Smith-Petersen, who reported six years’ experience in 1931[19] with a majority of the 20 patients achieving bony union. Results remained poor, with only 1:3 patients in a large American centre achieving “bony union and a cure” after a prolonged time in hospital. This situation apparently led some surgeons to declare that such patients should not be admitted to hospital.[20] Avascular necrosis of the femoral head was then being experienced by one-quarter to one-third of treated patients.[18]

Modifications of equipment and techniques over the next 25 years saw healing rates as high as 97 per cent claimed, though from small series. Although this was a major advance, conventional practice of the time required patients to be non-weight-bearing until X-ray evidence of bony union was achieved. This meant many weeks or up to nine months at bed rest [21] with attendant risks to subsequent function and survival.

In 1959, a surgical team from the National Orthopaedic Hospital, London commenced partial weight-bearing “as soon as the pain from the operation wound has subsided”, this being at 10 -19 days. Consequently patients were ready for discharge in no more than 6 weeks, and with rates of fracture healing closely approximating to other contemporary reports. [21]

The intervening half-century has seen numerous advances in surgical technique, with total hip prostheses and methacrylate cementing being introduced and developed by Charnley in the 1950s.[22] Among the numerous fixation devices required for trochanteric and subtrochanteric fractures (and some cervical fractures) none has yet emerged as clearly superior. [2]

In a large series of hip fractures, reported in 1979, [23] hemiarthroplasty was performed on 44 per cent of cervical fractures while 29 per cent were treated by internal fixation and 27 per cent were managed without operation. Hospital LOS, three-month and one-year mortality rates from this series were competitive with current results.[24]

Protocols describing current best practice are now available with respect to immediate resuscitation, pain management, prophylaxis against infection and thrombo-embolism, prompt surgery (for the great majority), anaesthesia and early ambulation and other elements of acute hospital care.[25,26] Increasing attention has also turned to programs of post-acute care and the promotion of primary and secondary prevention. [26,27]

Despite the extensive advances in equipment, technique and patient management over the past half century, and the undisputed improvements in outcomes, complications or imperfect results after surgery for hip fracture remain common. In a large series of cervical (intracapsular) fractures reported in 2009, avascular necrosis of the femoral head occurred in 11.4 per cent of displaced fractures and 4.9 per cent of undisplaced fractures. [28] In another series of 1133 patients reported in 2012,[29] non-union occurred in 20 per cent of all cases, 8.5 per cent in undisplaced fractures and 32 per cent in displaced fractures. Hip fracture remains a serious injury with a high rate of ongoing problems.

II (2). Incidence and Prevalence

2(i): Measuring hip fracture incidence

It is now accepted that, for practical purposes, hospital admission data best identify the hip fracture population. The earliest calculations of incidence were made in locations such as Dundee, Scotland and Rochester, New York where the population was definable and stable and hospital care was provided almost exclusively by a single facility. [30,31,32] Information from radiology reports or personal clinic records are alternate data sources in closed study populations,[33,34,35] but calculations of national incidence were derived from centralised data collections for hospital admissions.[36,37] It has long been recognised however that most of these regional or national data collections identify episodes of hospital care, not individual patients.[38,39] Hip fracture patients are likely to have more than one treatment episode within their initial hospital admission, [38,40] hence some degree of double counting is probable. Unadjusted hospital episode data for hip fracture appeared to overstate the true number of fracture patients by approximately 20 per cent. [38,40] A number of processes aimed at reducing this error, such as including only emergency admissions or excluding admissions through transfer from another hospital, or requiring that the diagnosis of hip fracture be accompanied by a relevant procedure code, were applied to population-based data. The extent of over-reporting could not be accurately determined but may have been 20-25 per cent. [39]

Hospital admission databases which included a patient identifier were established at national level in Finland and Denmark and at County level in Sweden in the latter decades of the 20th century. [23,37,41] These provided much more accurate incidence data. Accuracy of coded diagnoses for hip fracture proved to be high when checked against radiology findings. [35]

2(ii): Incidence of hip fracture prior to 1984: the "orthopaedic epidemic"

A sharp increase in hip fracture incidence with increasing age has been recognised for two centuries. [11] In the middle decades of the last century two converging factors were producing a rapid and accelerating increase in the number of hip fracture patients. Not only was the population ageing rapidly, but the age-specific incidence of hip fractures was also on the increase. [31,32,38,39] Predictions of a doubling or even trebling of the number of hospital admissions in the first 20 years of this century were made in several countries. [39,42,43,44]

Prior to the advent of national data sets, these projections were based upon small numbers of patients in discrete communities served by a limited number of hospitals. Rochester, Minnesota serviced almost exclusively by the Mayo Clinic [31] reported rising incidence for men and women between 1928 and 1952, but acknowledged incomplete case finding in the early years. After 1953 incidence did not change significantly: there were only 1355 patients recorded in 50 years to 1977.

In Göteberg, Sweden 104 fractures were recorded in 1940, 443 in 1965 and 928 in 1983. Between 1965 and 1983 the annual incidence increased by nearly 70 per cent for females and 100 per cent for males; although mean patient age increased by 8.5 years for females (to 81.7 years) and by 5.3 years for males (74.8 years) this demographic shift was estimated to explain only 20 per cent of the increased incidence. [43]

The Hospital In-Patient Enquiry dataset for England and Wales showed that hospital admissions increased by a factor of 2.7 between 1959 and 1977, with evident increases for all age-groups over 45 years.[38] Again less than 30 per cent of the increase was attributable to demographic shift towards older age. An additional 16,000 admissions and 600,000 bed-days were required in 1977 compared with 1959.

Data collected in Nottingham, England showed that the rate of increase in admissions for hip fracture accelerated further to 10 per cent per annum between 1977 and 1981, while population grew at 2 per cent. Females aged >75 years showed by far the greatest relative and absolute increases in this period. [39] Data were scrutinised to minimise double counting due to inter-hospital transfers. In discussing possible causes of the rising age-specific incidence the author speculated on the possibility of a cohort effect in a group which may have undergone dietary deprivations during and after World War II plus lack of physical activity in old age as 'labour-saving devices' made their appearance. [39]

2(iii): Hip fracture incidence after 1984: an epidemic averted

By the early 1990s, evidence was emerging that, while the proportion of persons aged over 80 years was continuing to increase, the rise in age-specific incidence was being replaced by progressive decline, especially for women. In Rochester, a decline in hip fracture incidence for women was found in the period 1973-1992; rates for men continued to increase until 1982 but then showed small declines.[45] Between 1985 and 2000 in Ostergötland, Sweden the rates of both cervical and trochanteric fractures declined for women but rose by higher margins for men. [36] The data of the Scottish Hip Fracture Audit demonstrated a fall of approximately 10 per cent in the population aged 50 years and over between 1999 and 2004. [42] English data for the period 1989–1998 showed that total hospital admissions and age-specific admission rates for hip fracture had increased but that all of this increase had occurred in the first five years after which rates were steady or slightly declining. Total hospital admissions were stable for all patients aged under 85 years. [46] In Stockholm County, Sweden between 1998 and 2007 the population aged 65 years and older increased by almost 20,000, but the combined incidence of hip fractures fell from 16.5 to below 14 per 10,000 persons. [37] In contrast to Scottish projections of increasing actual numbers of fractures, [42] hospital admissions for hip fracture fell by 8 per cent across the decade. The fall was evident for men and women aged 65–84 years but not in the youngest and oldest people. The differential rates of change between the oldest patients and younger age-groups was suggestive of a possible cohort effect as had been speculated as early as 1983. [39]

A New Zealand study has demonstrated a strong cohort effect in parallel with the period of rising incidence, and the subsequent decline. [47] The passing of cohorts born before the end of the 19^{th} century could, in keeping with the improving health and fitness of older people, explain some of the current downward trends. The described cohort effect is now minimal within this population. [47]

Section III. Hip fracture in Australia: incidence, prevalence, hospital utilisation data and caseload projection

The material presented in Section III examines the current and projected caseload for hip fracture in the general Australian population. The incidence and prevalence of hip fracture by age and sex, and the changes in these measurements over the 20 years to 2012-13 are described. A calculation of the projected hip fracture population in 2051 is presented. While seeking to acknowledge findings of other Australian original research, the descriptions and calculations in this Section were derived after cross-referencing and collation within national databases in the public domain. The data sources were the relevant editions of Australian Demographic Statistics (Australian Bureau of Statistics ABS 3101.0) and the National Hospital Morbidity Database (Australian Institute of Health and Welfare). Comprehensive data in the NHMD was first available for 1993-94. These data also provide a context for the specific findings of resource demands and benefits or burdens for DVA patients which are presented in the five research studies which form the major elements of this Thesis (Section V).

III (1). Data sources

There are currently no precise data to identify the annual number of hip fractures in Australia and therefore no precise calculations of incidence. Studies on localised populations have high levels of completeness and accuracy, but accurate extrapolation to the diverse national population cannot be assumed, on account of demographic differences and the likelihood of wide confidence limits. [33,34,48]

Administrative databases of hospital admissions are generally not the correct vehicle for calculation of incidence rates for any particular diagnosis. Hip fracture is accepted as being an exception, as very few cases will not be admitted to hospital and the diagnostic coding for this condition is accepted to be sufficiently accurate to support research studies. [49,50,51] A systematic review found sensitivity within the range of 69-97 per cent, or 83-97 per cent with positive predictive value of 86-98 per cent when the principal diagnosis code was coupled with a relevant procedure code. [51]

Interactive data cubes of the National Hospital Morbidity Database (NHMD) [52] report episodes from every public and private hospital except for a small number of private day-only facilities. Episodes are classified by principal diagnosis up to 5-digit ICD-10-AM, by year and by age-group and sex of the patient. Same-day and other episodes can be separated. These rich data resources have been available since 1993–94. The consistency of trend lines for demographic and secular variables across two decades testifies to high levels of accuracy and completeness.

However, databases record episodes of hospital care rather than individual patients, and it is universally recognised that hip fracture patients frequently have more than one episode of care during their initial (index) hospitalisation.[34,39,40,50] The extent of this excess counting is not precisely known but is probably in excess of 20 per cent. [38,40] A number of corrective processes are applied to such databases, both in Australia and elsewhere.[35,39,40,53,54] These include exclusion of episodes whose coding indicates inward transfer from another acute hospital, or limiting ascertainment to emergency admissions or with associated codes for low-impact falls or for a procedure relevant to hip fracture repair or some combination of the above. Individual studies may also exclude pathological hip fractures, and those associated with major trauma or multiple injuries.

While seeking to reduce the over-counting inherent in administrative data, some adjustments may fail to identify legitimate cases. The addition of procedure codes to the algorithm results in under-reporting through exclusion of patients treated conservatively and also those who have died in hospital before operation. [50] The level of heterogeneity between diagnostic algorithms was such that meta-analysis was declared to be impractical. [51]

An additional difficulty is the inconsistency of demographic criteria for hip fracture studies. In recent Australian studies, the lower limit for patient age ranges from zero to 65 years and age intervals are set between 5 and 15 years. [33,34,44,55] Despite the well- recognised rapid increase in numbers of the oldest old, such that patients aged 85 years or older now comprise at least 40 per cent of all hip fractures, [53] most studies including the NHMD reports, do not further separate this group by age. [33,34,54,55]

III (2). Estimates of hip fracture incidence and caseload

2(i): Studies of regional populations

There appears to be no information on fracture rates in Australia prior to 1979. Data based upon acute hospital admissions in NSW [56] showed that admissions for hip fracture increased for women but not men up to 1986 and then remained static: a further study using similar data suggested modest falls in hospital separation rates between 1986 and 1991. [57] Between 1989 and 1996, in South Australia, age-standardised rates for patients treated surgically initially fell slightly then stabilised for women while rates for men were essentially constant. [58] A later report from South Australia, covering the years 2002-03 to 2007-08, showed significant increases in incidence for men, and no significant reduction for women. Total numbers of hip fractures increased by almost 20 per cent across this latter interval, while the proportion of males increased from 24 per cent to 30 per cent. [59] In Victoria, age-standardised incidence fell from 600 to 467 per

100,000 in the decade to 2008-09, with significant reductions for men and women in all age groups over 65 years. [60]

Two longitudinal studies in Dubbo (NSW) and Geelong (Victoria) commenced in 1989 and 1993 respectively. In the former, conducted with a small and relatively young population, annual incidence of all osteoporotic fractures fell by 4 per cent for women and 6 per cent for men across the 12 years from 1989 to 2000. There was however no discernible change in respect of hip fracture. In 2000 the age-standardised hip fracture incidence was 7.6 per 1000 for women and 3.3 per 1000 for men. [33]

The Geelong study was drawn from a population of 222,000 in 1996 which had increased by 17 per cent in 2006-07. There was an increase of 80 per cent in the number of persons for persons aged 85 years or older. As in the Dubbo study, hip fractures were identified from radiological reports. Across 10 years, the total number of hip fractures increased by 53 per cent for men but only by 4.4 per cent for women. There were no significant changes in age-standardised fracture rates for men, while rates for women declined by 30 per cent. The age standardised incidence in 2006-07 was 4.4 per 1000 for women and 2.3 per 1000 for men. [34]

In the Australian Capital Territory (ACT) age-specific hip fracture rates were assessed from hospital discharge data. Patient ID numbers and scrutiny of personal data and admission/discharge dates were used to prevent double counting. For both men and women hip fracture rates in 1999-2001 were increased relative to data from 1994–98, then fell significantly for women, but not for men across the next four years. [55]

In a comparatively young population (only 14 per cent aged 60 years or older in 2006) the overall incidence was 6.8 per 1000 for women and 3.4 per 1000 for men. [54] Later data from the ACT showed a resurgent increase in incidence for women, coinciding with a sharp reduction in bisphosphonate dispensing, itself apparently triggered by reports linking this medication with osteonecrosis of the jaw. After three years hip fracture incidence has resumed a decline. [61]

2(ii): Estimates from national databases

As outlined in Section III-1, a variety of inclusion and exclusion factors have been applied to these data to adjust for double counting. Estimates of hip fracture prevalence in Australia for 2006-07 were 16152 and 18176 [53,54] and 17003 and 18676 for 2008-09, [54,62] a spread of 10-12 per cent. An earlier analysis in 2002-03 excluded episodes coded as incoming transfers but included cases where hip fracture was coded as a secondary diagnosis and found 18,616 hip fracture cases. [40] The calculated numbers of hip fractures in Australia has therefore varied substantially depending upon the method of ascertainment.

III (3). Hip fracture in Australia: more accurate estimates?

The various adjustments to NHMD and other databases would be unnecessary if all records within databases carried a secure patient identification code as do the DVA databases which support the studies in this Thesis. Such identifiers are no longer unique and indeed, the Finnish Health Care Register and its antecedents have included these since 1968. [50] This is the Gold Standard which can minimise uncertainty in the identification of patient numbers, resource burdens and outcomes of hospital care, across multiple services and jurisdictions.

Through the linkage capacity of the DVA databases, accurate assessment of the relationship between hospital episodes and individual patients was possible (see Section V, research study no.1). Of 2552 identified DVA patients, 555 (21.7 per cent) had multiple and connected acute episodes. The total of 3177 such episodes represented a ratio of 1.25 (95% CI 1.22-1.27) episodes per patient. This ratio was the same for men and women and there were no significant differences on account of patient age. A large series of hip fracture patients from NSW was found to have 1.28 acute episodes per patient (Lee Taylor, Epidemiology and Evidence, NSW Health Ministry, personal communication, 2013). The DVA adjustment factor of 1.25 has been applied to the national NHMD data to determine age-specific patient numbers and incidence in Tables III-1 and III-2.

The calculations for these Tables still include assumptions and estimates. The 95% confidence limits for the episode: patient ratio (1.22-1.27) include a range of 16743-17430 about the estimate of 17012, a spread of 4 per cent. The episode: patient ratio, based upon DVA data is assumed to hold for the rest of Australia, an assumption which could be readily tested.

III (4). Trends in national incidence and caseload 1993–94 to 2012–13

4(i): Hip fracture prevalence

In the two decades since 1993-94 the calculated hip fracture caseload has increased from 11378 to 18607 (Table III-1). In this time the proportion of men has risen from 23.5 per cent to 28.9 per cent and the proportion of patients aged 85 years or older has increased from 37.1 per cent to 49.8 per cent. These demographic shifts within the overall increasing caseload are illustrated in Figure III-1. It is also evident from Table III-1 and Figure III-1 that hip fracture numbers for women aged below 85 years have been essentially static since 2003-04 and have actually fallen among women aged 75-84 years. [52]

The age-specific incidence rates for men remained static or slightly increased between 1993-94 and 2003-04. In the last nine years, there were substantial decreases for men aged 75 years and older, and a fall of 8 per cent in the age-standardised incidence. For women rates fell steadily after 1998-99 for all age-groups except for women aged 65-69 years. In this period the age-standardised incidence for women reduced by 16 per cent. The greatest proportional declines in incidence since 1998-99 have been in the age range 75-84 years for both men and women (Table III-3).

Table III-1. Numbers of hip fractures by age and sex: Australia 1993–94 to 2012–13

Year	Age group					
	65–69	70–74	75–79	80–84	≥ 85	TOTAL
			Males			
			Episodes [1]			
1993–94	354	489	694	787	1021	3345
1998–99	321	598	841	1072	1378	4210
2003–04	345	536	1016	1371	1994	5262
2008–09	376	573	1026	1490	2350	5815
2012–13	521	706	979	1593	2917	6716
			Persons [2]			
1993–94	283	391	555	630	817	2676
1998–99	257	478	673	858	1102	3368
2003–04	276	429	813	1097	1592	4167
2008–09	301	458	821	1192	1880	4652
2012–13	417	565	783	1274	2334	5373
			Females			
			Episodes			
1993–94	610	1197	2008	2792	4270	10877
1998–99	601	1218	2402	3217	5691	13129
2003–04	607	1191	2478	3803	7034	15113
2008–09	654	1113	2135	3676	7873	15451
2012–13	847	1249	2082	3703	8661	16582
			Persons			
1993–94	488	958	1606	2334	3416	8702
1998–99	481	974	1922	2574	4553	10504
2003–04	486	953	1982	3042	5627	12090
2008–09	523	890	1708	2941	6298	12360
2012–13	678	999	1666	2962	6929	13234

[1] Episode data: National Hospital Morbidity Dataset (AIHW)
[2] Persons = episodes / 1.25 (see text).

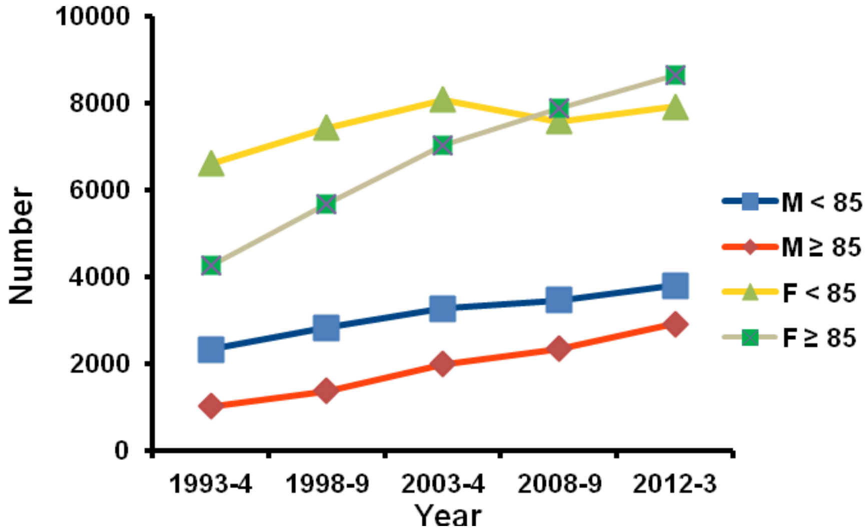

Figure III-1 Trends in distribution of hip fracture episodes

(From NHMD Data cubes by principal diagnosis: AIHW)

4 (ii): Trends in hip fracture incidence

Between 1993-94 and 2012-13 the Australian population grew from 17.7 million to 22.9 million. [63] The number of Australians aged 65 years or older increased by 57 per cent from 2.08 million to 3.27 million (14 per cent of the total) and the proportion of men increased from 43 to 46 per cent of this age-group. Persons aged 85 years or older increased from 212,000 to 432,000 (1.2 per cent to 1.9 per cent of total population) with the proportion of men rising from 24 per cent to 35 per cent.

Within this context, the age-specific incidence rates among men remained static or slightly decreased between 1993-94 and 2003-04, after which there were substantial decreases. (Table III-2) Among women, rates fell steadily after 1998-99 for all age-groups except 65-69 years. After 1998-99 the age-standardised incidence for men fell by 8 per cent and for women by 16 per cent. The largest proportional decreases in incidence since 1998-99 have been in the age-range 75-84 years for both men and women. (Table III-2)

There is however a suggestion in these data that the decline in incidence rates has been slowing in the four years to 2012-13. This would be in accord with a report of little or no ongoing increases in age-specific incidence after 2005-06. [64]

Table III-2. Hip fracture incidence by sex and age-group, Australia 1993–94 to 2012–13

Year	Age group					
	65–69	70–74	75–79	80–84	≥ 85	Standard [1]
			Males			
1993–94	0.85 [2]	1.52	3.37	6.62	15.81	3.53
1998–99	0.77	1.66	3.26	7.76	15.61	3.65
2003–04	0.76	1.43	3.34	7.26	17.13	3.66
2008–09	0.71	1.41	3.21	6.59	14.76	3.34
2012–13	0.80	1.51	2.89	6.61	15.28	3.36
			Females			
1993–94	1.36	3.09	6.94	13.88	27.55	8.07
1998–99	1.38	2.96	6.99	14.35	28.37	8.82
2003–04	1.31	2.91	6.61	13.45	27.99	8.48
2008–09	1.22	2.55	5.78	11.94	25.46	7.60
2012–13	1.28	2.56	5.40	11.88	24.84	7.44

[1] Australian population 2003–04 is reference population (ABS3101.0)
[2] Hip fractures per 1000 persons per year

In combination, the Australian data of Tables III-1 and III-2 closely reflect hospital admission trends for periods around the turn of the century in Sweden, the United States and England where numbers have been static or reducing for all but the oldest patients [37,65, 66] although in populations with lower growth rates than Australia.

III (5). Hospital utilisation for hip fracture: a large efficiency gain

In 1993-94 the mean length of hospital episodes (LOS) coded for hip fracture was 17.3 days for both males and females aged 65 years and older. (Table III-3) By 1998-99 these values had reduced to 12.0 days (males 12.6 days, females 11.8 days) and by 2012-13 mean LOS had further reduced to 9.8 days (males 10.2 days, females 9.6 days). If this reduction in LOS had not occurred, approximately 140,000 additional bed-days or some 450 additional acute hospital beds would have been required for the 2012-13 caseload. [52]

Full examination of the reasons for these large reductions in hospital stay, and particularly the major change between 1993-94 and 1998-99 is outside the scope of this Thesis. They are almost certainly multifactorial and complex. Evolving awareness of best-practice guidelines for hospital care of frail patients has possibly contributed. Numerous studies report that orthogeriatric programs, however delivered, can reduce acute hospital stay for hip fracture. [27,67]

Table III-3. Mean LOS for unlinked acute hospital episodes for hip fracture: Australia 1993-94 to 2012-13

Year	Age group					
	65–69	70–74	75–79	80–84	≥ 85	All
Males						
1993–94	17.4 [1]	16.2	18.3	18.9	15.8	17.3
1998–99	12.5	12.1	12.5	13.1	12.4	12.6
2003–04	11.0	10.5	12.1	12.4	12.1	11.9
2008–09	9.7	11.2	11.7	11.7	11.7	11.5
2012–13	9.2	8.9	10.6	10.9	10.2	10.2
Females						
1993–94	13.9	15.5	15.7	16.8	19.2	17.3
1998–99	10.6	11.7	11.4	11.8	12.1	11.8
2003–04	10.5	10.2	10.9	11.2	11.2	11.1
2008–09	9.6	10.4	10.8	10.8	11.4	11.0
2012–13	7.7	8.6	9.2	9.9	9.7	9.6

[1] Mean length of stay in days
Data source : NHMD Data Cubes (AIHW)

Rehabilitation is a major element in the hospital management of hip fracture, with almost 50 per cent of patients being referred to hospital based units in Europe [68, 69] and up to 90 per cent being referred for rehabilitation in hospital units or in skilled nursing facilities in the United States. [70] Table III-4 shows that, in Australia between 1998 and 2013, there has been an increase in the numbers of rehabilitation episodes, disproportionate to the population increases. The age-standardised rates for rehabilitation episodes (all causes) have risen from 18.3 episodes per 1000 persons in 1998-99 to 31.6 per 1000 persons in 2012-13 and length of stay in rehabilitation units has also fallen sharply during the same period.

Whether hip fracture patients share in the shorter rehabilitation LOS is not exactly clear, but whatever this interaction, strong efficiency gains in both acute and subacute hospital care, of relevance to hip fracture, are apparent. At a time when hospital costs, especially for the elderly are under increasing scrutiny, the progressively efficient use of expensive resources by hospital clinicians and managers should perhaps receive greater recognition, and the reasons for these gains be better understood.

Table III-4. All hospital episodes for rehabilitation, Australia 1998–9 to 2012–3

Year	Age group					
	65–69	70–74	75–79	80–84	≥ 85	All
			Number of episodes			
1998–99	4194 [1]	7084	9501	9391	9792	39962
2003–04	5195	8870	13710	15355	16355	59485
2008–09	7904	10592	15215	19010	23536	76257
2012–13	12818	15440	19042	23005	32904	103209
			Mean LOS of rehabilitation episodes			
1998–99	21.9 [2]	21.7	21.5	22.3	22.6	22.0
2003–04	22.3	19.3	19.4	20.9	21.9	20.7
2008–09	17.5	17.3	18.1	18.4	19.7	18.5
2012–13	16.1	15.5	16.2	16.7	17.8	16.7

[1] Numbers of episodes
[2] Hospital stay in days
Data source: NHMD Data Cubes (AIHW)

III (6). Hip fracture projections for Australia, the unaverted epidemic?

Projections based upon data from the Geelong Osteoporosis Study in the last decades of last century estimated hip fracture numbers in 2051 to reach approximately 60,000, or four times the estimated caseload for 1996.[44] At this time age-specific and age-standardised incidence rates were static for women and rising slowly for men, and the projected estimate was based upon continuation of existing rates. The mid-range projection for the Australian population in 2051 was of the order of 25 million, [70] with 5.1 per cent being aged 85 years or older as shown in Table III-5.

Since this estimation there have been substantial changes to both population projections and age-related incidence of hip fracture for Australia. The latest available projection (2012) is for a total population of 38 million in 2051, with 8 million persons being 65 years or older and 1.6 million (920 000 women and 670 000 men) aged 85 years or older. The proportion of the 'oldest old' is estimated to increase from 1.9 per cent at present to 4.2 per cent by mid-century. The overall proportions of men and women are expected to remain essentially constant over this time. [71]

Table III-5. Estimated Australian population in 2051[1]

Age group	1999 estimate		2005 estimate		2012 estimate	
	Males	Females	Males	Females	Males	Females
65–69	755 [2]	766	814	810	984	1013
70–74	691	719	725	744	810	855
75–79	631	691	661	719	708	781
80–84	494	587	550	636	577	676
≥ 85	532	761	678	942	667	920
All ages	12626	12783	17104	17109	18886	19070
Totals	25.4 million		34.2 million		38.0 million	

[1] Data: ABS Population Projections 1997-2051, 3222.0, ABS 2013, Canberra
[2] Mid-range projection, thousands

Should age-related incidence rates for hip fracture remain unchanged from those of the 1990s, the faster expanding and ageing population would have yielded more than 90,000 hip fracture cases by 2051. However, from the middle 1990s, rates have been falling steadily, especially for women. [34,53,55] Should the trend lines for age-specific incidence be projected unaltered from the data in Table III-2, the resulting caseload in 2051 would be 43,800 hip fractures of which 37 per cent would be men and 63 per cent would be aged 85 years or older. If the rate by which incidence declined were halved beyond 2013, the total caseload would be 52,000 with 34 per cent men and 59 per cent aged 85 years or above, as shown in Table III-6.

Table III-6. Estimated hip fracture prevalence, Australia 2051[1]

Age group	Males			Females		
	N (000's)	Rate [2]	Hip fractures	N (000's)	Rate	Hip fractures
65–69	984	0.7	690	1013	1.3	1320
70–74	810	1.3	1050	855	2.1	1800
75–79	708	2.7	1910	781	4.3	3360
80–84	577	6.4	4270	676	10.0	6760
≥ 85	667	14.8	9870	920	22.9	21070
Totals	3 746	4.7	17 790	4 245	8.1	34 310

[1] ABS mid-range population projections 1997-2051, 3222.0, ABS 2013
[2] Incidence decline for 2013-2051 = 50 per cent of rate from 1993-94 to 2012-13

A long-range projection for any health-related situation involves a complex interplay of assumptions. Future demography may be impacted by economic, political, environmental, health technology and numerous other factors, often unforeseen at present. It will be interesting to observe whether the reported, and counter-intuitive, stabilisation in the proportions of the very elderly is confirmed and whether tentative evidence for a cohort shift towards less fracture-prone individuals is realised.

Improvement in preventative measures for both osteoporosis and the other recognised risk factors for hip fractures can only be surmised but history suggests that many such advances will emerge. Even if case numbers continue to rise steeply, the burden upon hospitals, and community resources may be less than forecast. Current reductions in hospital LOS may continue. Some aspects of hospital-based management may be partially or wholly replaced with less costly community-based programs. Community resources would also be greatly increased should current trends towards both population growth and later retirement from the workforce are continued.

Section IV: Introduction to research studies

IV-1. Aims and objectives

When this work was commenced in 2011, there was no national information on the complete duration, cost or outcome of hospitalisation for hip fracture in Australia. An extensive report by AIHW in 2010 [1] had presented a great deal of numerical data on these subjects, but only in respect of acute hospital episodes with a principal diagnosis of hip fracture. In doing so, AIHW acknowledged that there were important limitations to the findings. Over half of the identified episodes of hospital care ended with transfer to further hospital care, but without capacity for data linkage at a patient level, the location and content of this care remained unknown. For the same reasons, data describing hospital readmissions, community supportive services, entry into residential aged care and post-hospital mortality were not available. The same limitations also applied to, and were recognised by several other Australian studies based in individual hospital or regional populations. [72,73] The available data in all these instances identified hospital episodes and not the complete experience of individual patients.

Given the changes in locations and clinical situations implied by these findings, it was unlikely that even treating clinicians understood the full hospital experience of hip fracture patients. The absence of capacity to link hospital and other health databases on a national scale also left unanswered the questions of what happened after final hospital discharge. Rates of readmission, placement into supported accommodation and death in the ensuing months or years could not be calculated on a population basis.

With access to linkable databases provided by the Department of Veterans' Affairs, this study commenced with the aim of describing the total length of hospital stay, the contributing episodes, the outcomes (as identified by separation codes) at final discharge and the costs of complete hospital care for a large national cohort.

The extensive range of clinical and administrative variables within these data, provided the opportunity to identify factors associated with longer or shorter hospital stay, and diverse outcomes. The linkage of hospital data with information on post-hospital RAC, community based services and mortality, permitted examination of rates of and determinant factors for longer term patient outcomes.

This Thesis describes a number of aspects of hip fracture management and the patient outcomes of these processes. The principal intention has been to provide more comprehensive analytical detail than has been previously published in respect of a large sample of Australian patients. Beyond this, there is no single objective, hypothesis or research question.

Objectives

The major objectives of these extended database analyses were therefore:

1. To describe the length of hospital stay, for acute care, for rehabilitation and for management of other contingent issues: in particular to identify the full burden of the initial hospital stay following hip fracture for a substantial sample of elderly Australians.

2. To identify the outcomes at the conclusion of the total hospital stay.

3. To identify the personal and clinical factors associated with longer or shorter hospital stay and hence costs.

4. To estimate mortality rates following hip fracture, their major predictors and the extent of excess mortality above predicted rates for a reference population adjusted for age and sex.

5. To examine hospital resources expended for initial hip fracture management in the different Australian states and the relationship, if any, between resource burden and medium to long-term patient outcomes.

6. To examine the resource burden of hospital-based rehabilitation and the associations with long-term outcomes for mortality and independent living.

7. To describe recent trends in incidence and prevalence of hip fracture in the general Australian population, and to calculate a projected caseload to 2051. This objective has already been identified and addressed in Section III.

8. To demonstrate the importance of database linkage in describing and analysing the management of a complex clinical condition. To show the additional information released when outputs from database linkage are applied to national datasets in the public domain.

Issues not addressed

It is recognised that many subjects of relevance to the study of hip fracture are not addressed in this Thesis. These include the prevention and treatment of osteoporosis, reduction in risk for and consequences of falling and the respective merits of different surgical techniques. In respect of these issues data provided in linked databases may not always be the ideal vehicle for comprehensive assessment. Other research opportunities and priorities are indicated at the conclusion of this document in Section VI (4).

IV (2). Patients and methods

2(i): The DVA Treatment Population (TPOP)

The study population was drawn from the DVA Treatment Population (TPOP) which includes all DVA beneficiaries entitled to health services at Departmental expense as holders of a Gold Card (treatment for all conditions) or White Card (treatment for cancer, tuberculosis, post-traumatic stress disorder, anxiety, depression or any condition(s) accepted as due to military service). Gold Card status is provided to either veterans or their surviving spouses and in December 2008, included 92 per cent of TPOP members aged 65 or older (85 per cent of males, 98 per cent of females).[74]

In the study year of 2008-09 the TPOP numbered 275,037 of which 209, 322 (103,332 males and 105,990 females) were aged 65 years or older.[74] This represented 20.5 per cent of Australians aged 80 years or older (males 26.1 per cent, females 17.0 per cent). The data are illustrated in Figure IV-1. The very high proportion of young men, and at least 50,000 young women, who volunteered for military service in World War II is reflected in these data, which now include an increasing proportion of their bereaved spouses as war widows or widowers.

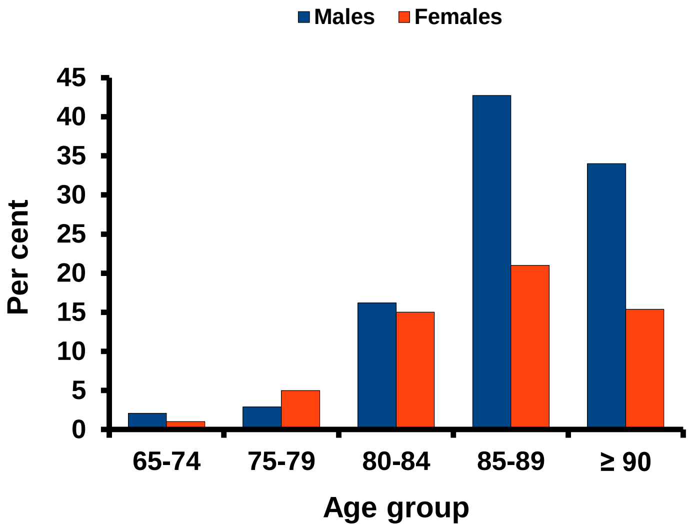

Figure IV-1. DVA TPOP as a percentage of Australian population.
Data sources: DVA Treatment Population Statistics and Australian Demography, ABS 3101.0

2 (ii): The study population

All TPOP members hospitalised for the first time on account of hip fracture (ICD-10-AM S72.0 to S72.2 inclusive) between 1 July 2008 and 30 June 2009 were included.

Patients with multiple injuries or malignancy were included but second hospital admissions within the study year were excluded. The comparative demographics of the study population and those of other Australian hip fracture patients are shown in Figure IV-2. The much higher proportion of DVA patients aged 85 years or older was more pronounced in men than for women.

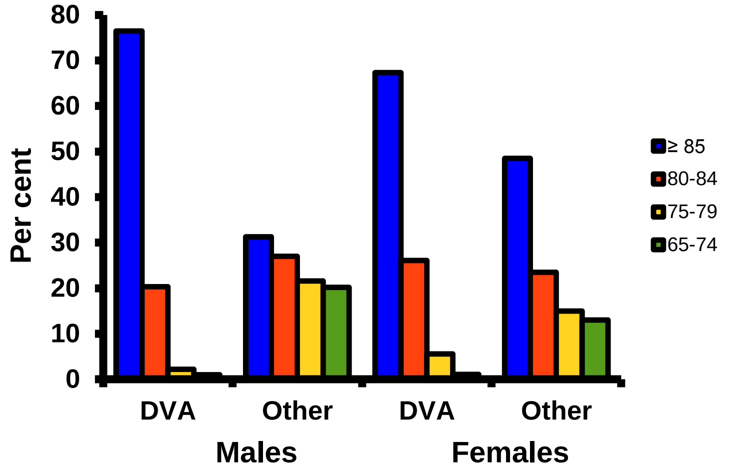

Figure IV-2. Age-distribution of hip fracture: DVA and non-DVA [1] patients.

[1] Data source: National Hospital morbidity Database (AIHW)

2 (iii): Data items

The DVA databases accessed and linked for these studies were routinely generated by the Department essentially for billing purposes. The databases for public and private hospital services were provided to DVA by the health administrations in the various states and territories. There are no items in the datasets exclusive to DVA patients with the exception of services from Veterans' Home Care, a variant of the Home and Community Care (HACC) program.

The following variables were included in the dataset: age, sex, fracture type, hospital separation status, surgery, intensive care and rehabilitation episodes, comorbidities and complications. ICD-10-AM codes in the hospital datasets were used to identify fracture type, surgical procedures, rehabilitation episodes, comorbidities and complications. Intensive care was identified by a service item descriptor. Surgical codes were accepted if they were accompanied by one of the codes for hip fracture. Rehabilitation codes were accepted whether treatment required transfer to another hospital or phase change within the same hospital. Codes for fracture type, procedures, rehabilitation, intensive care and complications were accepted for analysis if they appeared within the episode string for the index admission. Comorbid conditions from the 1999 revision of the Charlson Index [75,76] were identified from primary or secondary diagnoses for all hospital episodes in the study year, up to and including the episode string of the index admission. Itemised costs were provided for each hospital episode.

Fracture type was classified as cervical, trochanteric, subtrochanteric and 'other'. Surgical procedures were grouped as internal fixation, hemiarthroplasty, total hip replacement and 'other'. Comorbidities with significant impacts on LOS or patient mortality included dementia, renal failure, cardiac failure, ischaemic heart, renal, chronic respiratory and cerebrovascular diseases, diabetes and malignancy. Complications were skin (pressure) ulceration, delirium, post-haemorrhagic or unspecified anaemia, plus urinary, lower respiratory and surgical site infections. The ICD-10-AM codes for all clinical variables are listed at Table V3-A in Section V(3). The data compilations and calculations for Objective 7 and Section III were sourced from AIHW and ABS tables in the public domain.

(iv): Data linkage

The DVA-specific linkage key was used to match relevant records at patient and episode level ("line-by-line" data). The process of record linkage involved firstly concatenation of hospital episodes for each patient to describe the total continuous hospital stay for hip fracture. Criteria for episode linkage were (a) the admission date of a subsequent episode was one day or less after the prior separation date, or (b) separation was to another hospital and the interval to the next recorded admission was seven days or less. For reasons of patient or hospital choice, hospital episodes may not always be billed to DVA, and such episodes do not appear in the DVA databases.

Determination of episode strings and calculation of the length of the total hospital stay for each patient was performed by inspection of the primary database, which contained 9846 records. While DVA possessed an algorithm for identifying 'clusters' of continuous episodes, these sometimes included hospital days for unrelated conditions prior to and continuous with the defined index admission date. Merging of data in different datasets was performed in SAS 9.2 or 9.3. [77]

2 (v): Compilation of Master File

Data items from the primary dataset were re-formatted to meet the requirements for SAS analysis. To the listed items from the hospital datasets were added, as binary variables: identification of pre-fracture RAC status, classification of fracture type, surgical procedure classification and intensive care episode, date of death, RAC occupancy and provision of community nursing and Veterans' Home Care services (90 days, one year and two years after the index admission date), individual comorbid and complicating diagnoses and state of treating hospital. Concatenated LOS for acute, rehabilitation, other component episodes and for total LOS, comorbidity scores, [75, 76] and costs of hospital treatment were entered as continuous variables. Data for readmissions within the first year following the index admission and patient-specific hospital costs were included. The completed Excel spreadsheet contained more than 100 individual data items.

Section V: Research Studies

V (1): Research Study No. 1

Total length of stay, costs and outcomes at final discharge for admitted patients with hip fracture: linked episode data for Australian veterans and war widows

A W Ireland and PJ Kelly

Internal Medicine Journal 2013; 43(12): 1280–1286

Abstract

Objective: To identify the total duration of hospital stay, total hospital costs and outcomes at final discharge for a series of Australian patients with hip fracture.

Methods: The study was a retrospective cohort study using episode linkage within and between administrative databases. Study population was 2552 Australian veterans and war widows with primary diagnosis of hip fracture (ICD10, 72.00–72.2) and hospital separation dates between 1 July 2008 and 30 June 2009. The Unique Identifying Number (UIN) within Department of Veterans' Affairs health service databases was used to link records for relevant hospital episodes as defined. Additional linkages were made with data for residential care admissions and date of death.

Results: Mean length of stay (LOS) for unlinked acute episodes was 11.1 days and cost of hospitalisation was $A13095. Fifty-one per cent of these episodes ended with transfer to ongoing hospital care, 9.5 per cent were discharged to residential care (RAC), in-hospital mortality was 6.5 per cent and 23 per cent were discharged to "usual residence". When data for all continuous episodes following hip fracture were combined mean LOS was 30.8 days, costs were $A26023 and in-hospital mortality was 11.1 per cent. Additional linkage with RAC records identified 38 per cent of final discharges were to RAC facilities with 44 per cent of patients returning to independent living.

Conclusion: For complex conditions such as hip fracture, a process of patient-specific episode linkage is required to accurately identify hospital LOS, costs and patient outcomes.

Introduction

The hospital management of hip fracture is a complex process for patients with complex clinical issues. [1] Multiple episodes of hospital care are the norm rather than the exception to address care needs between initial admission and eventual discharge. [1,2,3]

Reports of hospital performance in respect of hip fracture which do not include information from all relevant hospital episodes provide an incomplete picture in respect of hospital resources and patient outcomes. The 2010 report on hip fracture by the Australian Institute of Health and Welfare noted that it could not track individual patients through the "hospital system" and therefore true outcomes could not be described. [4] The most recent Australian study which identifies length of stay (LOS) and hospital mortality for hip fracture patients describes only the acute episode of care. [5].

Western Australia was the first Australian jurisdiction to practice systematic linkage of health databases [6,7] but to date has not reported patient-based linkages within hospital data. The true values for LOS, cost and outcomes of treatment for hip fracture and other complex clinical conditions in Australian hospitals remain unknown. [4] Wide disparities in international reports of hospital performance in respect of hip fracture arise mostly from differing capacity to link the relevant episodes in the hospital care process. Systems which provide patient-linked reporting include the Stockholm County Patient Care Register [8] and the Hospital Episodes Statistics (HES) database for the English NHS. [9] While reporting total LOS of 17 and 23 days respectively both reports ascribe less than half of the total hospital days to acute (surgical) episodes. Systems which report only acute episode data show median values of 5–9 days [5,10] while systems which incorporate rehabilitation have mean LOS of up to 44 days. [10,11] There are commensurate differences in hospital outcome profiles. [5,11,12,13]

This study will demonstrate, for a cohort of elderly Australian patients, the very wide differences in LOS, hospital costs and patient outcome profiles between values derived through linkage of all relevant hospital episodes and those based upon unlinked data.

Methods

The study population was drawn from veterans, war widows and other beneficiaries of the Department of Veterans' Affairs (DVA)-funded health services. In the study year this comprises 185985 persons (87678 males and 98317 females) aged ≥ 75 years, being 14 per cent of this Australian demographic at that time.

Study data were drawn from DVA databases for episodes of admitted care in public and private hospitals. All hospital separations between 1 July 2008 and 30 June 2009 with principal diagnosis of hip fracture (ICD10 codes 72.00–72.2) were identified. The following variables were extracted: Unique Identifying Number (UIN), age, sex, state and postcode, principal and secondary diagnoses, surgical procedure(s), LOS, admission and separation dates, costs and separation codes. A patient's first recorded hip fracture during the study period was classified as the index episode.

Episode linkage was enabled through the UIN, a numeric code assigned to every DVA client and attached to all entries in all DVA databases. Patient transfers both within and between hospitals were thereby tracked and linked from first admission to definitive discharge.

An additional DVA dataset describing dates of admission to and discharge from residential aged care (RAC) was also linked to the hospital data through the UIN.

Costs for hospital episodes were transcribed directly from the DVA datasets. For public hospitals, these costs had been calculated in accord with the National Hospital Cost Data Collection. [14] For private hospitals the cost was the sum of itemised service costs according to standard DVA schedules, or contracted package costs.

Four different datasets were created:

Dataset 1: Unlinked episodes with primary diagnosis code for hip fracture

Dataset 2: Patient-linked episodes with primary diagnosis of hip fracture. Linkage was created between episodes with matching UIN, plus hip fracture diagnosis and interval of ≤ 1 day between separation date and next admission date.

Dataset 3: All episodes subsequent to and continuous with the index episode. Criteria for linkage were:

(i) interval of ≤ 1 day between separation date and next admission date; the principal diagnosis for second and subsequent episodes was not censored;

(ii) separation code from preceding episode identified transfer to another hospital, and interval to the subsequent recorded episode ≤ 7 days.

Dataset 4. As for dataset 3 with additional linkage to the DVA database for residential aged care. If admission date to an RAC facility was ≤ 1 day different from that of final hospital discharge then the separation code for transfer to RAC was recorded.

The outcomes of interest were LOS, cost and mode of separation. For the linked-episodes datasets, LOS and cost were the summation of values for the linked episodes. The outcome was according to the separation code of the last linked episode.

Exclusions

At the conclusion of the linkage processes patients with aggregate LOS exceeding 365 days were excluded. Apparent second fractures for the same patient within the study year, identified by time lapse of more than one week between previous definitive discharge and next admission coded to hip fracture, were also excluded.

Statistical Analyses

Student's 2-Sample t-tests and Pearson's Chi-square tests were conducted when comparing groups for continuous and categorical outcomes respectively. Associations between patient age, LOS and costs were examined by linear regression. For comparison between datasets, linear and logistic mixed models were used, respectively for continuous and binary outcomes, as data are paired according to patient. [15] All calculations were computed in Excel 2003 or SAS9.2.

Ethics approval was granted by the DVA Human Research Ethics Committee in December 2010.

Results

A total of 3177 episodes coded to hip fracture was identified, representing 2552 patients. An additional 94 episodes from 45 of these patients were identified as probable second fractures. Females comprised 62.4 per cent of patients, with mean age of 86.6 years (range 59–100). Mean age for males was also 86.6 years (range 54–104).

Data for the three levels of episode linkage are summarised in Table V1-A and Table V1-B. For unlinked data (dataset 1), there was no significant difference between mean LOS for females and males (P= 0.14). LOS increased with increasing age for females (P= 0.04) but not for males (P=0.25). For the complete study group LOS increased significantly with patient age (P=0.02). Males and females had similar values for episode costs (P=0.35).

LOS and Costs

The linked data of dataset 2 describe the acute phase of hospital management for hip fracture; 86 per cent of patients were treated surgically. Of the 2552 patients, 1997 had a single acute episode coded to hip fracture, and 555 (21.7 per cent) shared an additional 1180 episodes, with eight patients having four linked acute episodes coded to hip fracture. The episode : patient ratio was 1.25 for females and 1.24 for males (P = 0.93).

As before, mean values for females and males did not significantly differ in respect of LOS (P= 0.06) or cost (P= 0.22). The mean LOS value for all patients was 2.3 days greater than for unlinked episodes (95% CI 0.8–3.9, P < 0.0001) and the mean cost was higher by $1804 (95% CI $1372-$2236, P <0.0001).

The complete linkage process (dataset 3) identified 5228 individual episodes for 2552 patients of whom 1514 (59.3 per cent) shared 4190 episodes, 2051 being for principal diagnoses other than hip fracture. The mean episode: patient ratio of 2.05 in this dataset was almost identical for females (2.06) and males (2.04). The most complex hospitalisations involved up to eight continuous episodes in up to five different hospitals.

There were 1172 patients (45.9 per cent) referred for rehabilitation, for a total of 1307 episodes. The average time in admitted care for rehabilitation was 25 days per patient.

The complete process of episode linkage for the 2552 patients (dataset 3) in this study identified a very wide range of values (Range 1–310 days) for LOS about the mean of 30.8 days. 175 patients had a hospital stay of 10 weeks or more. Total hospital costs ranged from $680 to $194282 about the mean of $26023; 190 patients accrued more than $50000 of hospital costs.

The key results for all levels of episode linkage are summarised in Table V1-C.

Hospital outcomes

The distributions of coded outcomes for all levels of linkage are shown in Table V1-D. For unlinked episodes, more than half the episodes were “incomplete”, being transferred for further hospital care either in another hospital (43.5 per cent) or in another unit within the same hospital (7.4 per cent). The linkage of episodes coded to hip fracture (dataset 2) significantly reduced the reported rate of inter-hospital transfers to 35 per cent (P <0.001). The increase in identified rate of transfer to Aged Care was also significant (P = 0.02) as was the increased in-hospital mortality rate (P= 0.04).

The differences between reported values for patient outcomes in dataset 2 and dataset 3 were all highly significant (P< 0.0001). Essentially, when incomplete episodes were followed to their eventual discharge, transfers for further care were superseded by codes for discharge to "usual residence" or residential aged care. The linkage process also showed that in-hospital mortality rate for hip fracture was 72 per cent higher than the rate identified in unlinked data (Table V1-D).

Linkage with Aged Care databases showed that 701 patients (27.4 per cent) had been RAC residents at the time of hospital admission for hip fracture. Of these patients, 96.6 per cent who survived hospital returned to residential care. For the other 1851 non-RAC patients in this study, 393 (21 %) were found to have transferred to RAC upon hospital discharge: 14 transfers were for short-term respite.

Discussion

Patient-based episode linkage has revealed that for this population of hip fracture patients the total hospital stay, total costs and short-term outcomes all differed widely from values based upon unlinked episodes. There is ample Australian data describing both acute phase care [4,5,15] for hip fracture and related rehabilitation episodes [16,17]. The process of transfer between these two elements has also been well described [18]. However patient-identified data for both elements have not previously been linked for a substantial, national sample in this country.

The creation of cross-linkages between institutional databases is now not uncommon [19, 20]. The additional process of this study- identifying and linking patient-specific hospital episodes with non-hospital data- is less frequently attempted in population-based reports.

This study employs data drawn from DVA administrative databases, the primary function of which is for reconciliation of billing. Patient identification is systematically matched within DVA against other Departmental datasets. These features, and the study criteria for defining populations and data items, meet published principles for minimising bias in studies using such databases [21].

The presence of some coding inaccuracies within administrative databases is endemic but the rates of such errors are no longer seen as barriers to the valid use of databases for either human research or policy support [22]. Recent reviews of Australian hospital databases have confirmed their comparatively very high levels of coding accuracy [23]. The level of accuracy is further enhanced in the process of data linkage [24] as employed in this study.

In the study year the DVA Treatment Population represented 13.8 per cent of Australians aged 75 years or older in the study year. Males comprise 37.6 per cent of the 2552 patients in this study, significantly higher than 27.4 per cent (P=0.004) of hip fracture episodes attributed to males in Australian data [4] . Mean age of DVA patients with hip fracture in 2008–9 was 86.6 years, compared with 83 years for Australian females and 81 years for males in 2006–7 [4]. Females aged 85 years or older accounted for 79 per cent of DVA episodes compared with 62 per cent of non- DVA episodes (P < 0.001). Equivalent values for males aged 85 years or over were 28 per cent and 8 per cent respectively [15-derived]. The absolute values reported by this study for LOS, costs and outcome rates must be interpreted in the context of these demographics.

However, it is the dimensions of the differences between results from unlinked and patient-linked data which this study primarily addresses. These relativities would appear to be generally applicable, given the similarities between matchable data from this study and nationally reported datasets as described below.

For unlinked episodes in patients aged 75 years and over, LOS in this study- 10.9 days for females and 11.4 days for males — closely matched values of 11.2 and 11.8 days respectively for non-DVA patients.[15-derived] Costs for unlinked episodes in this study ($13095) compared favourably with the mean cost of $13012 calculated from the AIHW data for 2006–7. [4] The mean duration of rehabilitation in this study, 23.0 days was almost identical with the Australian benchmark for "orthopaedic fractures" (22.6 days) in 2009. [16]

The average number of episodes per patient in dataset 2 was 1.25, while the equivalent ratio in a large series of hip fracture patients from New South Wales was 1.28 (Taylor, NSW Health Ministry, personal communication). The lack of significant age or gender gradients in the DVA ratios would minimise any potential distortions due to demographic differences.

For dataset 3 no attempt was made to censor the principal diagnoses for episodes continuous with the index episode. The wide spectrum of clinical conditions — post-acute care, complications or co-morbidities — contribute to a diversity of hospital care for hip fracture. [1,3] The allowed interval of ≤ 7 days between an episode ending in transfer to another hospital and a subsequent episode reflects the uncommon occurrence of episodes not billed to DVA and thus not recorded in DVA databases.

The management of hip fracture frequently involves an emergency hospital admission in which diagnosis is established, with prompt transfer to another episode for definitive (usually surgical) treatment. In this study, 439 of 506 episodes (87 per cent) with LOS ≤ 2 days and separation codes other than death, were transferred to another hospital.

Comparative international reports of LOS for hip fracture vary widely. The Stockholm County Patient Care Register for 2007 identified total LOS of 17.3 days, comprising 7.0 days for acute phase care and 10.3 days for rehabilitation. [8] Another Swedish study reported 11.3 days for acute phase care and 27.9 days for ‘‘total hospitalisation”. [25]· French data for 2005–6 identified 16.2 days in acute phase care followed by 27.8 days in rehabilitation. [11] The Hospital Episodes Statistics (HES) for English NHS reports hospital “spells” of linked episodes under different consultants. These data describe LOS of 23.0 days for hip fracture in 2008–9, a value which appears to include inpatient rehabilitation, as such episodes are not separately reported in any numbers. Data for private hospitals were “mostly excluded” from this report. [8] A Japanese study reports LOS of 34 days and notes a marked contrast with the median of only 5 days reported from the United States. Hospital stay in Japan was inclusive of post-acute care, whereas the American data related purely to acute surgical treatment. [10] Scottish data from 2006 reported a mean of 25 days for total LOS, linking orthopaedic, rehabilitation and ‘other’ episodes, but this calculation excluded ‘‘at least a quarter’’ of patients who were still in hospital at 42 days. [26]

Recently reported in-hospital mortality rates are similarly diverse. In Australia the national data presented by AIHW for 2006–7 reports 6 per cent, [4] while a series from a Sydney teaching hospital shows 4.9 per cent for 2003–7. [5] The French Hospital National Data identifies deaths for only 2.8 per cent of patients aged 40+ years in 2008. [11] These figures all relate to data which describe unlinked episodes for acute treatment. Hospital mortality reported in the HES for the period 2006–8 was 13.7 per cent based upon linked episodes. [22]

The differences in profiles of hospital separations between unlinked and episode-linked datasets are substantial. Overall in-hospital mortality increased to 11.1 per cent from 6.5 per cent in unlinked data and the very high proportion of inter-hospital transfers in unlinked data is almost entirely replaced by discharges to “home” or residential aged care in fully linked results. The additional linkages with Aged Care data produced, in this elderly cohort, substantial revision of separation codes with transfers to Aged Care increasing from 20.0 to 37.8 per cent.

In an elderly and medically complex patient cohort, extra days in hospital are associated with additional untoward outcomes. Quoted rates for hospital mortality and other outcomes for hip fracture may be more dependent upon the definition of “separation from hospital” than upon standards of practice within a given hospital system.

Conclusion

A process of patient-based episode linkage to identify the total hospital stay and definitive outcomes in respect of hip fractures is presented. Two-thirds of the study population experienced transfer from acute phase episodes for ongoing admitted care., with 46 per cent of all patients referred for rehabilitation. Total LOS was 30.8 days, almost three times the value for unlinked data (11.1 days). Hospital costs were almost double the values identified in unlinked data. In-hospital mortality was shown to be higher by over 70 per cent, and transfer to RAC was four times more frequent than the values obtained from conventional reports based upon unlinked data. One in nine of these elderly patients did not survive hospital and more than 40 per cent of survivors were transferred to Aged Care facilities.

Conflicts of Interest: AWI is a contracted medical adviser to DVA but received no financial support for this study. Nil else declared.

Author Contribution Statement

AWI was responsible for creating the episode -based linked datasets out of the administrative databases supplied by DVA and for the study concept and design and for preparing the initial draft of the text. PJK provided statistical expertise and advice with tabulation and presentation of results. Both authors extensively reviewed the manuscript.

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Table V1-A. Length-of-stay (LOS) for patients with hip fracture 2008–09

	Dataset 1 Unlinked Episodes		Dataset 2 Linked acute episodes		Dataset 3 All Linked Episodes	
Age	**N**	**LOS[1]**	**N**	**LOS**	**N**	**LOS**
			Females			
< 75	27	10.0	20	11.9	20	24.3
75–79	115	10.2	89	13.0	89	27.0
80–84	523	10.6	415	12.8	415	33.1
85–89	812	10.9	644	13.5	644	32.0
≥ 90	506	11.5	424	13.0	424	28.2
TOTAL	1983	10.9	1592	13.1	1592	30.9
			Males			
< 75	34	9.3	28	11.4	28	23.7
75–79	25	10.3	21	12.3	21	25.2
80–84	242	10.7	191	13.5	191	31.2
85–89	595	12.0	470	14.7	470	32.5
≥ 90	298	11.1	250	12.9	250	27.5
TOTAL	1194	11.4	960	13.9	960	30.5
ALL	3177	11.1	2552	13.4	2552	30.8

1 Mean LOS in days

Table V1-B. Hospital Costs for patients with hip fracture 2008–09

	Dataset 1 Unlinked episodes		Dataset 2 Linked acute episodes		Dataset 3 All linked episodes	
Age	**N**	**$AUD**	**N**	**$AUD**	**N**	**$AUD**
			Females			
< 75	27	12354	20	13568	20	22521
75–79	115	12938	89	15698	89	25660
80–84	523	12916	415	14804	415	27045
85–89	812	12948	644	14826	644	26593
≥ 90	506	13411	424	14613	424	24303
TOTAL	1983	13049	1592	14797	1592	25998
			Males			
< 75	34	12237	28	14223	28	21018
75–79	25	12653	21	15545	21	22511
80–84	242	12287	191	13928	191	26037
85–89	595	13515	470	15446	470	27326
≥ 90	298	13362	250	15289	250	24581
TOTAL	1194	13174	960	15068	960	26065
ALL	3177	13095	2552	14899	2552	26023

Table V1-C. Summary of LOS and hospital costs for linked and unlinked datasets

Dataset	Females	(95 % CI)	Males	(95 % CI)	All	(95 % CI)
Mean Length of stay (days)						
Unlinked	10.9	10.5–11.4	11.4	10.7–12.0	11.1	10.7–11.5
Acute episodes[1]	13.1	12.6–13.7	13.8	13.1–14.6	13.4	12.9–13.8
Total episodes	30.9	29.6–32.2	30.5	28.9–32.2	30.8	29.8–31.8
Hospital costs ($AUD)						
Unlinked	13047	12687–13407	13174	12652–13696	13095	12797–13393
Acute episodes[1]	14797	14431–15163	15068	14424–15612	14899	14592–15206
Total episodes	25998	25195–26801	26085	24996–27134	26023	25381–26665

[1] Linked acute episodes, Dataset 2

Table V1-D. Distribution of separation codes: unlinked and linked data for patients with hip fracture 2008–09

Separation mode	Dataset 1 Unlinked	Dataset 2 acute episodes[1]	Dataset 3 All episodes	Dataset 4 Linked to RAC
Females	n=1983	n=1592	n=1592	n=1592
Transfer other hospital	46.2[2]	38.4	5.9	3.1
Transfer within hospital	6.9	7.0	1.4	1.2
Transfer to Aged Care	9.9	11.6	21.4	39.6
Death	4.3	5.3	7.7	7.6
Home discharge	23.2	26.5	59.5	45.0
Other	9.5	11.2	4.2	2.6
Males	N=1184	n=960	n=960	n=960
Transfer other hospital	39.2	29.6	4.1	2.1
Transfer within hospital	8.2	8.4	0.2	0.3
Transfer to Aged Care	8.8	10.5	17.8	34.8
Death	10.2	12.7	17.2	16.9
Home discharge	22.6	25.5	56.5	42.3
Other	11.0	13.3	4.3	3.7
All	n=3177	n=2552	n=2552	n=2552
Transfer other hospital	43.5	35.0	5.2	2.7
Transfer within hospital	7.4	7.6	0.9	0.9
Transfer to Aged Care	9.5	11.2	20.0	37.8
Death	6.5	8.1	11.2	11.1
Home discharge	23.0	26.1	58.4	44.0
Other	10.1	12.0	4.2	3.5

[1] Linked acute episodes, Dataset 2
[2] All values are percentages of total separations

Section V (2): Research Study No. 2

Total hospital stay for hip fracture: measuring the variations due to pre-fracture residence, rehabilitation, complications and comorbidities

Anthony W Ireland, Patrick J Kelly and Robert G Cumming

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http://www.biomedcentral.com/1472 – 6963/15/

Abstract

Background: Hospital treatment for hip fracture is complex, often involving sequential episodes for acute orthopaedics, rehabilitation and care of contingent conditions. Most reports of hospital length of stay (LOS) address only the acute phase of care. This study identifies the frequency and mean duration of the component episodes within total hospital stay, and measures the impacts of patient-level and clinical service variables upon both acute phase and total LOS.

Methods: Administrative datasets for 2552 subjects hospitalised between 1 July 2008 and 30 June 2009 were linked. Associations between LOS, pre-fracture accommodation status, age, sex, fracture type, hospital separation codes, selected comorbidities and complications were examined in regression models for acute phase and total LOS for patients from residential aged care (RAC) and from the community.

Results: Mean total LOS was 30.8 days, with 43 per cent attributable to acute fracture management, 37 per cent to rehabilitation and 20 per cent to management of contingent conditions. Community patients had unadjusted total LOS of 35.4 days compared with 18.8 days for RAC patients ($p < 0.001$). The proportion of transfers into rehabilitation (57 per cent vs 17 per cent, $p < 0.001$) was the major determinant for this difference. In multivariate analyses, new RAC placement, discharge to other facilities, and complications of pressure ulcer, urinary or surgical site infections increased LOS by at least four days in one or more phases of hospital stay.

Conclusion: Pre-fracture residence, selection for rehabilitation, discharge destination and specific complications are key determinants for acute phase and total LOS. Calculating the dimensions of specific determinants for LOS may identify potential efficiencies from targeted interventions such as orthogeriatric care models.

Keywords: hip fracture, length of stay, complications, residential aged care, rehabilitation

Introduction

The hospital treatment of hip fractures is a complex process involving multiple services [1,2]. Following initial assessment, acute phase treatment is usually surgical, sometimes in a different hospital. Definitive discharge from the acute unit to the patient's previous accommodation is the exception [2,3,4]. Transfer to another service for rehabilitation occurs in almost half of all cases [4,5] and transfers between hospital units for other reasons are not uncommon [4,6].

The traditional pattern of acute orthopaedic care followed by selective referral to rehabilitation or other aftercare is now frequently replaced by a variety of shared care models, with involvement of specialist geriatric and/or rehabilitation teams in the acute phase, or accelerated transit from the surgical ward to rehabilitation services [3,7,8]. Despite these developments, most reports of hospital stay for hip fracture describe only the acute surgical phase of treatment. This phase has a wide range of reported LOS from two days to more than two weeks [8,9]. In the few studies which report total LOS, mean values lie between 17 days and six weeks [3,9,10,11]. Total LOS for the current study has been previously reported at 30.8 days [4].

A wide variety of factors, including patient age [12], fracture type [3], preoperative delay [13] and specific comorbid conditions and complications[14] have been shown to impact the length of either acute phase or total LOS. However, the actual increase or decrease in LOS attributable to patient-level factors is rarely calculated, and then only for the acute phase of care [14].

The significance of residence in aged care institutions for risk factors and outcomes of hip fracture has been well described [15,16]. Less well documented is the impact of prior living status upon the duration and composition of hospital stay.

This study has two aims. First, to identify the proportion of total hospital stay due to acute phase treatment, rehabilitation and the management of contingent problems. Second, to identify and quantify the patient-related and clinical service factors associated acute phase and total LOS. For both aims, pre-fracture residential status is a major consideration.

Methods

Episode-based datasets were obtained from the Australian Department of Veterans' Affairs (DVA) for all veterans and war widows hospitalised for hip fracture (ICD-10-AM S72.0-S72.2) between 1 July 2008 and 30 June 2009. The Unique Identification Number (UIN) attached to every DVA record permitted linkage of continuous hospital episodes for individual patients, as well as linkage with RAC datasets and mortality records. Additional details of the data linkage process have been described previously. [4]

Subjects were identified as community-dwelling or as residents of RAC facilities at the time of fracture and hospital admission. In Australia, defined reductions in capacity for activities of daily living and/or cognitive functionality, are statutory criteria for admission to RAC facilities, which include nursing homes.[17]

Data Collection

Hospital episodes contributing to total LOS were classified into three components — acute, rehabilitation and "other". The acute phase included all episodes continuous with the index admission date with a primary diagnosis of hip fracture (ICD10-AM: S72.0-S72.2). The rehabilitation phase was the sum of all episodes coded (Z50.8-Z50.9) which were part of a continuous sequence of episodes following the index episode. The third component included all other episodes which were likewise in a continuous sequence following the index episode. These included care for comorbidities and complications or hospital time awaiting placement elsewhere. Every patient had an acute phase, but may or may not have had a rehabilitation or other phase.

The following variables were included in the dataset: pre-admission residential status (RAC or community), age, sex, fracture type, separation status (for each phase), clinical services (rehabilitation, intensive care, surgery), comorbidity and complications. Fracture type was classified as cervical (S72.01-72.04), trochanteric (S72.05, S72.10-72.11), subtrochanteric (S72.2) and 'other' (S72.00, S72.08). The dataset also included the comorbidities listed in the Charlson Index as modified for ICD-10-AM [18].This information was extracted from all hospital episodes in the study year, up to and including the episode(s) comprising total LOS for the index hip fracture. Complications of skin ulceration (L89, L97), delirium (F05), anaemia (D62, D64.9), and urinary (N39), lower respiratory (J13-J15, J18, J20-22) and surgical wound (T81.4, T84.5-7) infections were also identified, due to associations with either LOS or unwanted outcomes following hip fracture. [2,13,19] Complications were identified only from those episodes comprising total LOS for the index fracture.

Hospital separation Code 9 — "separation to usual residence" or "other" — was interpreted as transfer to RAC if the patient had been in such care immediately prior to the index hospital admission. If hospital discharge and subsequent RAC admission dates were continuous, then transfer was also assumed regardless of the separation code. Details of the level of care provided within RAC for a given patient were not consistently available and were not analysed.

Since patients admitted from RAC or similar forms of supported living have different hospital trajectories from those who admitted from the community, [12, 20, 21] data are tabulated and analysed separately for these two groups.

Statistical analyses

Student's t-test and Pearson's Chi-squared test were used to assess differences in groups for continuous and categorical outcomes respectively. Total LOS, acute phase, rehabilitation phase and other phase LOS were tabulated for both RAC and community patients. Negative binomial regression models were then used to identify variables which significantly altered the length of acute phase and total LOS. Variables entered the model if univariate $P < 0.25$ and, using backward elimination, remained in the final model if $P < 0.05$. For each variable in a final model, the average number of days greater or less than the baseline value (mean LOS when all predictor variables are zero or the referent group within a class variable) was calculated. All analyses were performed using SAS 9.3 (SAS Institute Inc; Cary, NC) or Excel 2010 (Microsoft Corporation, Redmond, WA).

Ethics approval was granted by the DVA Ethics Committee in December 2010.

Results

There were 2552 patients hospitalised for hip fracture between 1 July 2008 and 30 June 2009. Linkage with RAC databases identified 27.7 per cent of patients as aged care residents at the time of hospital admission. Table V2-A summarises the patient characteristics of the two sub-populations. There was a higher proportion of RAC patients aged 90 years or older (37 per cent vs 22 per cent, $p < 0.001$). The proportions of females, the distributions of fracture types and the proportions treated surgically were not significantly different. A greater proportion of community patients was admitted to Intensive Care (7.4 per cent vs 5.1 per cent, $p = 0.035$). Comorbidities and complications were similarly distributed apart from dementia (43.1 per cent vs 14.6 per cent, $p < 0.001$) and respiratory infection (12.3 per cent vs 9.1 per cent, $P=0.015$). The proportion of transfers to rehabilitation was more than three times greater among community patients (57 per cent vs 17 per cent, $p < 0.001$).

Components of LOS

For the total study population, 43 per cent of total LOS was attributable to acute fracture management, 37 per cent to rehabilitation and 20 per cent to other causes. Mean LOS values for the various components are shown in Table V2-B. There were 29012 hospital days for rehabilitation (1172 patients) and 15415 hospital days for "other" episodes (652 patients) out of the grand total of 78592 days.

The acute phase of care was significantly longer (14.1 days vs 11.6 days, $p <$ 0.001) for community patients than for RAC patients. Both the proportion of patients transferred to rehabilitation and the total time in rehabilitation phase (25.1 vs 21.3 days) were significantly higher for community patients. The resulting per capita contribution to total LOS was (1050* 25.1/1844) =14.3 days for community patients and (122*21.3/708) = 3.7 days for patients from RAC (data in Table V2-B).

Linked hospital episodes attributed to neither acute fracture care nor rehabilitation occurred in 652 patients (26 per cent) and again in a higher proportion of community patients (28 % vs 19 %, $p < 0.001$). Total stay in "other" episodes was also longer for community patients, especially among those not transferred to rehabilitation.

Factors which impact upon LOS

The factors which significantly affected the acute phase of hospital stay are shown in Table 3. The length of the acute phase was not significantly affected by patient age, sex or fracture type within either sub-group, but age had a minor effect in the combined population. For RAC patients the acute phase was substantially increased by surgical treatment, admission to intensive care and by complications of skin ulceration and infections, particularly in the fourteen patients with surgical site sepsis. No listed comorbid condition had any significant impact in this group.

For community patients, direct transfer to RAC extended the acute phase by six days. Cardiac failure, skin ulceration, respiratory and urinary infections were all associated with increases of at least 20 per cent of the baseline value, and diabetes, stroke and delirium by significant but lesser amounts. Community patients who died or were transferred to rehabilitation or other units had shorter acute phases (Table V2-C).

The baseline value of total LOS for RAC patients was more than doubled for patients who received rehabilitation and by separation to a hospital or other facility (Table V2-D). Intensive care admission, and surgical site sepsis were also associated with increases exceeding 50 per cent of baseline value while increases of 20 per cent or more were associated with surgery, skin ulceration and urinary infection. Neither sex, age, fracture type nor any specific comorbidity impacted total LOS for RAC patients.

Among community patients, those aged between 80 and 89 years had longer stay than both younger and older patients (Table V2-D). Patients with intracapsular fractures had shorter total stay than those with other injuries. The increase associated with rehabilitation was over 60 per cent of the baseline value. Discharge to RAC or to other facilities, Parkinsonism, skin ulceration and surgical site sepsis were all associated with increases of at least 30 per cent. Community patients who died had a shorter total LOS. In the complete sample patients with dementia had a small reduction in total LOS but this was not evident within either sub-population (Table V2-D).

There were 763 episodes for management of conditions not coded to hip fracture or rehabilitation (652 patients). Sex, age and fracture type were not substantial determinants of LOS in this category. Diabetes, chronic respiratory disease, Parkinson's disease, anaemia and "awaiting accommodation in another facility" (ICD10 -AM, Z751) were the most frequently identified reasons for episodes in this category (data not tabulated).

The impact of multiple LOS determinants is compound: a community patient aged 85 – 89 years, with subtrochanteric fracture, complications of leg ulcer and wound infection, transferred to rehabilitation and eventually discharged to RAC would have a calculated total LOS of 92 days.

Discussion

This study has employed data linkage to identify three key findings for hospital management of hip fracture. First, the majority of hospital days (57 per cent) occurred after the acute phase, as observed in other studies. [3, 13] Secondly, total LOS for patients admitted from RAC was approximately half that of those admitted from the community. Thirdly, referral to hospital-based rehabilitation effectively doubles the total LOS.

Factors impacting LOS

The value of assessing the complete hospital experience is evident in the differing profiles of determinant factors for LOS for acute phase and total stay. Age and fracture type do not influence acute LOS but are significant factors for total stay. Transfers to other treating facilities, including rehabilitation, facilitate separation from the acute phase but result in substantially longer total LOS. Parkinsonism, diabetes and anaemia have no significant impacts on acute stay but are associated with longer total LOS. The reverse situation is seen in respect of cardiac failure. These variations are mostly due to differing rates of transfer to rehabilitation, and hospital episodes due to "other" causes. Surgery prolonged the acute phase as in English data, [22] however a prolonged total stay was seen only among RAC patients.

The shorter stay for patients aged under 80 years reflected the findings of other studies,[23] but unlike Scottish findings, patients aged over 90 years did not stay longer than octogenarians.[12] Fewer transfers to rehabilitation among the oldest patients was again the probable reason. Additional post-acute days and longer total stay for patients with trochanteric and subtrochanteric, compared with intracapsular fractures, reflect data from the Finnish Health Care Register. [3]

It is customary in Australia for rehabilitation after hip fracture to involve transfer to a dedicated hospital unit or hospital, removed from the acute facility. [23] These transfers, while including some days of inappropriate acute care, [23] still resulted in reduced LOS in acute units, as do transfers to other facilities. Surgery prolonged the acute phase as in English data, [24] however a prolonged total stay was seen only among RAC patients. Admission into intensive care extended both acute phase and total LOS by more than 60 per cent for RAC patients but had no impact for community patients.

Of the selected comorbidities, cardiac failure and stroke in respect of acute phase and Parkinsonism and diabetes for total LOS were the only associations with substantially longer stay. The complications listed in Tables 3 and 4 were more potent in extending hospital time, particularly skin (pressure) ulceration and surgical site (wound) infections, both responsible for >30 per cent increase in acute and total LOS.

Both these conditions have been associated with considerable increases in LOS in other studies [25, 26] but not examined in comprehensive multivariate models. Systems of co-managed (orthogeriatric) care, [7] resourced to promptly recognise and manage comorbidity and complications have been shown to reduce acute phase LOS, costs and the incidence of unwanted outcomes. [7,8,20] In quantifying the impact of LOS determinants at specific phases of the hospital experience, this study gives dimensions to potential benefits in both costs and reduced morbidity through timely interventions.

Pre-fracture residence

Residential status prior to hip fracture is variously defined and variably reported. [13,20,21] Some studies exclusively address RAC patients, [27] others exclude them [23,28] and many do not identify pre-fracture residence.[10,24] The findings of this study suggest that knowledge of pre-fracture residential status is vital to the understanding of the hospital trajectory for hip fracture. While other studies have previously noted a comparatively short LOS for RAC patients in the acute phase [13, 20, 29) and similarly for "total institutional days", [13, 27] LOS in all phases of hospital stay were shorter for these patients in this study.

The difference in the acute phase was greatest (11.7 to 17.0 days, p <0.001) for patients who did not transfer to rehabilitation. Immediate access to post-hospital accommodation for RAC patients was the probable reason. [28] Hospital episodes for "other" reasons (comorbidities or complications) were fewer and shorter for RAC patients. Most of the difference in total LOS between RAC and community patients was attributable to the greater than threefold difference in rates of hospital-based rehabilitation. This large difference parallels findings from the Scottish Hip Fracture Audit. [29]

The linkage of hospital and RAC datasets is regarded as vital to the accurate interpretation of separation codes and hence LOS data for hip fracture patients. In this study 14.4 per cent of all discharges were re-classified as transfers to RAC after examining linked data [4]. RAC patients returning to institutional care have low hospital stay [29] whereas community patients requiring new RAC placements have shown significantly longer stays than those who return to non-institutional living. Lower LOS values for patients with dementia in a large Australian study [30] possibly reflect the high proportion of institutional patients in the dementia group, who do not transfer to rehabilitation but have expedited discharges back to RAC.

Strengths and weaknesses

Administrative databases have intrinsic strengths and weaknesses for studies of this nature. Large patient numbers and a comprehensive list of data items are major assets. Current levels of coding and transcription errors are now regarded as acceptable for meaningful analyses of diagnostic and procedural data, with reported accuracy rates as high as 96 per cent. [31] The evidence of this study suggests that separation codes in Australian hospital databases require further scrutiny. [4] The linkage facility of DVA records enabled measurement of total LOS, a wide search field for comorbidities, accurate matching of RAC status with fracture events and alignment of specific variables with components of LOS.

The principal disadvantages include the lack of information regarding disease severity, pre-fracture functional status and preoperative waiting time. Australian admission criteria make pre-fracture RAC residency at least a partial surrogate for poor functionality [17] and pre-operative delay is partly due to medical complexity [32] as reflected in comorbidity profiles.

The mean age of hip fracture patients in this study was up to 6 years greater than elsewhere reported. [3,10,24] The proportion of males was 37.6 per cent, compared with 25- 30 per cent in other population-based studies. [3,10,30] These differences were reflected in a higher proportion of patients from RAC than reported from a large Scottish sample (27.7 per cent vs 21.3 per cent). [29] DVA patients did not appear to use hospital services differently from other Australians of comparable age. [4] The distribution of fracture type was unremarkable [3, 5] after 380 “unspecified or unknown” fractures (S72.00, S72.08) were proportionally reclassified.

With respect to comorbidities, this study identified higher rates for diabetes, cardiac and respiratory conditions than those drawn from the English Hospital Episode Statistics. [24]

A large database study from New South Wales, Australia found dementia in 35.9

per cent of hip fracture patients aged ≥ 85 years. [30] In this study the comparable prevalence was 31.8 per cent (*p* =0.03*)*, based upon less extensive data surveillance. We acknowledge that there were substantial levels of false negatives for some other key diagnoses. Targeted studies of clinical records reported delirium in between 29 and 50 per cent of hip fracture patients [33,34] and pressure ulcers in more than one third [35], both approximately three times the rates found in this study. However, comorbidity capture from linked episode data is substantially superior to that derived from acute episodes alone. [36]

It is also recognised that the characteristics of individual hospitals or groupings of hospitals may contribute to differences in LOS. In this study 476 different treating hospitals were identified by code, but no information as to hospital characteristics was provided. More than half of all patients were treated in more than one hospital, with nine per cent treated in three or more hospitals. Identifying hospital-level determinants for LOS was therefore not attempted.

Conclusion

Hip fracture patients admitted from residential care or from the community have widely different component and total LOS, for which the threefold difference in rates of transfer to rehabilitation is the major determinant. New transfer to RAC, other inter-facility transfers, Parkinsonism, pressure ulcers, and urinary and wound infections all increased LOS by at least 4 days or 25 per cent of baseline values at some phase of the hospital stay. Multiple factors associated with increased LOS had an exponential effect. These data give dimensions to potential resource efficiencies and reduced patient morbidities through targeted intervention, and emphasise the importance of specialist medical care during the acute surgical management of hip fracture patients. The additional insights provided by data linkage in studies of complex conditions are also evident.

Authors' contributions

AWI: Study concept and design, data linkage, descriptive and statistical analyses, literature search, report writing. PJK: Study design, data quality review, statistical analyses, report writing and editing. RGC: Data selection, report writing, review and editing. All authors reviewed the final version of this paper. The views expressed in this article are those of the authors, and do not necessarily represent those of the Australian Department of Veterans' Affairs

Competing interests: AWI is a contracted advisor to DVA, but received no financial support for this study. The authors declare no other competing interests

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Table V2-A. Characteristics of study cohort by pre-fracture residential status

	Community patients (N=1844)		RAC patients (N=708)		All patients (N=2552)	
	N	%	N	%	N	%
Females	1148	62.3	444	62.7	1592	62.4
Age group						
< 80	138	7.5	20	2.8	158	6.2
80–84	465	25.2	141	19.9	606	23.7
85–89	832	45.1	282	39.8	1114	43.7
90 +	409	22.2	265	37.4	674	26.8
Fracture type						
Cervical	712	38.6	269	38.0	981	38.4
Trochanteric	781	42.4	300	42.4	1081	42.4
Subtrochanteric	86	4.7	24	3.4	110	4.3
Other, unspecified	265	14.4	115	16.2	380	14.9
Rehabilitation	1050	56.9	122	17.2	1172	45.9
Surgical treatment	1543	83.7	611	86.3	2154	84.2
Intensive care	137	7.4	36	5.1	173	6.8
Comorbidities						
Dementia	269	14.6	305	43.1	574	22.5
Renal failure	253	13.7	96	13.6	349	13.7
Cardiac failure	231	12.5	104	14.7	335	13.1
Cardiac ischaemia	191	10.4	70	9.9	261	10.2
Diabetes	178	9.7	69	9.7	247	9.7
Respiratory disease	156	8.5	60	8.5	216	8.5
Stroke	108	5.9	53	7.5	161	6.3
Malignancy	131	7.1	30	4.2	161	6.3
Parkinson's Disease	48	2.6	26	3.7	74	2.9
Complications						
Urinary infection	315	17.1	119	16.8	434	17.0
Skin ulceration	268	14.5	99	14.0	367	14.4
Anaemia	253	13.7	113	16.0	366	14.3
Chest infection	167	9.1	87	12.3	254	10.0
Delirium	166	9.0	80	11.3	246	9.6
Wound infection	49	2.7	14	2.0	63	2.5
Separation status						
Private dwelling	1106	60.0	14	2.0	1120	44.7
RAC	391	21.2	575	81.2	966	37.1
Hospital, other	71	9.3	12	1.7	183	7.0
Death	176	9.5	107	15.1	283	11.2

Table V2-B. Unadjusted mean values for components of total LOS for hip fracture. The impact of pre-fracture residential status and referral to rehabilitation

Phase	Community patients N	Community patients Mean LOS (days)	RAC Patients N	RAC Patients Mean LOS (days)	All patients N	All patients Mean LOS (days)
All admissions						
Acute	1844	14.1	708	11.6	2552	13.4
Rehabilitation	1050	25.1[1]	122	21.3	1172	24.8
Other	519	24.9[1]	133	18.6	652	23.6
Combined phases	1844	35.4[1]	708	18.8	2552	30.8
Admissions which include rehabilitation						
Acute	1050	11.8	122	10.9	1172	11.7
Rehabilitation	1050	25.1	122	21.3	172	24.8
Other	272	20.8	37	16.3	309	20.2
Combined phases	1050	42.3	122	37.2	1172	41.7
Admissions without rehabilitation						
Acute	794	17.0	586	11.8	1380	14.8
Other	247	29.5	96	19.4	343	26.7
Combined phases	794	26.2	586	14.9	380	21.4

1 Mean LOS for combined phases (total LOS) = weighted average from each component. For community patients =
((1844 × 14.1) + (1050 × 25.1) + (519 × 24.9)) ÷ 1844 = 35.4 days

Table V2-C. Factors associated with acute phase LOS after hip fracture

	Community patients N=1844			Patients from RAC N=708		
	Added days[1]	95 % CI	*P*	Added days	95 % CI	*P*
Baseline LOS[2]		12.4			7.3	
Sex	0.9	(0.1–1.8)	0.029		-	-
Separation mode			<0.001			-
Usual residence		referent			-	-
New RAC transfer	6.0	(3.6–8.7)				
Rehabilitation	-3.2	(-3.9, -2.5)				
Other transfer	-1.2	(-2.4, 0.0)				
Death	-2.0	(-3.3, -0.4)			-	
Surgery	1.3	(0.1–2.5)	0.027	3.0	(1.6–4.6)	<0.001
Intensive care		-	-	4.6.	(2.3–7.5)	<0.001
Comorbidities						
Cardiac failure	2.8	(1.5–4.3)	<0.001		-	-
Diabetes	1.8	(0.4–3.4)	0.009		-	-
Stroke	2.4	(0.6–4.5)	0.006		-	-
Complications						
Delirium	2.2	(0.6–40)	0.006		-	-
Pressure ulcer	5.4	(34–7.5)	<0.001	3.2	(1.4–5.3)	<0.001
Chest infection	3.1	(1.2–5.3)	0.001	1.9	(0.6–3.5)	0.003
Urinary infection	2.9	(1.4–4.4)	<0.001	2.8	(1.5–4.4)	<0.001
Wound infection	-	-	-	12.3	(6.0–21.7)	<0.001

1 Mean addition to baseline value
2 LOS for female <80 years: cervical fracture, no surgery, rehabilitation, intensive care, comorbidity or complications; separated to usual residence

Table V2-D. Factors associated with LOS for total hospital stay after hip fracture

	Community patients N=1844			Patients from RAC N=708		
	Added days[1]	**95 % CI**	***P***	**Added days**	**95 % CI**	***P***
Baseline LOS[2]		14.8			10.2	
Age-group			0.001		-	
<80		referent			-	
80–84	3.5	(1.4–5.9)			-	
85–89	3.6	(1.6–5.8)			-	
90 +	2.1	(0.1–4.3)				–
Fracture type			<0.001		-	
Cervical		referent			-	
Unspecified	4.3	(2.7–6.1)			-	
Subtrochanteric	3.1	(0.7–5.8)			-	
Trochanteric	2.0	(0.9–3.1)				<0.001
Separation mode			<0.001			
Usual residence		referent			referent	
Other transfer	4.7	(2.8–6.9)		18.3	(8.8–32.7)	
New RAC transfer	5.1	(3.7–6.7)		N/A	N/A	
Death	-2.7	(-4.0, -1.3)		-0.5	(-1.9, 1.1)	<0.001
Rehabilitation	9.9	(8.4–11.4)	<0.001	13.9	(10.8–17.4)	0.009
Surgery	–	–		2.4	(0.6–4.5)	<0.001
Intensive care	–	–		7.9	(4.1–12.7)	
Comorbidities						
Parkinson's disease	5.7	(2.3–9.7)	<0.001		–	
Diabetes	2.5	(0.9–4.3)	0.002		–	
Dementia	1.7	(0.0–3.5)	0.04		–	
Complications		–				
Pressure ulcer	5.6	(4.0–7.4)		3.7	(1.7–5.9)	<0.001
Wound infection	4.9	(1.7–8.8)	<0.001	5.9	(0.9–13.0)	0.010
Urinary infection	2.8	(1.5–4.3)	0.001	4.2	(2.4–6.4)	<0.001
Delirium	1.9	(0.4–3.7)	<0.001	1.9	(0.1–4.1)	0.04
Chest infection	2.7	(1.0–4.5)	0.02	–	–	

1 Mean addition to baseline value 2 LOS for female <80 years :cervical fracture, no surgery, rehabilitation, intensive care, comorbidity, complications; separated usual.

V (3): Research Study no. 3

Risk factor profiles for early and delayed mortality after hip fracture: Analyses of linked Australian Department of Veterans' Affairs databases

Ireland A W, Kelly P J, Cumming R G

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Abstract

Background and Aims

One-year mortality after hip fracture may exceed 30 per cent with a very large number of reported risk factors. Determinants of mortality beyond one year are rarely described. This study employs multiple data linkages to examine mortality rates, risk factor profiles and age-specific excess mortality at intervals from 30 days to four years.

Method

Retrospective cohort study of linked administrative datasets describing hospital episodes, residential aged care (RAC) admissions and date of death for 2552 Australian veterans and war widows hospitalised for hip fracture in 2008–09. Associations between time to death and patient age, sex, pre-fracture accommodation, fracture type, treatment options, selected comorbidities and complications were tested in Cox proportional hazards models.

Results

In a population with mean age of 86.6 years (range 54–100 years), overall death rate was 11 % at 30 days, 34 % at one year, 47 % at two years and 67 % after four years. For males hospitalised from RAC one-year mortality was 72 %, contrasting with 19 % for females from the community. Cancer, cardiac failure, cerebrovascular and renal disease were each associated with increased mortality risk of 20–60 %t at one year. Above-expected age-specific mortality was sustained for four years except for males ≥ 90 years.

Conclusion

Pre-fracture RAC residence was the strongest determinant factor for mortality. Patients selected for rehabilitation had lower mortality rates. The profiles of explanatory variables for death altered with increasing time from the index fracture event.

Keywords

Hip fracture, mortality, residential aged care, comorbidity, comparative mortality

Introduction

An increased mortality rate following hip fracture is beyond dispute. [1.2] There is however a wide variation in reported mortality rates at 30 days, one-year and subsequently. International population based studies report one-year mortality rates between 22 and 31 %, [3–6] and higher in some smaller series.[7] Identified risk factors for mortality are numerous, but the selection and definition of determinant variables are both inconsistent.[8]

Study datasets are derived from sources as diverse as single hospitals, meta-analyses and national databases covering multiple years. [2, 9, 10] Exclusion criteria, such as minimum age, coincident injuries, pathological fractures, pre-fracture residential status or non-surgical management are variably defined and inconsistently applied. [11–14] Mean age of subjects ranges from 80 to 87 years. [11, 15] Studies which identify pre-fracture residence consistently show higher mortality in patients from supported living or "nursing homes". [12–14, 16] Differences in classification of residential aged care facilities present difficulties for comparing studies.[17] Mortality rate after hip fracture relative to expected population death rates is highest in the early months after injury, but may persist for at least 10 years. [2] The excess of deaths diminishes with time, more quickly for men than for women, and for older survivors. [2, 6]

This study describes the mortality of a cohort of elderly hip fracture patients over periods of up to four years. In addition to the conventional risk factors of age, sex, fracture type and comorbid diagnoses, the impacts of pre-fracture residential aged care status and selection for surgery, intensive care and rehabilitation during the index hospitalisation are also examined. To our knowledge this is the first Australian study to report and analyse determinants of hip fracture mortality in a substantial national cohort which identifies a large sample of aged care residents.

Methods

The Australian Department of Veterans' Affairs (DVA) maintains patient-specific records of all health services funded for its clients. All records carry the unique identifying number of the client, which facilitates linkage of datasets. The DVA Treatment Population (TPOP) comprises all clients who have received health-related service during the year in question. For this study, datasets for public and private hospital episodes, residential aged care (RAC) admissions, and date of death were obtained for all TPOP members who were hospitalised for hip fracture (ICD-10-AM S72.0-S72.2 inclusive) between 1 July 2008 and 30 June 2009 (the index hospitalisation). Hospital episode records for each patient were first concatenated to identify the total continuous hospital stay for the index hip fracture. Second and subsequent hospital admissions for hip fracture within the study year were excluded from analyses. Pre-fracture RAC residence was identified by matching or overlapping dates of discharge from RAC and hospital admission. Patients who were not admitted directly from RAC were thereafter described as “community patients”. Time to death was counted from the admission date for the index fracture. Further details of the linkage processes are described in a previous publication. [18]

The following variables were included in the dataset: age, sex, fracture type, hospital separation status, surgery, intensive care and rehabilitation episodes, comorbidities and complications. ICD-10-AM codes in the hospital datasets were used to identify fracture type, surgical procedures, rehabilitation episodes, comorbidities and complications. Intensive care was identified by a service item descriptor. All coding items are listed within Table 1. Surgical codes were accepted if they were accompanied by one of the codes for hip fracture. Rehabilitation codes were accepted whether treatment required transfer to another hospital or phase change within the same hospital. Codes for fracture type, procedures, rehabilitation, intensive care and complications were accepted for analysis if they appeared within the episode string for the index admission. Comorbid conditions from the 1999 revision of the Charlson Index [19, 20] were identified from primary or secondary diagnoses for all hospital episodes in the study year, up to and including the episode string of the index admission.

Fracture type was classified as cervical, trochanteric, subtrochanteric and ‘other’. Surgical procedures were grouped as internal fixation, hemiarthroplasty, total hip replacement and ‘other” Comorbidities with significant impacts on mortality included dementia, renal failure, cardiac failure, ischaemic heart, chronic respiratory and cerebrovascular diseases, diabetes and malignancy. Complications were skin ulceration, delirium, post-haemorrhagic or unspecified anaemia, plus urinary, lower respiratory and surgical site infections (Table V3- 1)

Mortality risk was classified into four groups according to the combined effects of age, sex, and prior RAC residence. Males aged ≥ 85 years from RAC were assigned the highest risk and females aged < 85 years were the lowest risk group.

Statistical analyses

Univariate analyses of study variables were assessed with Kaplan-Meyer survival curves and log-rank testing. Cox Proportional Hazards models were then constructed for qualifying variables. Sex and age-groups were retained in all multivariate models regardless of their significance. Other variables entered a given model if univariate $P < 0.25$ and remained in the final model if $P < 0.05$.

Comparative mortality was calculated by comparing, for males and females, the mortality of the aggregated DVA TPOP July 2009 to 30 June 2012 inclusive (reference population) with age-standardised mortality rates of the study population in each of four years following fracture. Patients aged < 70 years were excluded because of small numbers and inconsistent age ranges in this group. Data for annual deaths within the reference population were provided by DVA. [21]

Comparisons of mortality rate (MR) between this and other studies necessitated accounting for demographic differences. After adjusting male: female proportions to the DVA profile, known sex-specific rates were applied to the new sub-populations. If these rates were not given a conservative estimate that male MR =1.5 female MR was used. [22, 23, 24] The resulting number of total deaths was then uplifted by 1.05 [22,24] compounding for every year by which the DVA mean age exceeded that of the comparison population. All analyses were performed using SAS 9.3 (SAS Institute Inc; Cary, NC) or Excel 2010 (Microsoft Corporation, Redmond, WA).

Ethics approval was granted by the DVA Human Research Ethics Committee in December 2010 and renewed in December 2013 (Reference E010/030).

Results

The study population was 2552 DVA clients of whom 960 (37.6 %) were males. Mean age was 86.6 (Range 54–100 years) with 1788 patients (70.1%) being 85 years or older (Table V3-A). Multiple comorbidities were identified for 591 patients (23%) with 44% having none of the listed conditions. Multiple complications were found in 6 % of patients with 72 % having no recorded complication. There were 708 patients admitted from RAC (27.7%) and these were slightly older than community patients (88.1 years vs. 86.0 years (P<0.001), but with the same proportion of males.

Mortality rates at four time intervals up to two years are shown in Table V3-B. At 30 days after the index admission date 285 patients (11 %) had died, 222 of these without leaving hospital. By the end of one year 864 patients (34%) had died. Barely half of all patients (53%) survived to the end of the second year and only one-third were alive after four years. At all listed time points the mortality rate for males was significantly higher (P<0.001). Younger patients had lower rates throughout (Table V3-B) with this trend being more defined for males. At one year, 10 of 49 males (20 %) aged < 80 years had died compared to 52 per cent of 250 males aged 90 years or older (P <0.001).The corresponding rates for females were 24% and 36% (P <0.001).

Determinant factors for mortality

The spectrum of significant factors for mortality varied across time (Table V3-C). In the first 30 days, male sex, older age and admission into intensive care were all associated with approximately twice the baseline mortality risk, and patients from RAC had a 50 per cent greater risk of dying. Patients selected for surgical treatment were much less likely to die in the first 30 days: only 11 of 1172 patients selected for rehabilitation died between the 10th and 30th day after admission. Cardiac failure, non-AMI ischaemic heart disease and renal disease all increased mortality risk by approximately 50 per cent and a diagnosis of urinary infection had apparent survival value.

Between 30 days and one year, the hazard ratios for sex and age were smaller but the decline was not significant. Pre-fracture residence in RAC was the strongest determinant of mortality risk across this period (Table V3-C and Figure V3A). Admission into intensive care, comorbid cardiac failure and renal disease continued to impart a higher risk as earlier. Patients with cerebrovascular disease, cancer and pressure ulcers prior to or at the time of hip fracture had increased risk of death between 30 days and one year after fracture.

Direct transfer of community patients from hospital to RAC (new RAC transfer) was associated with higher mortality after 30 days (Table V3-3). At 90 days, 36 of 391 such patients (9.2%) had died and at the end of one year 26.1 % had died. Corresponding values for patients discharged elsewhere were 2.7 % ($P < 0.001$) and 12.1% ($P < 0.001$).

In the second year following hip fracture, 335 patients died (20% of 12-month survivors). Males were 40 % more likely to die, and risk for those aged 90 years or older was nearly three times that for persons younger than 80 years. Patients from RAC were more than three times more likely to die. Diabetes with complications, cardiac failure, cancer and dementia were, in descending order, associated with increased mortality, the latter having borderline significance (Table V3-3).

The higher mortality for RAC patients is illustrated in Figure V3A, which shows survival curves for four identified risk groups. Females from the community had one-year mortality of 19% while 72% of males from RAC had died. The addition of extra variables for age and comorbidity further widened this disparity. Of 216 community females aged 85 years or older with no comorbidities, 21 (10 %) were dead at one year, compared with 65 of 73 (89 %) RAC males aged 85 years or older with two or more comorbidities.

Correlation between age-group and RAC status in this atypical cohort was low (Pearson coefficient=0.13) and insertion of an interaction variable for age group and RAC into the regression model did not alter the results displayed in Table V3-3. RAC patients had higher mean comorbidity scores than community patients (1.11 vs 0.82, $P<0.001$) and a higher proportion of patients with multiple comorbidities (29 per cent vs 21 per cent, $P<0.001$).

Time-related differences in impacts upon mortality are illustrated in Figure V3B 2 in respect of sex, surgical treatment, transfer to intensive care and RAC patients in two time periods (before 30 days and 30 days to one year). Patients treated surgically had no detectable survival advantage after 30 days in this population and increased mortality for patients treated in intensive care not apparent after six months.

Table 4 shows the mortality rates for males and females standardised against the DVA treatment population for each of four years following fracture. Comparison rates are higher for all four years, being substantially higher in year 1, then essentially stable. Males and females have similar ratios. Higher than expected mortality was seen for all age groups except for males mortality was sustained into the fourth year after fracture for all patients except for males aged 90 years or older in year 4.

Discussion

The mortality rates at 30 days, 90 days and one year in this study were 11%, 20% and 34% respectively. These are higher rates than reported in most other Australian and international studies, [6,11,24,25] but demographic factors probably account for much of the differences. When adjusted to the age-sex distribution of other Australian studies [22,25,26] the calculated one year mortality rate for the study population was 29.3 per cent. The factors which determine mortality rates following hip fracture are numerous and diverse: only the major elements from this study are discussed.

Patient demographics

Comparisons between mortality rates in different studies should be drawn with care. Adjustment for differences in age and sex distributions, as defined for this study, can substantially alter crude rates. The Bureau of Health Information in New South Wales reported 30-day mortality of 6.9 % for public hospital patients with surgical treatment for hip fracture .[26] Mean age was 82.9 years, with 72.4 % females. Adjustments for age and sex resulted in a mortality rate of 8.6 %, comparable with 9.3 % for surgical patients in the present study (P=0.35). A tertiary hospital in Newcastle NSW, reported a series with mean age of 83.5 years and 73.7% females.[22] The reported 30-day mortality of 8.2 % equated to 10.3 % after adjustment to the DVA demographics.

Register-based studies of large Danish, Swedish and Finnish cohorts with similar demographics (mean ages 80.7–81.4 years and females 72–74%) reported one-year mortality rates of 29.3%, 23.9% and 27.0% respectively. The one-year mortality for the present study would not exceed 26 per cent with these demographic profiles, assuming equivalence of other risk factors. It is noted for example that patients admitted from RAC were excluded from the Finnish study, while not specifically identified in the others. [3,4,24].

Residential aged care

Admission from RAC was the most important single determinant of mortality in this study. Other reports have confirmed this, although not in comprehensive multivariate analyses. An orthogeriatric service in Norway reported one-year mortality of 46% (61%) for 137 patients admitted from nursing homes compared with 14 per cent for the remaining 430 patients. [15] A Dutch study, in which patients from RAC were older by 5 years, found 45 % and 17% respectively [12] An Australian hospital study of 666 hip fracture patients admitted between 2003–06 found one-year mortality of 40% in patients from RAC with an age-adjusted relative risk of 1.8 (95% CI 1.4–2.4): other potential risk factors were not identified. [16]. Adjusted HR values for RAC patients of 1.6 at 30 days and 3.2 at one year, in separate studies [5,15] very closely matched the values in our study. It is additionally noted that, hip fracture increases mortality risk even within a cohort of exclusively frail, institutionalised persons.[27]

The higher mortality risk of RAC patients in the context of hip fracture is only partially explained by the data of this study. RAC residents in the atypical cohort of this study were significantly older, though by only two years and comorbidity was significantly higher. Three times more RAC patients have diagnosed dementia in these data, but as discussed below this has marginal additional impact on mortality in this study. RAC patients have shorter hospital stay, much lower rates of transfer for hospital-based rehabilitation and hospital survivors are discharged almost exclusively back to RAC.[28] Details of physical functionality were not available but it is noted that the Australian criteria for RAC admission equate with substantial functional and/or cognitive incapacities. [29]

Comorbidity

This study elected to describe the effect of individual comorbid conditions on the assumption that clinicians are more likely to identify and respond to a medical diagnosis than (even a validated) calculated index. Eight of the twelve diagnoses identified in the 1999 modification of the Charlson Index [20]were associated with increased mortality for this study population at some time period. Cardiac failure, cancer and renal impairment were most consistently associated.

Comorbidities in hip fracture patients may be identified from coded administrative databases, by physician assessment, or from searches within clinical records or, [5,14,16] with resulting wide differences in detection rates. The reported prevalence of cardiac failure ranges from 3.7% to 17%, [5,30] while some studies conceal this diagnosis within 'cardiovascular disease' [7,14] or omit it . [30,31]. Of the nineteen referenced studies which identify comorbidity, only three examine all eight of the diagnoses listed in this study [4,24,29] while others use Charlson scores only. [15,23,32]

Coincident dementia is reported in rates ranging from 12.3 to 28.8 per cent and is cited as contributing to increased 30-day or longer-term mortality.[10,22,32] Our study found that dementia, though much more frequent in RAC patients, was not an independent risk factor across the first year when pre-fracture RAC residence or new RAC transfers were identified in multivariate models. In the second year a marginal association between dementia and mortality was identified (Table 3).

Such inconsistencies in study design compromise the value of comparisons between studies and meta-analyses in particular [8] The improving levels of compliance with data reporting in the National Hip Fracture Database in the UK [34] — and the consequent improvements in outcomes — suggest that standardisation of data collection and analytical protocols may be both practical and beneficial. At least two algorithms for differentiating risk status for hip fracture mortality have been validated. [5,33] These are based upon data items which are readily available in the clinical setting.

Comparative mortality

An extensive meta-analysis [2] showed that mortality risk was as high as eight times that of control populations in the first three months after injury and remained above threefold in the second year. Thereafter rates declined slowly but remained significant at 10 years. Males had higher relative mortality than females. Several studies reported in a 2008 review confirm that this higher mortality diminishes in older patients.[8] Although age-standardised death rates in this study tended to be higher for men for at least four years, we could not confirm that the degree of excess mortality was greater for men.

Strengths and weaknesses

This study benefited from the capacity to link different administrative datasets, in particular the matching of RAC occupancy with dates of hospital admission and discharge. An extensive list of comorbidities and clinical process options was available in coded formats. The accuracy of Australian diagnostic coding in such datasets is accepted as sufficient to support valid analyses of this nature. [35,36]

Prevalence of individual comorbidites and complications did not match the detection rates obtained from personal medical files in some studies [15]but generally exceeded those reported from an Australian tertiary hospital. [29] Other studies based on administrative databases found lower rates for key comorbidities in most instances. [5,7,10] Information on disease severity and pre-fracture functional status was not available to further inform risk status our study. While pre-and post-fracture RAC occupancy was accurately identified from our data, the exact residential status of community patients was not available. The clear statistical separation of results for these two residential groups would, if anything, have been enhanced if community patients included some with less than ideal health and physical capacity.

This higher age distribution and greater proportion of males in this study has been recognised by reporting relevant values by age and sex and by adjusting global mortality rates for age and sex.

Conclusion

Pre-fracture residential status is the strongest single determinant of mortality after hip fracture: patients from RAC have three times the one-year mortality rate of those previously living elsewhere in multivariate models. Male sex, increasing age, new transfer to RAC and comorbid cardiac failure, cancer, respiratory and renal disease are all associated with increased mortality at one and two years, while patients selected for rehabilitation have lower rates. The use of data items routinely available during initial hospital care can be combined to clearly define high and low risk for subsequent mortality.

Knowledge of pre-fracture residential status is vital to the interpretation of mortality rates following hip fracture. Acceptance of a common protocol for measuring mortality risk would greatly enhance the value of studies which describe outcomes for this complex population.

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Table V3-A. Definition and distribution of study variables

Item	ICD-10-AM Coding	N	Per cent
Females		1592	62.4
Age Group			
< 80		158	6.2
80–84		606	23.7
85–89		1114	43.7
≥ 90		674	26.4
Admitted from RAC		708	27.7
Fracture type			
Cervical	S720.1-S720.4	981	38.4
Trochanteric	S720.5, S721.0, S721.1	1081	42.4
Subtrochanteric	S722	110	4.3
Other, unspecified	S720.0, S720.8	380	14.9
Rehabilitation	Z50.8, Z50.9	1172	45.9
Intensive Care		173	6.8
Surgery		2213	86.8
Internal fixation	47519	981	38.4
Hemiarthroplasty	47522	1081	42.4
Primary hip replacement	49315, 49318	110	4.3
Other	47528, 49324, 49333, 49342	380	14.9
Comorbidities			
Dementia	F01-F03, F05.1, G30.9	574	22.5
Renal failure	N18, N19	349	13.7
Cardiac failure	I50	335	13.1
Cardiac ischaemia	I20-I25	261	10.2
Diabetes	E10–E14	247	9.7
Respiratory disease	J40 -J47	216	8.5
Cerebrovascular disease	I60–I69	161	6.3
Malignancy	C00–C99	161	6.3
Complications			
Urinary tract infection	N39	434	17.0
Pressure Ulcer	L89, L97	367	14.4
Anaemia	D62, D64.9	366	14.3
Respiratory infection	J13, J15-J18, J20-J22	254	10.0
Delirium	F05	246	9.6
Surgical site infection	T81.4, T84.5, T84.7	63	2.5

Table V3-B. Mortality rates following hip fracture: by sex and age groups at time intervals to two years

Age group	N	30 days (%)	90 days (%)	One year (%)	Two years (%)
Males					
< 85	240	28 (12)	44 (18)	74 (31)	103 (43)
≥ 85	720	140 (19)	217 (30)	330 (46)	426 (59)
All males	960	168 (18)	261 (27)	404 (42)	529 (55)
Females					
< 85	524	27 (5)	57 (11)	123 (23)	174 (33)
≥ 85	1068	90 (8)	187 (18)	337 (32)	493 (46)
All females	1592	117 (7)	244 (15)	460 (29)	667 (42)
All patients	2552	285 (11)	505 (20)	864 (34)	1196 (47)

Table V3-C. Determinants of mortality: time intervals to 2 years following hip fracture

	< 30 days		30–365 days		365–729 days	
	HR[1] (95% CI)	P	HR (95% CI)	P	HR (95% CI)	P
Male sex	1.9 (1.5–2.4)	<0.001	1.3 (1.1–1.6)	0.001	1.4 (1.1–1.7)	0.006
Age-group		0.002		0.007		0.004
< 80	referent		referent		referent	
80–84	2.1 (0.9–4.9)		0.9 (0.6–1.3)		2.0 (1.0–3.9)	
85–89	2.4 (1.0–5.4)		1.0 (0.7–1.5)		2.3 (1.2–4.5)	
≥ 90	3.4 (1.5–7.7)		1.3 (0.9–1.9)		2.9 (1.5–5.8)	
RAC[2]	1.5 (1.2–1.9)	0.001	3.4 (2.8–4.2)	<0.001	3.3 (2.5–4.4)	<0.001
New RAC transfer[3]	0.4 (0.2–0.8)	0.007	1.5 (1.2–1.9)	0.002	1.6 (1.2–2.2)	0.002
Rehabilitation	0.1 (0.0–1.0)	<0.001	0.6 (0.5–07)	<0.001	0.7 (0.5–0.9)	0.001
Surgery	0.4 (0.3–0.5)	<0.001				
Intensive care	1.9 (1.3–2.7)	<0.001	1.6 (1.2–2.1)	0.002		
Comorbidities						
Cancer			1.4 (1.2–1.6)	<0.001	1.5 (1.2 -1.8)	<0.001
Cardiac failure	1.6 (1.2–2.1)	0.003	1.6 (1.3–2.0)	<0.001	1.8 (1.3–2.4)	<0.001
Ischaemic HD	1.5 (1.1–2.1)	0.017				
Dementia					1.3 (1.0–1.7)	0.054
Diabetes[4]					2.0 (1.4–3.1)	0.001
Renal disease	1.4 (1.2–1.6)	<0.001	1.2 (1.1–1.3).	0.003		
Stroke			1.4 (1.0–1.8)	0.049		
Complications						
UTI	0.4 (0.2–0.7)	0.001				
Skin ulceration			1.3 (1.1–1.6)	0.008		

1 HR=Hazard Ratio
[2] RAC = RAC occupancy immediately before fracture
[3] Community patients transferred to RAC
[4] Includes diabetes with complications

Table V3-D. Relative mortality rates (MR) following hip fracture in 2552 DVA clients

	Number[1]	Deaths[2]	Actual MR[3]	Expected MR[4]	Comparative MR[5]
			Males		
Year 1	939	388	0.413	0.125	3.3 (3.0–3.5)
Year 2	535	121	0.226	0.125	1.8 (1.5–2.1)
Year 3	411	96	0.234	0.125	1.9 (1.6–2.2)
Year 4	314	79	0.252	0.125	2.0 (1.6–2.4)
			Females		
Year 1	1583	434	0.274	0.086	3.2 (2.9–3.4)
Year 2	1125	201	0.179	0.086	2.1 (1.8–2.3)
Year 3	915	163	0.178	0.086	2.1 (1.8–2.4)
Year 4	745	149	0.200	0.086	2.3 (2.0–2.6)

1 Survivors at commencement of year
2 Values for deaths are age-standardised against DVA Treatment Population July 2009 – June 2012
3 Mortality Rate for given year
4 From DVA Treatment Population July 2009- June 2012
5 Actual MR / expected MR

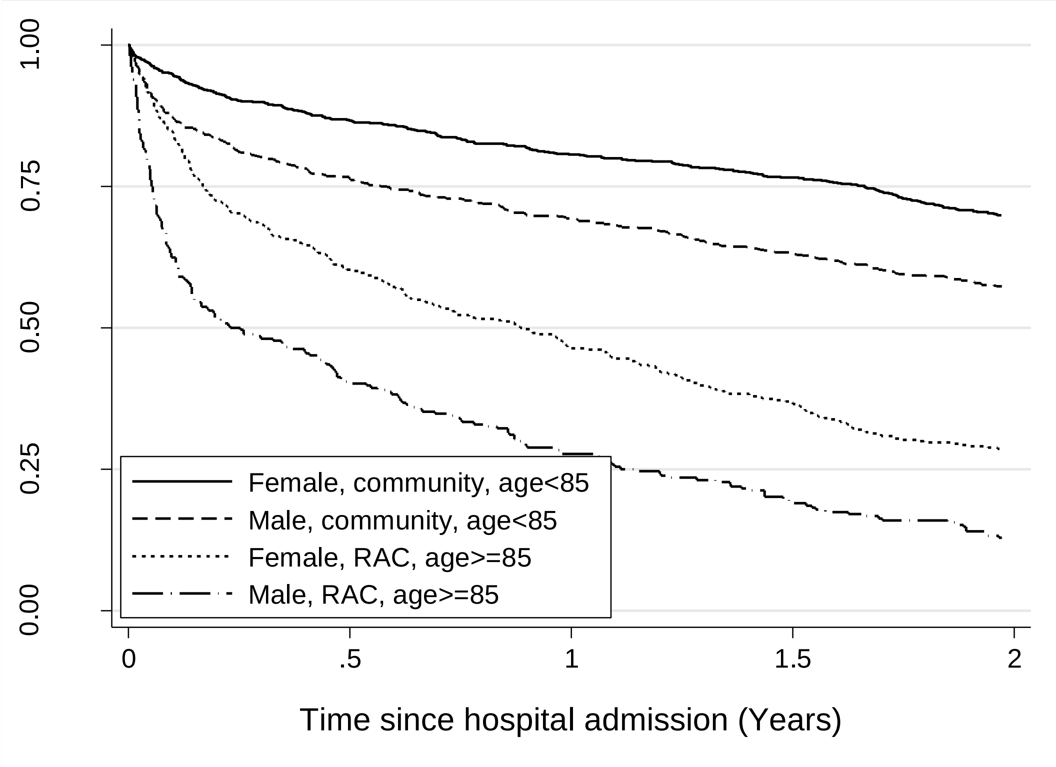
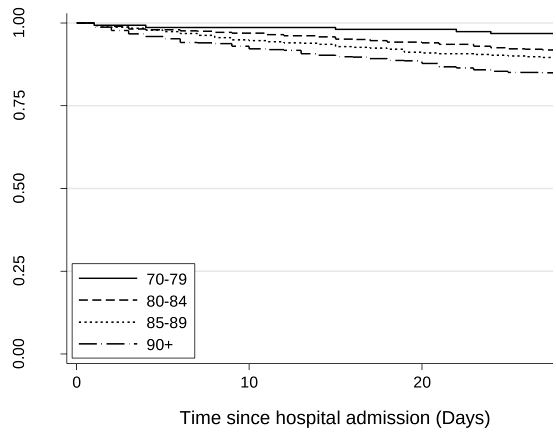
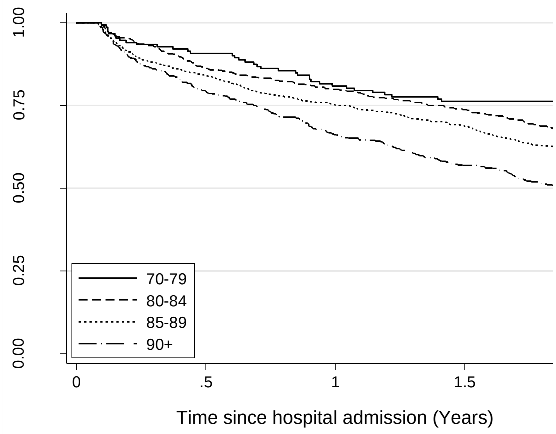


Figure V3-1. Survival for 2 years after hip fracture by risk group

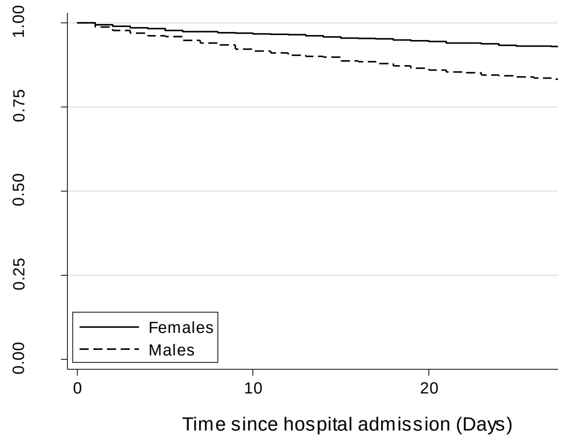
Survival 0–29 Days | Survival 30 days – 2 years

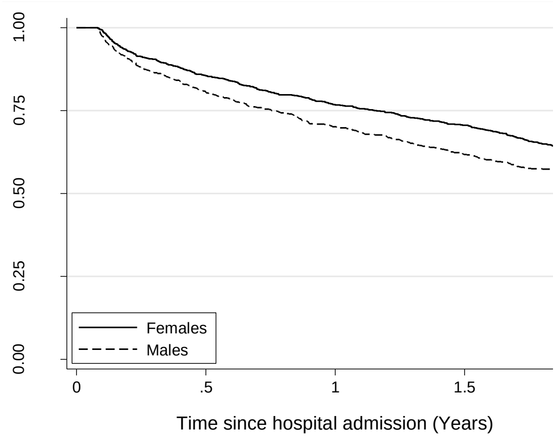
Age



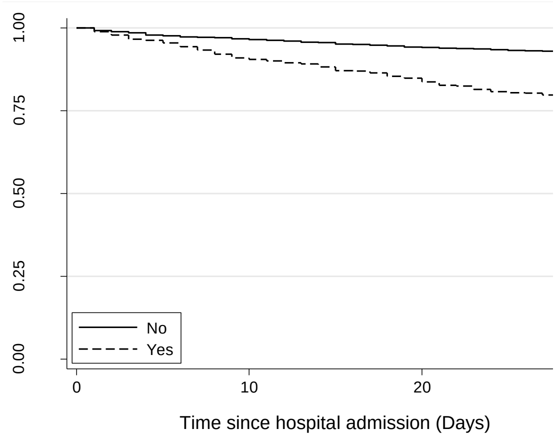


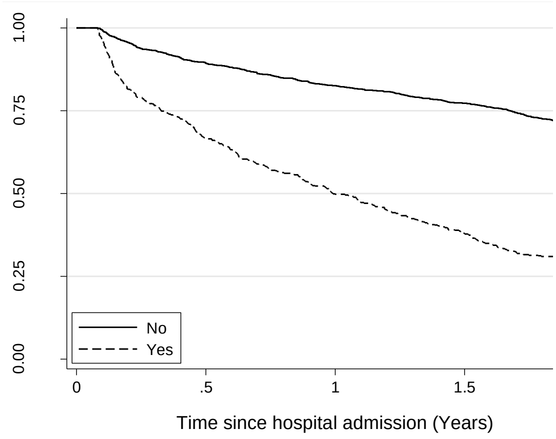
Sex



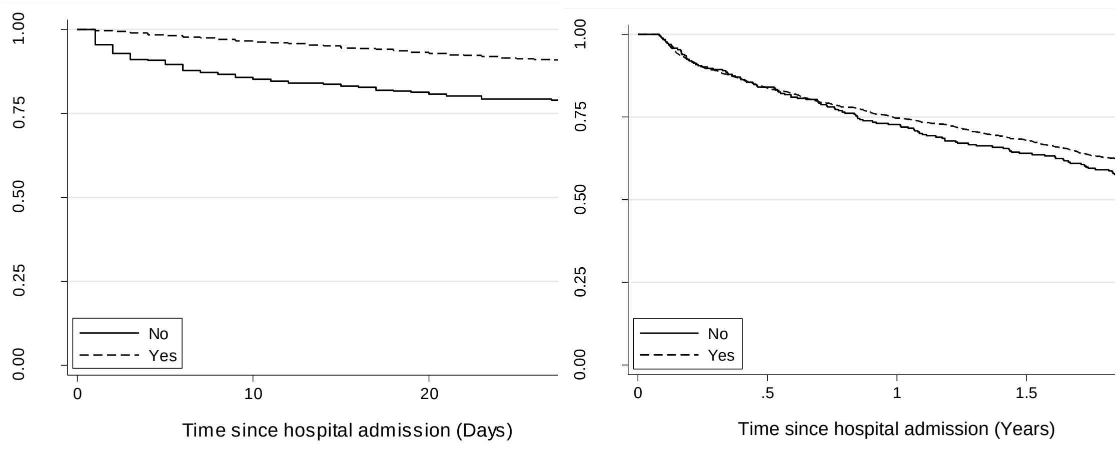


RAC prior to hip fracture

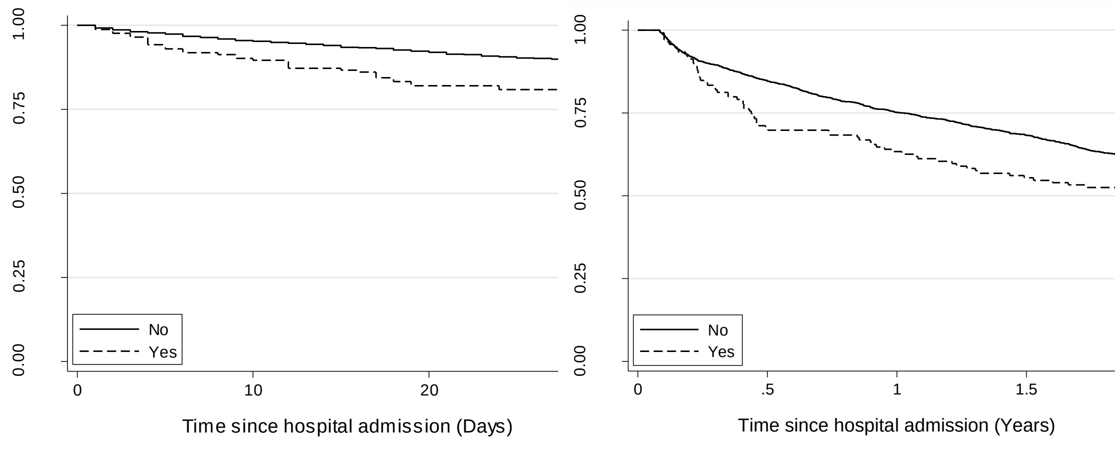




Patients treated surgically



Patients transferred to Intensive care



Patients transferred to rehabilitation

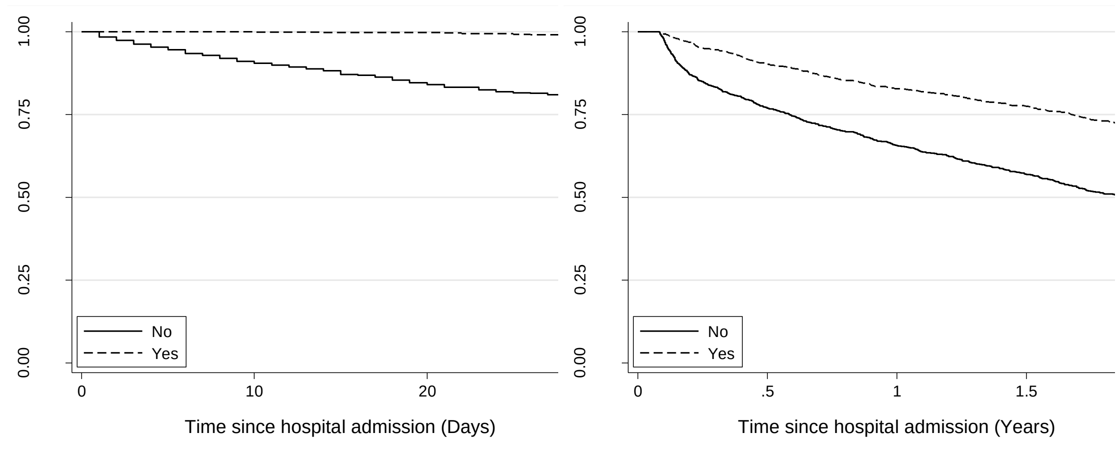


Figure V3-2. Survival curves in two time intervals for selected determinants of mortality

V (4): Research Study no. 4

State of Origin: Australian States use widely different resources for hospital management of hip fracture but achieve similar outcomes. Analyses of linked Department of Veterans' Affairs databases

Ireland A W, Kelly P J, Cumming R G

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Abstract

Background and objective

Hospital management of hip fracture varies widely in respect of length of stay, delivery of post-surgical care and costs. The present study examines the association between hospital resource outlays and patient outcomes in six Australian States.

Study type

Retrospective cohort study of linked administrative databases for 2530 Australian veterans and war widows aged ≥65 years, hospitalised for hip fracture in 2008–09.

Methods

Department of Veterans' Affairs (DVA) datasets for hospital episodes, residential aged care (RAC) admissions and date of death were linked. Patient characteristics, hospital utilisation and process data, rates for mortality and residential care placement were compared for patients from each of six defined jurisdictions.

Results

There were no significant differences in fracture incidence, patient demographics or fracture type among the States. Adjusted total mean length of hospital stay ranged from 24.7 days (95%CI 22.3–27.5 days) to 35.0 days (95%CI 32.6–37.6 days, P<0.001) and adjusted total hospital cost was between $24792 (95%CI $22191-$ 27700) and $35494 (95%CI $32853 -$38343, P<0.001). Rates of referral to rehabilitation ranged from 31.7 per cent to 50.4 per cent (P=0.003). At one year there were no significant differences between States for key outcome determinants of mortality (P=0.71) nor for proportions of patients who retained their independent living status (P=0.66).

Conclusion

Hospital resources for management of hip fracture differ substantially among the Australian States. Key medium-term patient outcomes do not show significant differences. A potential for substantial cost efficiencies without increased risk to patient welfare is suggested.

What is known about this topic? Hospital resources deployed in the initial management of hip fracture differ widely between countries, regions and individual hospitals. Patient outcomes also vary widely, but are inconsistently associated with resource outlays.

What does this paper add? Description of the differing resource outlays for management of hip fracture in six Australian jurisdictions and the absence of equivalent differences in medium-term patient outcomes.

What are the implications for practitioners? The data of this study suggest that efficiencies in hospital management of hip fracture may be achieved without negative consequences for patient outcomes.

Introduction

The management of hip fracture is complex and costly and patient outcomes for both survival and function are less than ideal [1, 2, 3]. Comparisons of duration and content of hospital management at national, regional and facility levels show wide diversity [1, 4, 5]. Across the world, duration of hospital stay for hip fracture ranges from as little as 5 days [6] to more than six weeks [1]. These variations are mostly the result of different approaches to provision of post-acute hospital services [4, 7, 8].

Between 2.7 per cent and 16 per cent of subjects are treated without surgical repair [9, 10]. Post-fracture rehabilitation can differ in both overall rate (21 to 67 per cent) and manner of delivery across regions [4, 8, 11]. Because of the wide differences in duration and content of the primary hospital admission, mortality rates at 30 days are mostly accepted to better represent the safety and effectiveness of hospital management. Reported values range from 2.7 to 14 per cent [12, 13].

In the past 20 years a number of management protocols have been created which involve various combinations of orthopaedic, geriatric and rehabilitation services. These 'orthogeriatric' models mostly result in speedier passage through the acute wards, reduction of short-term complications and sometimes in lower rates of in-hospital or 30-day mortality [14, 15, 16]. However, evidence for association between orthogeriatric acute care and longer-term benefits is inconsistent [12, 17, 18].

The acute phase of care is coming under particularly close scrutiny in national audit programmes which document compliance with recommended process elements and report comparative rates of short-term outcomes. Performances are compared between health services or more commonly between individual hospitals [5, 11]. Repeated feedback of audit results is associated with increased compliance with recommended "best practice", and also results in reduced time in hospital, lower costs and improved short-term outcomes [5, 11].

The Australia and New Zealand Hip Fracture Registry [19] has commenced reporting availability of key service components for a majority of registered hospitals but to date has not yet reported patient-level performance data. The Registry and other agencies within Australasia have also produced recommended care pathways or guidelines for hip fracture management [19, 20].

This study describes the variations in hospital utilisation for management of hip fractures among six jurisdictions within Australia and their corresponding medium-term outcomes. It is the first Australian study to link resource utilisation, key process elements and patient outcomes in a national dataset.

Methods

This is a retrospective cohort study. This study comprises all Department of Veterans' Affairs (DVA) treatment beneficiaries aged 65 years or older who were hospitalised for hip fracture (ICD10-AM S720-S722) between 1 July 2008 and 30 June 2009. A Universal Identification Number for each patient allowed linkage of all hospital episodes continuous with the index admission, together with records of admissions into Residential Aged Care (RAC) facilities and the DVA Mortality Index. Data items included patient age, sex, fracture type, pre-fracture residential status (as RAC or "community") up to 16 diagnosis codes, operation type, episode separation codes, date of death, hospital type, itemised costs and State of treating hospital. Additional details of the record linkage processes have been described previously [21]. Dates of service for community nursing and Veterans' Home Care (VHC) services, up to one year following fracture were also collected. VHC provides a wide range of personal and domestic supports for entitled veterans, war widows and their carers, including institutional or in-home respite.

The outcomes of interest were hip fracture incidence, total length of stay and total cost for the index hospitalisation, new RAC admission and deaths within one year, total time spent in RAC for hospital survivors and time from index admission to death. These outcomes were analysed for each of the six Australian States. Data for hospitals in the Australian Capital Territory were reported with data from New South Wales and data from the Northern Territory were included within data for South Australia.

For calculation of hip fracture incidence, age and sex distributions in each State were standardised to the distributions within the complete study population. The hospital period defined as 'acute phase' included all episodes coded as hip fractures which were continuous with the index admission. Rehabilitation length of stay was the total duration of one or more episodes with principal diagnosis of rehabilitation (ICD10-AM Z508-Z509) which were included within total hospitalisation. Total hospital stay was the concatenated value of all episodes, however coded, which were continuous with the index admission. These included episodes for management of complication and comorbidities and for subacute and non-acute care. Hospital cost was the total of charges for accommodation, theatre and prosthesis costs plus fees for medical, allied health, pathology and diagnostic imaging services approved and paid by DVA in respect of the total hospitalisation period.

Comorbidity was assessed by Quan scores [22] for patients from the community only, this being the relevant group for to all outcome measures applied in the study.

Several different sub-populations are described and analysed. Post-hospital community services can only be provided to patients who have been discharged alive and are not in RAC. The denominator for the proportion of persons in RAC is the surviving population at the specified time point. Community nursing and VHC services can only be provided to persons not in RAC. Patients surviving in the community without resource to community nursing or VHC services were also identified.

One-way analysis of variance was used to assess differences between mean values for continuous variables, and differences between proportions of categorical variables were analysed by Pearson's chi-square test. To assess differences between States, all other risk factors and confounders, as listed above, which retained significance of $P<0.05$ were included in multivariate models. Continuous outcomes were analysed using negative binomial regression and binary outcomes analysed using logistic regression.

All analyses were performed using SAS 9.3 (SAS Institute Inc; Cary, NC) or Excel 2010 (Microsoft Corporation, Redmond, WA).

Results

There were 2530 patients aged ≥ 65 years admitted to hospitals in the study year. This was a relatively elderly population with 71 per cent being ≥ 85 years of age. The overall incidence of 12.0 per 1000 persons aged ≥ 65 years was reduced to 5.6 per 1000 when the age-sex distribution was adjusted to that of other Australian hip fracture patients. The age-sex adjusted incidence of hip fracture was 9.9 per 1000 in Tasmania and 13.1 in Queensland, but this difference did not achieve significance in this sample (Table V4-A).

Table 1 shows that there were no significant differences between the States in distributions of age, sex or the proportions of patients who had been in residential aged care (RAC) prior to fracture.

Hospital process and utilisation

The proportions treated surgically were similar between the States but there were significant differences in the proportions of patients who received in-hospital rehabilitation ($\chi 2 = 17.8$; df =5; P=0.003), rates being highest in Victoria and New South Wales and lowest in Tasmania and Queensland. In the period immediately following the index hospitalisation, 231 episodes of same-day rehabilitation (27 study patients) were additionally identified. All but six of these patients were from New South Wales. Rates of transfer into Intensive care were also different but numbers were relatively small -172 in the entire sample (6.8 per cent)

There were significant differences in the length of acute phase care, as shown in

Figure V4-1. Mean values for the individual states ranged from 9.4 days in Tasmania to 14.6 days in Queensland. Values were similarly diverse for the length of total hospital stay with South Australia having the shortest (24.7 days) and Western Australia the longest (36.2 days) in adjusted models. The same two States had the lower and upper values for the duration of rehabilitation episodes, with the highest value being 52 per cent above the lowest (Figure V4-1A,B,C).

Mean total cost of the index hospitalisation was $31208 inclusive of accommodation, operating theatre and prosthesis costs and fees for medical, allied health, pathology and diagnostic services provided during the hospital period. There were significant differences among States in overall cost per occupied bed-day (range $909 to $1149 per day, P<0.001, data not shown). The highest State value for total hospital cost exceeded the lowest value by 51 per cent (Figure V4-1D). In each of the four utilisation analyses illustrated in Figure 1, differences in mean values between States were significant and substantial. Total cost of hospital services was $79 million.

Private hospitals in total had lower bed-day charges for both surgical and rehabilitation episodes and were less costly overall despite having equal or longer LOS. The national mean LOS for surgery was lower in public hospitals, but there was no difference in respect of rehabilitation (Table V4-B). The proportions of patients having surgical procedures and rehabilitation episodes in private hospitals showed State-specific profiles. Overall, 59 per cent of operations to repair hip fractures were performed in public hospitals. In New South Wales, 82 per cent of surgery was in the public sector, but more than two-thirds of operations were in private hospitals in Queensland and South Australia (Table V4-B, Figure V4-2A). Private hospitals provided 56 per cent of 1272 hospital episodes for rehabilitation (1159 patients). This value ranged from 81 per cent in South Australia to 32 per cent in Victoria (Table V4-B, Figure V4-2B).

Significant and substantial differences for total hospital costs persisted, after data for each State were standardised for public: private distribution and for bed-day costs in respect of surgery and rehabilitation.

Post-hospital services

Community nursing services were provided to 613 persons and VHC services to 666 persons at some time within the year after fracture, and 360 persons received both services at some time. There were significant differences between the states in unadjusted rates of service provision (Table 1). By one year post-fracture, 444 of 1076 (41.3 per cent) potentially independent persons were currently receiving one or both services but the adjusted State distribution was no longer disproportionate (P=0.20). The one-year combined cost of these services was $3.7 million or $1631 per hospital survivor (untabled data).

Hospital readmission within one year occurred for 50.4 per cent of patients. This rate varied between 43 per cent (Tasmania) and 58 per cent (South Australia), but the results for the other States clustered tightly about the mean and the overall distribution did not show significant difference.

One-year outcomes

In contrast to the diversities in patterns of service delivery, there were no significant differences in unadjusted or adjusted data describing mortality rates and occupation of aged care facilities at one year after fracture (Table V4-C). At one year, the spread of unadjusted mortality rates was 31 to 41 per cent, but all confidence intervals were overlapping (P=0.73), and the multivariate regression model showed similar lack of significant difference (P=0.71). The pattern was repeated for RAC occupancy among one-year survivors and for the composite outcomes of 'potential independence' with and without additional supportive services. One year after the index admission date, 632 community patients (35 per cent) were living in non-RAC accommodation without support of nursing or VHC services. In the adjusted model there were again no significant differences in proportions of these "good outcomes" between the States (p=0.20). Crude and adjusted values for all outcome measures suggested that the State with the lowest costs (South Australia) achieved equivalent or superior outcomes to those of other States. (Table V4-C, FigureV4-1B,C).

Discussion

There were substantial and significant differences in hospital utilisation profiles among the six States for mean total length of stay (24 to 35 days), rates of referral to rehabilitation (32 to 51 per cent) and the aggregate time in rehabilitation (18 to 27 days). These differences, contributed to the wide range of hospital costs between States. Differential rates of private hospital admissions for surgery and rehabilitation episodes and cost differences between public and private providers may also have been a factor. Costs, especially in the private sector, may have reflected differing contract arrangements between DVA and provider organisations, but details were not available to the study.

Equally wide utilisation differences are reported in other contemporary studies, in which total hospital stay ranged from 17 to 48 days [1, 23]; rates of referral to rehabilitation ranged from 21 to 67 per cent [8, 11] and mean duration of hospital-based rehabilitation was between one and six weeks [23, 24].

A recent Australian study found significant differences between four States in LOS for rehabilitation of specific classes of lower limb amputees [25].

The outcome parameters accessible to this study were mortality, RAC residency and the absence of both, taken as a surrogate for independent living. These elements are widely acknowledged as key indicators of "poor" or "good" longer-term outcomes in the elderly [26]. An additional level of better functionality was possibly indicated by the absence of community nursing or VHC services, especially in the longer term, as identified in Table 3.

Examples of the disconnect between resource deployment and patient outcomes following hip fracture are evident at national, regional and individual hospital level. A review of Medicare data in the United States for the period 2000–2008 showed a downward trend for acute phase LOS and a small downward trend for mortality [6].

In the 2008 report of the Scottish Hip Fracture Audit [11] which compared data from 22 hospitals, the four hospitals with the shortest aggregate hospital stay (mean 31.5 days) and the four with the longest stay (42.4 days) had 120-day mortality rates of 19.5 per cent and 18.9 per cent respectively (P=0.74). The proportions of patients from these groups of hospitals in care home accommodation at 120 days were likewise equivalent (17.8 per cent and 17.2 per cent, P=0.71).In the National Hip Fracture Database of 2012, total hospital stay for seven hospitals (with ≥ 100 separations) with the lowest rates of "private home to private home" outcome at 30 days and for nine facilities with the highest such rates were 20.0 and 19.1 days respectively [5-derived]. In the last three years of the NHFD report, the national mean LOS has reduced while hospital mortality has remained steady [5].

All three of these large nationally-based reports suggest that hospital stay can be reduced without detriment to immediate or medium term outcomes. Two smaller American studies conversely described lower in-hospital or 6-month mortality rates for patients of high cost teaching hospitals albeit with very high cost increments relative to modest mortality gains [27, 28].

At a regional level, eleven health districts in Tuscany reported an approximately eight-fold difference in rates of hospital-based rehabilitation across eleven health districts with commensurate cost differentials due to differing referral rates and proportions of episodes delivered as admitted care [4]. Six- month mortality rates were not significantly diverse. For two hospital districts in Finland, with 527 and 731 hip fractures respectively, one group with a significantly shorter total hospital stay reported significantly more patients returned to their homes at 120 days and lower mortality at one year [29].

At the hospital level, an orthogeriatric service in New Zealand reduced hospital stay and increased rate and promptness of transfers to rehabilitation, without altering 6-month mortality [17]. The 12-month mortality for community dwelling patients was not associated with length of hospital stay in an orthogeriatric unit in Oslo [30]. An Australian study over a 10 year period showed reductions in 30-

day mortality from 12.1 to 8.2 per cent while LOS marginally increased [31]. In the latter two studies, an apparent association between longer stay and improved survival for the whole study population was attributed to the early discharge of frail patients. None of these hospital-based studies identified costs.

Strengths and weaknesses

These are essentially the inherent issues presented by the use of administrative datasets. Large populations and an extensive range of data items are available. The sample reported in this study represented approximately 1:7 of the Australian caseload for hip fracture [19]. The level of coding accuracy in Australian hospital data has been assessed as adequate for population-based studies of clinical subjects [32] and accuracy is further enhanced by data linkage [33]. The database linkage capacity permitted a comprehensive description of hospital resources and of post-hospital events in specific groups of patients, with an extensive list of variables for multivariate analyses.

Data on Transition Care (TC), while potentially relevant to many patients in this study, by providing short-term support to elderly patients discharging from hospitals, was not available to this study. This service, jointly provided through the Commonwealth and State Health agencies in Australia, is therefore not funded nor recorded by DVA. National reports published by the Australian Institute of Health and Welfare, showed that the distribution of TC places closely reflected state demography in 2008–09, but DVA clients were not identifiable [34].

The particular demographics of the DVA population are noted. Patient age and sex were not significant determinants of cost in this study, but were major determinants of outcomes. As previously reported [21], hospital stays for acute phase or rehabilitation episodes show little difference between DVA and non-DVA populations in comparable data. Appropriate adjustments for demographic differences have been made when comparing these data with outcomes of other Australian and international studies. There were no significant between-state differences in demographics.

Conclusions

The data of the present study indicate potentially major cost-efficiencies for hospital management of hip fracture. If the second lowest State value for total LOS (25.7 days), and the second-lowest bed-day cost ($951) were applied across the entire study population the cost for hospital management of hip fracture would be reduced by 18 per cent. The lack of association between resource expenditure and longer-term outcomes suggests that this could be achieved without detriment to patient welfare.

In the hospital management of hip fracture there are significant and substantial differences among the Australian States with respect to acute and total length of stay, rates of rehabilitation referral, public-private service distribution and costs. In adjusted models for total hospital stay and cost, the highest values exceed the lowest values by more than 40 per cent. With one exception, patient outcomes as assessed by rates for mortality and RAC placement and defined independence at 12 months, do not significantly differ. These findings indicate a potential for substantial cost efficiencies in hospital management of hip fracture without compromise to patient outcomes.

Conflicts of interest

AWI is a contracted adviser to the Department of Veterans' Affairs, but received no funding for this study. The authors received no other funding and declare no other competing interests.

Acknowledgments

The opinions stated within this paper are entirely those of the authors and do not necessarily reflect the views of the Department of Veterans' Affairs. Offices from the section of Data Analysis and Nominal Rolls, DVA Canberra, provided skilled assistance in accessing departmental data. A/Prof Adam Elshaug reviewed an earlier version of the manuscript and made helpful suggestions.

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Table V4-A. Patient characteristics, service profiles and hip fracture incidence by State for 2530 patients aged ≥ 65 years, admitted to hospital 2008–09

	NSW (N=904)	QLD (N=526)	SA (N=194)	TAS (N=63)	VIC (N=643)	WA (N=200)	*P*
Incidence	11.7[1]	13.1	11.1	9.9	12.4	12.5	0.09
Patient characteristics							
Males	36.1[2]	40.1	36.6	39.7	35.9	38.7	0.66
Age ≥ 85	70.4	69.2	64.9	74.6	72.8	73.9	0.26
RAC[3]	29.1	26.8	30.4	34.9	25.8	28.6	0.46
Quan Score ≥ 3[4]	13.7	12.2	12.6	9.86	16.8	15.4	0.20
Hospital services							
Surgery	83.6	83.3	88.7	92.1	84.4	82.9	0.24
Intensive care	5.5	6.1	14.4	0.0	9.3	1.0	<0.001
Rehabilitation	47.7	40.9	41.8	31.7	50.4	44.0	0.003
Total LOS (Days)	30.6	35.0	24.7	25.7	31.5	31.6	<0.001
Total cost ($AUD)	32880	31838	24052	28747	29625	36247	<0.001
Post-hospital services							
Community Nursing[5]	29.0	29.6	33.5	26.8	22.8	21.1	0.001
Veterans' Home Care[5]	29.2	25.5	41.9	26.8	29.8	23.4	0.001
RAC days[6]	21.3	22.1	17.5	18.8	23.5	18.5	<0.001

[1] Incidence per 1000 of DVA Treatment Population.
[2] Values are percentages
[3] Patients admitted from residential aged care
[4] Community patients only
[5] Proportion of hospital survivors receiving service within 12 months of fracture
[6] Days in RAC as proportion of total survival days within 12 months of fracture

Table V4-B. Length of Stay, bed-day costs and total episode costs by State and hospital type Australian veterans and war widows 2008–09

Episodes including surgery: 2303 episodes for 2194 patients

	Private hospitals				Public hospitals			
State	**N[1]**	**LOS**	**$/day[2]**	**Cost[3]**	**N**	**LOS**	**$/day**	**Cost**
NSW	146	13.6	1563	21313	676	11.8	1934	22731
VIC	268	14.3	1477	21118	317	11.2	1599	17888
QLD	346	13.8	1343	18591	128	14.5	1537	22237
SA	129	11.4	1478	16878	56	14.3	1437	20526
TAS	14	8.9	1733	15351	45	9.6	1976	18877
WA	51	20.3	1136	23059	127	9.1	2657	24097
AUST	**954**	**13.9**	**1417**	**19677**	**1349**	**11.7**	**1840**	**21455**

Episodes including rehabilitation : 1272 episodes for 1159 patients

	N	**LOS**	**$/day**	**Cost**	**N**	**LOS**	**$/day**	**Cost**
NSW	269	25.9	578	14971	200	20.8	690	14378
VIC	134	17.5	584	10207	214	25.0	663	16599
QLD	195	23.0	584	13444	48	22.3	649	14436
SA	59	15.7	555	8773	28	19.4	546	10589
TAS	16	18.6	661	12319	6	26.2	482	12612
WA	33	26.9	608	16358	70	20.7	706	14597
AUST	**706**	**22.5**	**582**	**13128**	**566**	**22.5**	**668**	**15044**

[1] LOS= length of stay for episode
[2] Cost per occupied bed-day
[3] Cost of hospital episode. All costs in Australian dollars.

Table V4-C. Outcomes at one year by State

A: Mortality

		Unadjusted (P=0.73)		Adjusted[1] (P=0.71)	
	N	**Deaths**	**Per cent (95%CI)**	**Odds Ratio**	**95% CI**
NSW / ACT	904	305	33.7 (30.6–36.8)	referent	
QLD	526	176	33.5 (29.5–37.5)	0.99	(0.76–1.29)
SA / NT	194	61	31.4 (24.9–37.9)	0.79	(0.53–1.18)
TAS	63	26	41.3 (29.1–53.5)	1.25	(0.68–2.29)
VIC	643	222	34.5 (30.8–38.2)	1.02	(0.80–1.31)
WA	200	73	36.5 (29.8–43.2)	1.17	(0.81–1.69)
AUST	**2530**	**863**	**34.1 (32.3–35.9)**	–	

B: RAC residents (12-month survivors)

		Unadjusted (P=0.90)		Adjusted (P=0.56)	
	N[2]	**Residents**	**Per cent (95% CI)**	**Odds Ratio**	**95% CI**
NSW / ACT	599	210	35.1 (31.3–38.9)	referent	
QLD	350	123	35.1 (30.1–40.2)	1.13	(0.86–1.48)
SA / NT	133	42	31.6 (24.3–39.2)	1.12	(0.75–1.68)
TAS	37	14	37.8 (22.2–53.4)	1.02	(0.53–1.96)
VIC	421	156	37.1 (32.5–41.7)	1.11	(0.86–1.43)
WA	127	43	33.9 (25.7–42.1)	0.77	(0.51–1.18)
AUST	**1667**	**588**	**35.3 (33.0–37.6)**	–	

C: Independent without community support services (community patients only)

		Unadjusted (P=0.59)		Adjusted (P= 0.20)	
	N	**Persons[3]**	**Per cent (95% CI)**	**Odds Ratio**	**Per cent (95% CI)**
NSW / ACT	641	212	33.1 (29.5–36.7)	referent	
QLD	385	141	36.6 (31.8–41.4)	1.18	(0.83–1.66)
SA / NT	135	46	34.1 (26.1–42.1)	0.79	(0.49–1.26)
TAS	41	16	39.0 (24.1–53.9)	2.40	(0.85–7.64)
VIC	477	160	33.5 (29.3–37.7)	1.22	(0.88–1.68)
WA	143	57	39.9 (31.9–47.9)	1.39	(0.84–2.29)
AUST	**1822**	**632**	**34.7 (32.5–36.9)**	–	

[1] Adjusted for sex, age group, comorbidity score, pre-fracture RAC residence, and rehabilitation, intensive care, community nursing and veterans' home care services

[2] Survivors at 12 months. [3] Survivors not in RAC at 12 months

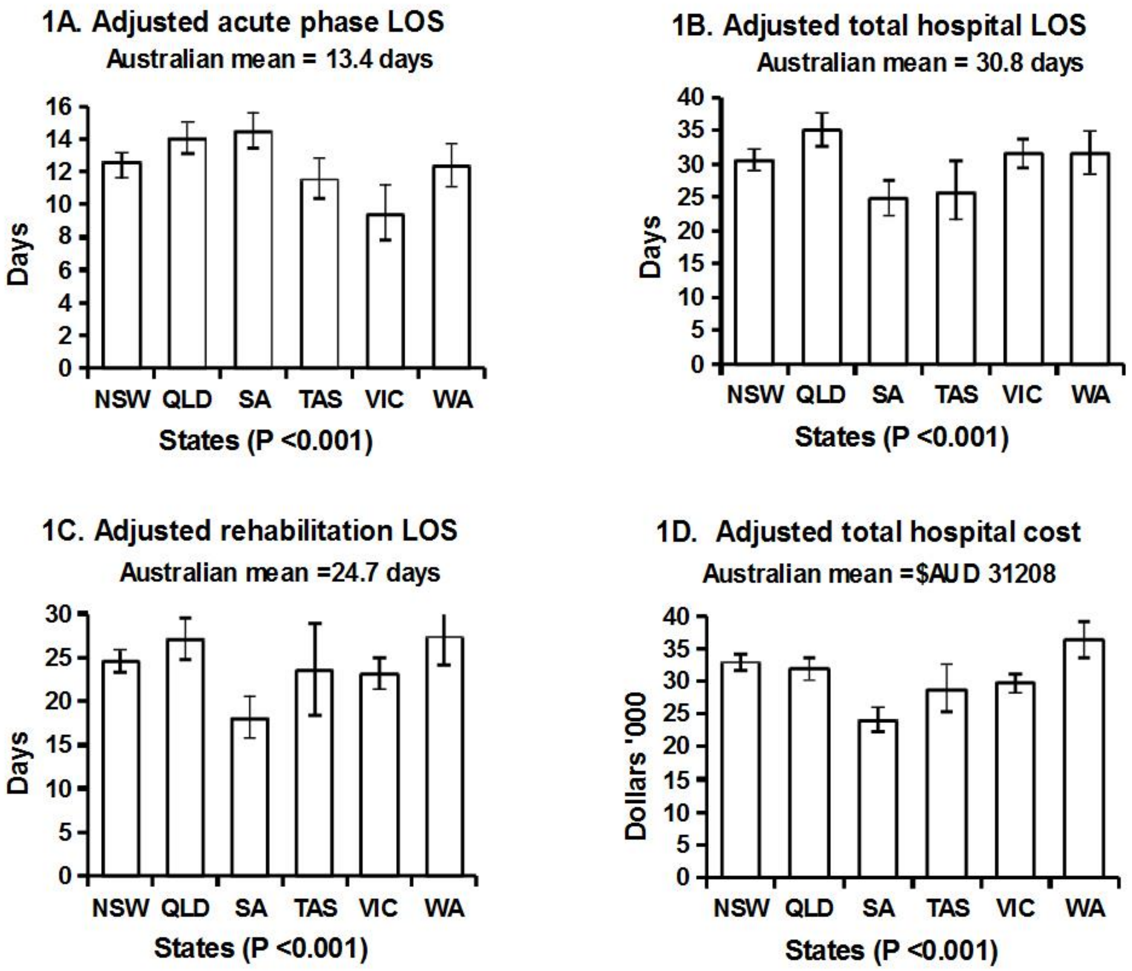
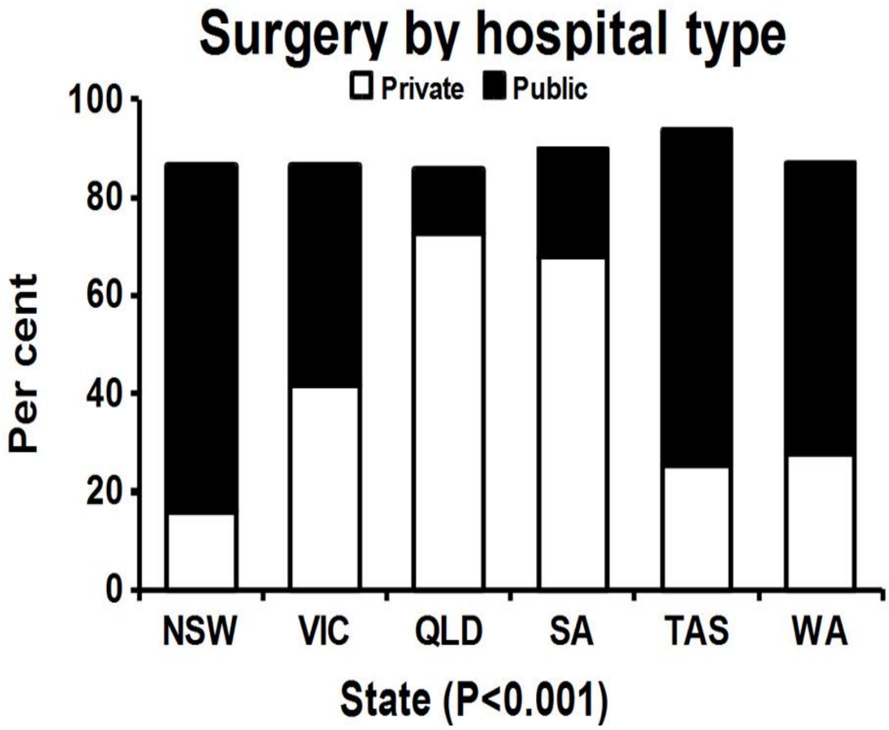


Figure V4-1: Hospital utilisation by State: 2530 patients aged ≥ 65 years, 2008–09

LOS = length of hospital stay. Y-error bars represent 95 % confidence intervals



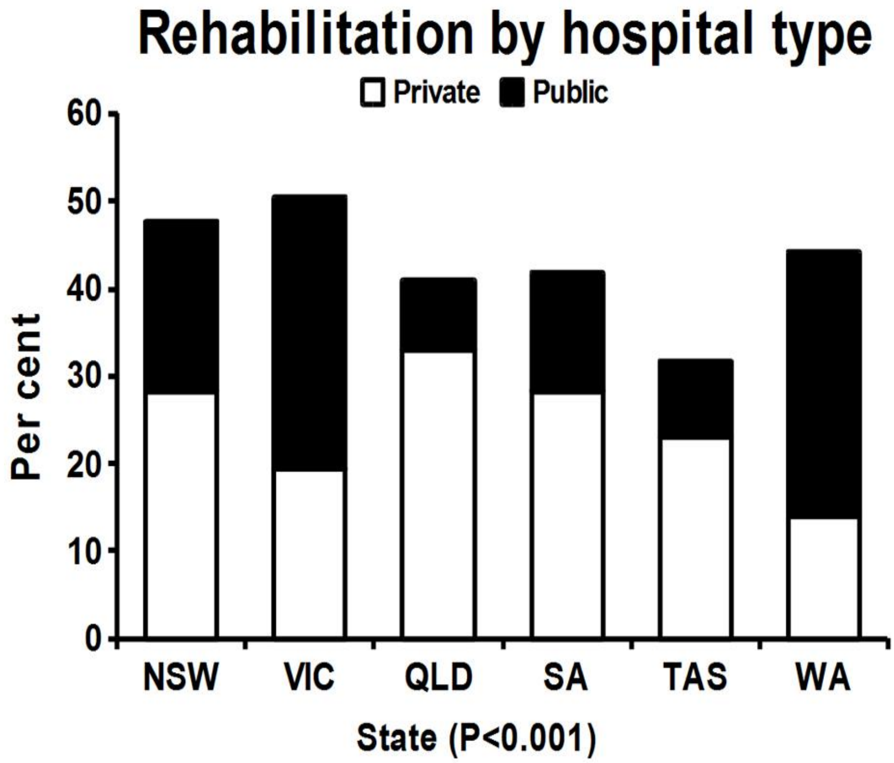


Figure V4-2. Service distribution by State and hospital type

V (5): Research Study no. 5

Rehabilitation after hip fracture: association with two-year survival, and independent living status. Findings from Department of Veterans' Affairs databases for 1724 community-dwelling patients

Ireland A.W, Kelly PJ, Cummings RG

Journal of Rehabilitation Medicine. Under review, 30 November 2015

Abstract

Objective

To compare rates of mortality, hospital readmissions and independent living status for two years following hip fracture in community-dwelling patients who did and did not receive hospital-based rehabilitation.

Design

Retrospective cohort study

Methods

Administrative datasets were linked for hospital treatment, residential aged care admissions, selected community services and date of death for community-dwelling hip fracture patients. Mortality, readmissions, residency within aged care facilities and independent living status at intervals up to 2 years were compared in multivariable logistic regression for patients with and without hospital-based rehabilitation

Results

Age, sex and comorbidity distributions were similar for 1050 patients who received rehabilitation and 674 patients who did not. Rehabilitation added 11 days to total hospital stay and $12000 to hospital costs. Mortality at 90 days after hip fracture was 4.7 % for rehabilitation patients vs. 10.7 % for others (p <0.001) and 26.2 % vs 37.2 % (p <0.001) at 2 years. In the year following the index fracture the difference in hospital readmission rates for the two groups was of borderline significance (60.3% vs 55.6%, p = 0.05). Beyond 90 days there was no significant association between receipt of rehabilitation and the proportion of patients meeting criteria for independent living.

Conclusion

In-hospital rehabilitation substantially increases total hospital costs. It is associated with improved early and late survival, but not with the likelihood of living independently for up to two years after hip fracture.

Keywords

Hip fracture, rehabilitation, hospital costs, mortality, independent living.

Introduction

Hip fracture is a common and frequently devastating event for elderly persons. Although age-specific incidence is steadily falling in Australia (1), approximately 13 in every 1000 women aged 75 or older and about half as many men will be affected each year (1, 2, 3). Despite the progress in acute hospital practices in recent decades, the one-year mortality following hip fracture remains in the region of 25–30 per cent (4, 5). Rates of functional recovery after one year also remain poor, with more than one-third of survivors failing to regain pre-fracture levels of physical functions, and at least one-quarter being in permanent institutional care (5, 6, 7).

In seeking better patient outcomes, the high rates of comorbid medical conditions and peri-operative complications in this frail, elderly population are increasingly addressed through advocacy of best-practice guidelines and management by multispecialty, ortho-geriatric teams (8, 9, 10, 11). These initiatives have produced short-term benefits — reductions in hospital mortality, complication rates, time in acute hospital care and functional status at hospital discharge. Long-term benefits with regard to survival and independent living status are suggested by only a minority of studies (11, 12).

Attention has therefore turned to post-acute care and rehabilitation (REH) programs. The majority of hip fracture patients now receive formal rehabilitation. In Ontario Canada, up to 90 per cent of discharges in 2003 were via inpatient REH or skilled nursing facilities (13). In the United States in 2008, 85 per cent were transferred to skilled nursing or "other hospital" facilities, mostly for REH, and fewer than 3 per cent of patients went home without any formal after-care program (14).

While ambulatory, home-based and even telemedicine models for rehabilitation have been trialled (15, 16, 17), the great majority of services are delivered in hospital units (13, 14, 18) . Short-term benefits in physical function, especially ambulation, and some additional psycho-social advantages are now almost universally reported by all programs (19, 20).

Numerous programs address specific functionalities such as improved balance or lower limb strength with a view to improving independence or reducing risk of further injury (21, 22). While specific targets are frequently met in the short term, significantly superior rates of independent living at the end of even the first year after hip fracture are reported for only a few studies (17, 19, 20).

A Cochrane Review published in 2009 described controlled trials of a wide variety of rehabilitation services, mostly delivered to inpatients. Some programs showed a tendency to infer longer-term benefits to patients, but none achieved statistical significance. The concluding comment was that rehabilitation was not harmful (23).

This study compares mortality, hospital readmissions and independent living status across the first two years after hip fracture for a cohort of elderly community-dwelling patients who received hospital-based rehabilitation and a series of similar patients with no documented rehabilitation.

Methods

The study population was drawn from a cohort of 2552 Australian veterans and war widows hospitalised for a first hip fracture (ICD-10-AM, S72.0-S72.2 inclusive) between July 2008 and June 2009. The existence of a unique identifying number for each patient in Department of Veterans' Affairs (DVA) databases permitted linkage of continuous hospital episodes, residential aged care (RAC) admission history, hospital readmissions, delivery of community nursing and/or veterans' home care services, and date of death for each individual subject. Details of this cohort have been reported previously (24).

Subjects who were RAC residents immediately prior to hospital admission for hip fracture or who died within the acute surgical phase of hospital care were excluded. Patients admitted from RAC have shorter hospital stays, higher hospital mortality, and survivors almost exclusively return permanently to RAC (25). Since referral to REH presupposes survival to the end of the acute phase episode, the exclusion of non-REH patients who died in the acute phase reduces bias in mortality comparisons.

Study data were obtained from DVA administrative databases for care in public and private hospitals for all patients. Data items included patient age, gender, fracture type, operation type, comorbidities and complications, treatment in intensive care, and separation code for each component episode. Fracture type was classified from ICD-10-AM codes for principal diagnosis as cervical (S72.01–72.04), trochanteric (S72.05, S72.10–72.11), subtrochanteric (S72.2) and 'other' (S72.00, S72.08). Comorbidity codes were extracted from all hospital episodes in the study year, up to and including the episode(s) comprising the index hip fracture admission. Comorbidity weight was assessed by the Quan modification of the Charlson Comorbidity Index (26).This algorithm, derived from hospital data in Alberta Canada and internationally validated, assigns a score of 1- 6 for each of 12 conditions.

Complications of skin ulceration (L89, L97), delirium (F05), anaemia (D62, D64.9), and urinary (N39), lower respiratory (J13–J15, J18, J20–22) and surgical site (T81.4, T84.5–7) infections were also identified, due to known associations with either length of stay (LOS) or unwanted outcomes following hip fracture (2, 13, 19). Complications were identified only from those episodes comprising the index fracture admission. Admitted care for REH was identified if one or more episodes with principal diagnosis, coded as ICD-10-AM Z50.9 or Z50.8, was included in an episode sequence continuous with the index admission date. No additional details of the processes of delivering the various REH services were available in the database.

Acute phase care was defined as those episodes with principal diagnosis of hip fracture (S72.0-S72.2 inclusive) which were continuous with the admission date. Rehabilitation length of stay (LOS) was the total of all REH episodes between the end of the acute phase and final discharge. 'Other' care included all episodes included within an episode sequence continuous with the index admission date, but not defined as acute or REH care. Total length of stay described the duration of hospitalisation from the index admission date until final discharge. The total cost of hospitalisation included all charges for accommodation, theatre, prostheses, and fees for medical, allied health and diagnostic services accepted for payment by DVA in respect of the index hospital admission. Hospital readmissions, and the LOS and cost of each episode were identified for one year dated from the index admission. Costs were expressed in Australian dollars ($AUD) at 2009 values.

The three main outcome measures, were mortality, RAC status and "living independently" measured since index admission date. Mortality was obtained by linkage with the DVA Death Index. RAC status was defined as living in RAC, as identified in DVA records, but the denominators only include those patients who are alive at the specified time point. "Living independently" was defined as neither deceased nor resident within RAC nor receiving community nursing or Veterans' Home Care services at the specified time point. Female subjects, aged < 85 years with one or zero coded comorbidities were defined as a "low risk" group for mortality at one year.

Statistical analyses

Univariable analyses were conducted comparing patients that did and did not receive rehabilitation using Student's t-test and Pearson's Chi-square test for continuous and categorical variables respectively. A multivariable logistic model was also fitted for receiving versus not receiving rehabilitation. Variables were included in the regression model if $p < 0.25$ in the univariable analyses and remained in the final model if $p < 0.05$ after backwards elimination. For the outcomes of mortality, RAC and "independent living" logistic regression models were each fitted separately for the specified time points of 90 days, one and two years, with rehabilitation as the exposure variable and adjusted for the following other factors: sex, age group and comorbidity. Logistic regression was used rather than survival analysis as, unlike mortality, commencement dates for RAC status were not consistently available. These outcomes were also analysed against LOS of acute care and REH episodes within the index hospitalisation.

All analyses were performed using SAS 9.3 (SAS Institute Inc; Cary, NC) or Excel 2010 (Microsoft Corporation, Redmond, WA). Ethics approval was obtained from the DVA Human Research Ethics Committee in December 2010 and renewed in December 2013.

Results

There were 1050 community patients who were referred to hospital units for REH following acute care for hip fracture. An additional 674 community patients who survived the acute phase of care did not receive formal rehabilitation. The characteristics of these two groups are listed in Table V5-A. This DVA population was somewhat older (mean age 86 years) and with a higher proportion of males (36.5 per cent) than is customary for series of hip fracture patients (26). The proportions of patients meeting the defined criteria for low mortality risk were not significantly different (Table V5-A). Patients aged under 80 years and those with associated dementia or delirium were under-represented in the REH population, while the reverse applied for patients treated surgically (Table V5-A). Multivariate models confirmed a two-thirds increase in referral rate for surgical patients, and patients with dementia (ICD10-AM, F01-F05.1 inclusive) were referred at one-third of the rate of other patients (data not shown).

REH involved a distinct increase in total LOS for the index hospitalisation and in the cost of hospital care as shown in Table V5-B. The mean total time spent in REH units — there were 1172 coded episodes for the 1050 patients — had a duration of 25 days and a mean cost of almost $AUD15000. Acute phase LOS and cost were higher for the non-REH patients who also had more frequent and longer hospital episodes for care of complications and comorbid conditions (‘other’ episodes). In univariable models mean total LOS was 14 days longer and total costs $AUD14000 greater for REH patients, or 11 days and $AUD 12000 in models adjusted for sex, age-group and comorbidity.

Patient outcomes

Outcomes were assessed at intervals of 90 days, one year and two years from the index admission date. In unadjusted data, the 90-day mortality for REH patients was less than half that of non-REH patients (4.7 per cent vs 10.7 per cent, $p<0.001$). In the remainder of the first year after fracture the difference was not significant (11.1 per cent vs 13.8 per cent. $p=0.11$) but in the second year, REH patients again had lower mortality (12.9 per cent vs 18.5 per cent, $p=0.005$). At the end of all three time periods, mortality rates were substantially and significantly lower for REH patients (Table V5-C).

RAC residency among all surviving patients at the end of 90 days was higher for non-REH subjects: this difference was maintained when the 50 REH and 28 non-REH subjects still in hospital at 90 days were excluded. At one year and two years after hip fracture there were no significant differences in RAC residency rates between the groups.

The proportion of patients who were living independently, as defined, showed no significant differences between the groups at the end of any of the three follow-up periods (Table V5-C). The higher proportion of REH patients accessing community services at 90 days (38.5 per cent vs 24.1 per cent, $p<0.001$) was a factor in reducing the rate of independence for REH patients at this time point.

There were 3912 hospital readmission episodes (for all causes) recorded for 1007 (58.4 %) patients within one year of the index fracture (Table V5-B). Readmission rates were marginally higher for REH patients (60.3% vs 55.6 %, $p=0.049$). However, readmission status was not a significant variable in regression models for the three defined outcomes for REH against non-REH patients. Within each subgroup, higher two-year mortality for readmitted REH patients (31% vs 18 %, P<0.001) was the only instance in which readmission was significantly associated with outcomes. For all causes of readmission, occupied bed days and costs per capita were not different for REH and non-REH patients (Table V5-B). There were 635 readmission episodes coded as rehabilitation within the first year, for 239 patients. Of these 580 episodes and 199 patients came from the REH group.

In models adjusted for sex, age group, and comorbidity (Table V5-C) REH patients again had significantly lower mortality risk at the end of all follow-up periods. There were no differences in probability of RAC residency across the two-year period. There was a clear increase in probability of independent status at one year for non-REH patients, but the results at 90 days and two years were not different in the adjusted models. These profiles persisted when patients with defined 'low-risk' were separately considered: 12-month mortality was 5 per cent for REH and 13 per cent for non-REH patients ($p=0.009$), but there were no differences in RAC occupation. The inclusion of individual comorbid conditions rather than Quan scores in multivariable models did not materially change the direction or dimension of these results.

Among 1050 REH patients, the length of the acute care phase prior to REH transfer, a close approximate of time delay between fracture and commencement of REH, was directly related to the one-year mortality rate in the univariate analysis (Table V5-D). Longer acute care was associated with higher rates of RAC residency and lower rates of independence at one year. The total time in REH was not associated with one-year mortality in either univariate analysis or in models adjusted for sex, age-group and comorbidity weight. There was a direct association between duration of REH and rate of residence in RAC, and an inverse relationship with the likelihood of independent living, at one year post-fracture, in both univariable and multivariable analyses (Table V5-D). Similar associations were found in respect of acute phase LOS.

A total of 306 patients (29.1 per cent) who received REH and 212 (31.5 per cent) of those without REH became RAC residents at some time within one year of fracture. Total time in RAC was 68.3 days per capita for REH patients and 71.5 days for non-REH patients. Neither of these differences was significant.

Among community-dwelling survivors at one year, 275 subjects (25.0 per cent) were receiving community nursing and/or veterans' home care services. These subjects did not differ from those not receiving services with regard to male/female distribution, mean age, or comorbidity scores. It was found that more REH patients were referred to community nursing in the first 90 days after hospital discharge, but the difference was not significant for later end-points. Rates of death or RAC placement between one and two years were not different for these patients (data not tabled).

Discussion

Admitted care for rehabilitation following hip fracture added almost 2 weeks to the index hospital stay and at least $AUD 12000 to hospital costs. Among patients referred for REH, mortality at one and two years post-fracture was lower by 40 percent than for patients not referred. The rates of admission into, duration of residence in aged care facilities or proportion of patients meeting criteria for independent living were not significantly different in multivariable models. Hospital readmission rates during the first post-fracture year were not reduced for REH patients.

The acute hospital management of hip fracture continues to be refined, and continues to yield better results with respect to hospital mortality, complication rates and hospital costs (27, 28). The benefits of subsequent REH for sustained survival and independent living, whether in hospital units or a variety of community-based programs have not been so convincing (19, 20, 22).

The claim that multidisciplinary REH may have both short and longer- term benefits is advanced in both systematic review (19) and meta-analysis (20). However only a minority of the quoted studies (4 of 9 in the latter report) relating to hip fracture continued follow-up to the end of the first post-fracture year. Our paper suggests that outcomes in the first 90 days after fracture are not consistently predictive of ongoing outcomes. When data from meta-analyses (20) were restricted to studies with at least 12-months follow-up, associations between REH and positive 12-month outcomes were significant for Katz scores (two studies only) but not significant for RAC admission (RR 0.79, 95% CI 0.51-1.22, p=0.30) and borderline for mortality (RR 0.76, 95% CI 0.58 -1.00, p=0.047).

Analyses of a large sample of Medicare (USA) data for the period 2000–2008 (14) showed that the proportion of hip fracture patients admitted from RAC (the most frail) declined, while providing indirect evidence for an increase in rates of transfer to and duration of post-acute REH. Despite these trends, the proportion of subjects resident in RAC at one year post-fracture remained essentially unchanged at 35 per cent. Providing more institution - based REH for a seemingly more robust population did not translate into better outcomes (14).

In the present study, increased length of in-hospital REH was inversely related to independence at one year, with residence in RAC being more than twice as likely for patients in REH for 35 days or longer than for patients in REH for less than 3 weeks. Data from almost 68000 REH episodes for "orthopaedic conditions" (22 per cent hip fracture) in the United States showed a 42 per cent fall in LOS over the period 1994-2001, associated with a slight increase in proportion of patients living at home at 180-day follow-up (29). An earlier American study found that longer stay in REH was associated with reduced ADL capacity after one year (30).

The present study has confirmed the overall findings from a systematic review (23) that REH does not impact upon hospital readmission rates. The relationship between readmissions and longer term outcomes is complex for hip fracture patients. One Italian study reported ongoing higher mortality beyond 180 days for readmitted patients, but this finding was not tested in multivariate analysis (31). A study in Genova found that the predictors for readmission within one year of fracture were comorbidity and low functional status at original discharge (32), factors which are themselves associated with higher mortality .

The evidence for any superior clinical benefit from delivery of REH in hospital units compared to use of alternative models, including home-based programs, is also weak. More than 30 years ago Swedish researchers (33) noted that prolonged hospitalisation, whether in orthopaedic or rehabilitation units, was associated with reduced capacity for subsequent independence. They advocated for early hospital discharge and consideration of rehabilitation as a domiciliary program. At the same time a Danish team (34) identified substantially lower costs but equivalent outcomes for patients rehabilitated in convalescent hospitals with physical therapy services, compared with similar patients treated in specialist REH hospitals.

A small Australian trial of domiciliary vs hospital-based REH for previously independent patients showed no differences in measures of physical function at

12 months. Importantly, carer burden was reduced for patients treated at home (35). Another Australian program (HIPFIT) provided 12 months of high-intensity resistance training coupled with evidence-based treatment of other issues relevant to frailty, in a multidisciplinary outpatient program supervised by a geriatrician. Although study numbers were small - 62 participants, 62 controls - significant reduction in mortality and nursing home occupation after 12 months was achieved (18). In 2007, a study in Tuscany (17) showed that REH models for hip fracture ranging from admitted care to domiciliary programs, with an 18-fold cost variation, produced very similar 6-month mortality rates.

Despite the weak evidence for sustained benefits from hospital-based REH, the age-standardised rates of hospital-based REH (for all conditions) increased in Australia from 18 to 32 per 1000 persons aged ≥ 65 years between 1998-99 and 2011-12 (2, 3). Evidence for a similar increase in ambulatory programs is lacking. Of almost 50000 episodes of REH for orthopaedic fractures (all types) reported to the Australasian Rehabilitation Outcomes Collaboration (AROC) from 2012 to 2014 inclusive, only 2.4 % were in ambulatory settings (36).

The assessment of “potential to benefit” which is integral to the process of selection for admission into REH appears to identify factors associated with better survival. In this analysis of community patients, referral to REH was associated with prolonged survival benefit. Perhaps surprisingly, given that REH programs are directed toward improvement of functional capacities, no impact was found upon longer-term dependence upon RAC, or use of community support services, even though there were lower rates of identified dementia in the REH group.

The principal strengths of this study lie in the substantial patient numbers, the comprehensive dataset and most importantly the facility for linkage of hospital, aged care and mortality data. The potential for coding errors in administrative data is acknowledged, but acceptable coding accuracy for hip fracture in database records has been confirmed (37), further enhanced by the additional inputs through episode linkage (38). Under-reporting of some comorbidities is highly probable, particularly as the look-back period, confined to the “study-year” was of necessity brief for some patients. However this would be at least as likely to add to the validity of any identified associations as otherwise.

The study would have been strengthened by access to data describing physical function status such as with Functional Independence Measure (FIM) scores and also by information on carer and social context at both the commencement of rehabilitation and at specified follow-up intervals. Associations between both of these items and short-term mortality and functional gain following REH are well established (39, 40). The study data contained no details of differences in the admission criteria, processes or intensity of the REH programs delivered by the various public and private hospitals. The reasons why individual patients were not selected for REH could not be discerned from the study databases. It is appreciated that patients can be either too able or too frail to meet REH admission criteria, the similarities in patient characteristics between the REH and non-REH groups would suggest that neither reason was sufficiently prominent to bias the study findings.

It is acknowledged that the DVA population is atypical, being several years older than the general hip fracture population in Australia (29), and having a higher proportion of males. Where comparable data sets are available, mostly relating to acute hospital care, utilisation data are very similar (25, 29), and patient age has only minor impact upon hospital stay and costs in the population presented here (25). However the findings and conclusions should be generalised with caution, unless compared in age-gender specific analyses.

Database studies, with restricted capacity for describing clinical details, have an important role in presenting broad descriptions of process and outcomes for large patient populations. As with this study, important questions of efficacy and cost-efficiency may be posed, which call for analyses based upon studies with access to deeper levels of both clinical and administrative detail.

In summary, this paper has found, in a large series of elderly, community-dwelling Australians, post-fracture rehabilitation in hospital was associated with lower mortality for up to two years. There were no consistently significant effects attributable to REH upon hospital readmission rates, proportions of survivors who required support in Aged Care facilities, in the total days in RAC for the first post-fracture year, or in the proportions of patients living without defined community services. Hospital-based REH added substantially to the duration and cost of the index hospital admission and prolonged stay in rehabilitation units was associated with poorer long-term outcomes. Given that hospital-based REH is resource intensive, and the cited evidence that non-hospital REH programs provide equivalent long-term outcomes, it is suggested that community-based programs be further considered for hip fracture patients.

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Table V5-A. Patient characteristics of 1724 community-dwelling patients by rehabilitation selection

	Rehabilitation (N=1050)		No Rehabilitation (N=674)		
	N	**Per cent**	**N**	**Per cent**	***P***
Males	383	36.5	245	36.4	0.96
Mean age (years)		86.0		85.8	0.45
Age group					0.004
≥ 90	226	21.5	151	22.4	
85–89	471	44.9	302	44.8	
80–84	289	27.5	152	22.6	
< 80	64	6.1	69	10.2	
Fracture type					0.10
Cervical	413	39.3	255	37.8	
Trochanteric	459	43.7	277	41.1	
Subtrochanteric	37	3.5	38	5.6	
Other	141	13.4	104	15.4	
Surgery		88.9		84.9	0.02
Quan score					0.12
≥ 3	132	12.6	106	15.7	
1–2	312	29.7	205	30.4	
0	606	57.7	414	53.9	
Low mortality risk [1]	174	16.6	104	15.4	0.53
Comorbidities					
Cancer	83	7.9	42	6.2	0.19
Cardiac failure	132	12.6	67	9.9	0.09
Dementia	101	9.6	152	22.6	<0.001
Diabetes	44	4.2	33	4.9	0.17
Cardiac ischaemia	106	10.0	57	8.5	0.25
Renal failure	136	13.0	82	12.2	0.63
Respiratory disease	92	8.8	41	6.1	0.13
Stroke	62	5.9	37	5.5	0.72
Complications					
Anaemia	83	7.9	53	7.9	0.46
Delirium	92	8.8	41	6.1	0.04
Pressure ulcer	87	8.3	46	6.8	0.27
Respiratory infection	122	11.6	76	11.3	0.83
Urinary infection	112	10.7	82	12.2	0.34

[1] Relative low mortality risk: Females aged < 85 years, comorbidity = 0

Table V5-B. Hospital utilisation data: 1724 community patients with hip fractures

	Rehabilitation (N=1050)			No rehabilitation (N=674)			*P*
	Patients	**Days**	**95% CI**	**Patients**	**Days**	**95% CI**	
Mean length of stay : index hospital admission [1]							
Acute phase	1050	11.8	(11.3-12.3)	674	17.5	(16.3-18.7)	<0.001
Rehabilitation	1050	25.1	(24.2-26.0)	-	–	–	–
Other episodes	273	20.7	(18.4-23.0)	238	30.5	(27.1-34.1)	<0.001
Total [2]	1050	42.4	(40.9-43.9)	674	28.3	(26.1-30.5)	<0.001
Readmissions within 365 days of index admission							
Patients [3] (%)	633	60.3	(57.3-63.3)	374	55.6	(51.8-59.4)	0.05
Mean Days [4]	1050	14.5	(12.6-16.4)	674	17.1	(13.5-20.6)	0.11
Days > 30 [5] (%)	182	28.8	(25.3-32.3)	112	29.9	(25.3-34.5)	0.69

Mean total hospital costs

	$AUD	**95% CI**	**$ AUD**	**95% CI**	
Index admission	40439	(39338-41640)	26242	(24913-27571)	<0.001
Readmissions	14170	(12566-15774)	14729	(12373-17085)	0.06
Total	54595	(52685-56505)	40970	(22492- 30022)	<0.001

[1] LOS data for rehabilitation patients from Ireland et al. BMC Health Services Research 2015, 15:17 doi:10.1186/s12913-015-0697-3 (Table V2-B).
[2] Total LOS = Acute + Rehabilitation + pro-rata for Other episodes
[3] Patients who had at least one hospital readmission
[4] Days = sum of LOS for all readmission episodes / all patients
[5] Mean days as for [4] above

Table V5-C. Outcome rates by rehabilitation status in 1724 acute phase survivors after hip fracture

Univariable analyses

Interval [1]	With rehabilitation N=1050			Without rehabilitation N=674			
	N	Per cent	(95 % CI)	N	Per cent	95 %CI	*P*
Death							
90 days	49	4.7	(3.4–6.0)	72	10.7	(8.4–13.0)	<0.001
One year	160	15.2	(13.0–17.4)	155	23.0	(19.8–26.2)	<0.001
Two years	275	26.2	(23.5–28.9)	251	37.2	(33.5–40.9)	<0.001
RAC resident							
At 90 days	150	15.0 [2]	(12.8–17.2)	114	18.9	(15.8–22.0)	0.04
At one year	192	21.6	(18.9–24.3)	120	23.1	(19.5–26.7)	0.50
At two years	148	19.1	(16.3–21.9)	79	18.7	(15.0–22.4)	0.95
Independent living [3]							
At 90 days	592	56.3 [2]	(53.3–59.3)	404	59.9 [2]	(56.2–63.6)	0.14
At one year	438	41.7	(38.7–44.7)	313	46.4	(42.6–50.2)	0.054
At two years	396	37.7	(34.8–40.6)	271	40.2	(36.5–43.9)	0.30

Multivariable [4] analyses: Outcome risk for rehabilitation patients

Interval [1]	Death			RAC Resident			Independent living [3]		
	OR [6]	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
90 days	0.40	(0.3–0.6)	<0.001	0.89	(0.7–1.2)	0.42	0.87	(0.7–1.1)	0.19
One year	0.61	(0.5–0.8)	<0.001	1.09	(0.8–1.4)	0.52	0.46	(0.4–0.6)	0.002
Two years	0.59	(0.5–0.7)	0.003	1.22	(0.9–1.6)	0.18	0.87	(0.7–1.1)	0.20

[1] Interval= Time since index hospital admission
[2] Per cent survivors at specified time point: 150/(1050 – 49) = 15.0 per cent at 90 days
[3] Not deceased, not in RAC, not receiving community nursing or veterans' home care
[4] Adjusted for sex, age-group, comorbidity
[5] OR = Odds Ratio for given outcome for REH vs non-REH

Table V5-D. One-year outcomes by length of stay in acute care and rehabilitation for 1050 patients receiving rehabilitation

	Death		Residential aged care		Independent living [1]	
	Per cent	**95 % CI**	**Per cent**	**95 % CI**	**Per cent**	**95 % CI**
Acute care LOS						
< 10 days	12.0	(9.1–14.9)	17.9 [2]	(14.2–21.6)	72.3	(68.3–76.3)
10 –14 days	15.7	(11.7–19.7)	22.6	(17.6–27.6)	65.2	(60.0–70.4)
≥ 15 days	20.2	(15.3–25.1)	31.1	(24.8–37.9)	55.0	(48.1–61.1)
P	0.004		0.017		<0.001	
Rehabilitation LOS						
< 21 days	13.5	(10.4–16.6)	16.3	(12.7–19.9)	72.4	(68.3–75.5)
21–34 days	15.3	(11.7–18.9)	22.4	(17.9–27.0)	65.7	(60.9–60.5)
≥ 35 days	19.2	(13.8–24.6)	32.3	(25.2–39.4)	54.7	(47.9–61.5)
P	0.16		<0.001		<0.001	
Multivarible [3] for Acute LOS						
	OR [4]	95 % CI	**OR**	95 % CI	**OR**	95 % CI
< 10 days	referent		referent		referent	
10 –14 days	1.47	(0.96-2.24)	1.09	(0.73-1.64)	0.79	(0.58-1.05)
≥ 15 days	1.60	(1.04- 2.45)	1.93	(1.30- 2.88)	0.66	(0.48-0.91)
P	0.066		0.003		0.030	
Multivariable [3] for Rehabilitation LOS						
< 21 days	referent	–	referent	–	referent	–
21–34 days	1.07	(0.72-1.59	1.34.	(0.92-1.97)	0.79	(0.59-1.04)
≥ 35 days	1.28	(0.81-2.03)	2.21	(1.44-3.43)	0.60	(0.42-0.86)
P	0.57		0.002		0.015	

[1] Neither deceased ,resident in RAC nor receiving community services
[2] Per cent of survivors at 365 days
[3] Adjusted for sex, age group, comorbidity
[4] OR = Odds Ratio for given outcome for REH vs non-REH

Section VI. Overview of results with additional findings

In this section the principal findings of the various studies within this thesis are reviewed and summarised. Some additional original research findings are included where relevant to better illustrate the complexity of the data and to add further context to the published material in Section V. All additional material presented in this section is drawn from the original study databases by methods described for the individual research studies in Section V.

VI (1). Length of Stay

Research studies 1 and 2 have identified the total burden of hospital stay for the initial management of hip fracture, the varied composition of that stay and the factors associated with shorter or longer time from admission to final discharge. These findings address the requirements of Objectives 1 and 2 in Section IV(1).

The mean acute phase LOS for unlinked episodes in this study was 11.1 days (median 10 days): 11.4 days for men and 10.9 days for women. There was a small increase of slightly more than one day in mean LOS with increasing age between 70 and 85 years, which was significant for women, but not for men. Patients aged 90 years or older had shorter acute LOS than did octogenarians.

Episode linkage for acute care showed that 22 per cent of patients had multiple acute episodes coded to hip fracture, with eight patients having four such continuous episodes. When additional acute phase episodes for the same patient were combined, the mean LOS was 20 per cent higher at 13.4 days than the unlinked value.

Total LOS for hip fracture is the sum of all hospital time for acute fracture management, rehabilitation and care for other reasons, the latter group ranging from management of surgical complications, to issues arising from pre-existent comorbidity to subacute care while completing discharge arrangements. Only 41 per cent of patients were discharged from hospital after a single episode while the other 59 per cent of patients averaged 2.8 episodes each. The most complex hospitalisation involved eight episodes of care in five different hospitals. The variety of episode combinations and eventual LOS demonstrates the clinical complexity of this patient population. The mean total LOS identified in Research Study 1 was 30.8 days with a median of 26 days. The range was 1-310 days. Almost 7 per cent of patients were in hospital for 10 weeks or longer.

Composition of total hospital stay

Research Study 2 found that 43 per cent of total stay occurred in the initial acute phase. Rehabilitation as admitted care accounted for a further 37 per cent, and the remaining 20 per cent was on account of other episodes comprised of acute care for complications and comorbidities, and subacute care for other reasons. There were 1352 episodes of in-hospital rehabilitation for 1172 patients (46 per cent) and 652 patients (26 per cent) had 780 other episodes as defined. Referral to rehabilitation occurred in 57 per cent of community patients and 17 per cent of RAC patients (P<0.001) and other episodes were identified for 30 per cent of community patients and 20 per cent of patients from RAC (P<0.001).

There were 780 episodes for 652 patients for reasons other than acute fracture management or rehabilitation. This group was not separately analysed in Study 2. These patients did not differ from the whole sample with regard to age or sex distribution. Immediate and longer-term outcomes for this group are described in the review of Research Study 3 (page 129).

Determinants of LOS

Patients who were admitted from RAC or from the community had widely different episode distributions and resultant total LOS values of 18.8 days and 35.4 days respectively (Table V2-B). An extensive list of factors which increase acute LOS for community and RAC patients are shown in Study 2, Table V2-C. The profiles of associations with altered LOS differed markedly between Community and RAC patients, as demonstrated in Study 2, Tables V2-C and V2-D. For RAC patients, neither acute nor total LOS was impacted by any comorbid condition, but transfers to rehabilitation or intensive care were associated with much greater increases than for community patients (Tables V2- C, D).

For the combined study sample, total LOS for patients referred for rehabilitation was 20 days longer than that of other patients. Total LOS for patients requiring other episodes was 49 days, even though the proportion referred to rehabilitation within this was not significantly high (48 per cent vs 45 per cent, P = 0.31). When the length of "other" episodes was seven days or longer (478 patients), mean total LOS was 56 days.

Table VI-1 shows the associations with both acute phase and total LOS for the complete study population. The mean values for LOS increments are the exponentials of outputs from multivariable negative binomial regression models. Increases of greater than 2 days in the acute phase were associated with, in descending order, wound infection, skin (pressure) ulcer, urine infection, chest infection and referral to intensive care. For total LOS, increases of greater than 3 days were associated with referral to rehabilitation, transfers to unspecified facilities, skin ulceration, wound infection, urinary infection, Parkinson's disease, subtrochanteric fracture and age between 85 and 89 years.

Death in hospital was the only factor associated with a substantial decrease in either acute or total LOS for the complete population. It was evident from the data of Table VI-1 that individual comorbidities play only a minor role in determining LOS. There was a small but significant increase in acute LOS for patients with multiple comorbidities (Quan score ≥ 2), of 0.9 extra days ($P = 0.03$), but no significant difference in respect of total LOS ($P = 0.32$). Complications exerted a much greater influence upon both acute and total LOS, especially pressure ulcers, and urinary tract or surgical site infections (Research Study 2). By far the strongest overall determinants of hospital stay were pre-admission residential status and referral for rehabilitation. The requirement for other hospital episodes other than acute phase and rehabilitation was a third major determinant.

Table VI-1. Factors significantly associated with acute and total LOS after hip fracture

	Acute LOS : Baseline[1] = 10.6 days		Total LOS: Baseline = 13.7 days	
	Increment[2] (95% CI)	*P*	Increment (95% CI)	*P*
Age-group		0.04		< 0.001
< 80	referent		referent	
80-84	0.4 (-0.8, 1.9)		2.5 (0.6–4.6)	
85-89	1.0 (-0.3, 2.4)		3.4 (1.5–5.5)	
≥ 90	0.0 (-1.2, 1.3)		1.4 (-0.3, 3.4)	
Fracture Type	–			
Cervical	referent		referent	
Trochanteric	–		1.6 (0.7–2.5)	
Subtrochanteric	–		3.5 (1.3–6.0)	
Unspecified	–		3.8 (2.5–5.3)	
Separation mode		< 0.001		< 0.001
Usual residence	referent			
New RAC transfer	1.5 (0.4–2.7)		0.0 (-0.9, 0.9)	
Other transfer			6.2 (4.1–8.5)	
Death	-1.3 (-2.7, -0.2)		-2.9 (-3.9, -1.8)	
Rehabilitation	–	–	12.5 (11.0–14.1)	
Surgery	1.3 (0.4–2.2)	0.003	–	
Intensive care	2.2 (0.9–3.6)	0.001	3.0 (1.3–4.9)	0.001
Comorbidities				
Dementia	–	–	-1.2 (-2.0, -0.3)	0.008
Diabetes	–	–	2.1 (0.7–3.6)	0.002
Parkinson's disease	–	–	3.9 (1.3–6.9)	0.001
Cardiac failure	1.8 (0.8–2.8)	< 0.001	–	–
Cerebrovascular	1.4 (0.1–2.8)	0.03	–	–
Complications				
Anaemia	–	–	1.5 (0.3–2.7)	0.001
Delirium	1.6 (0.5–2.9)	0.006	2.6 (1.1–4.2)	< 0.001
Pressure Ulcer	4.9 (3.4–6.6)	< 0.001	5.3 (3.9–6.8)	< 0.001
Chest infection	2.2 (0.9–3.6)	< 0.001	2.2 (0.9–3.7)	< 0.001
Urinary infection	2.5 (1.5–3.6)	<0.001	4.0 (2.7–5.3)	< 0.001
Wound infection	5.6 (2.1–10.2)	< 0.001	5.0 (2.0–7.9)	< 0.001

[1] Baseline = LOS for female <80 years with cervical fracture: no surgery, rehabilitation, intensive care, comorbidity, complications: separated to usual residence

[2] Mean additional days above baseline value

VI (2). Costs of hospital treatment

The charges raised by hospitals for accommodation, theatre, prostheses and for any package arrangements with DVA were identified in Study 1, Table V1-B. The mean cost for the complete period of acute phase care was very close to $AUD15,000 and for total stay was just above $26,000. In subsequent work comparing DVA costs in the different states, additional fees for health practitioner services during hospitalisation (Study 4) raised the mean total cost of the index hospitalisation to slightly above $31,000. While formal cost analyses and projections are outside the expertise of this Thesis, the current cost for total hospital management would be in excess of $45,000 if annual inflation of 5 per cent was applied, as quoted for public hospital spending 2008 to 2015.[78]

Determinants of hospital cost

These are displayed in Table VI-2.The mean cost increments above defined baselines were derived by the same method as for LOS values (Table VI-1). As may be expected the factors associated with the greatest cost increases were similar to those responsible for increased LOS. The major cost increases were associated with transfers to rehabilitation, intensive care, surgical treatment and surgical site infection. Co-incident Parkinson's disease and complicating pressure ulcer are the next most substantial cost factors. Effecting discharge to other than pre-admission accommodation increased expense. Subtrochanteric fractures were more costly for RAC but not community patients, otherwise sex, age group and fracture type are not substantial determinants of hospital cost. Patients with multiple comorbidities (Quan ≥ 2) had only slightly greater total costs than those with single or zero comorbid conditions ($32000 vs $30630, P=0.037).

In unadjusted data, determinant factors for cost had a strongly cumulative effect. RAC patients treated non-surgically, without rehabilitation, who did not acquire a pressure ulcer and return to RAC (n=66) had a mean cost of $10,010. Community patients treated surgically, referred to rehabilitation, had a complicating pressure ulcer and are discharged to RAC (n=38) have a mean cost of $54,027.

Table VI-2. Factors significantly associated with cost for total hospital stay after hip fracture

Baseline Cost[1]	All Patients (N=2552) $AUD 13195 Increment (95% CI)[2]	Community (N=1844) $AUD 15217 Increment (95% CI)	RAC (N=708) $AUD 10459 Increment (95% CI)
Age-group			
< 80	referent	referent	referent
80-84	718 (-409, 1946)	–	–
85-89	1509 (368–2747)	–	–
≥ 90	413 (-692, 1616)	–	–
Fracture Type			
Cervical	referent	referent	referent
Trochanteric	-530 (-1052, 13)	–	-949 (-1614, -234)
Subtrochanteric	2827 (1293–4520)	–	3528 (1110–6450)
Unspecified	503 (-263, 1314)	–	180 (-808, 1270)
Separation mode			
Usual residence	referent	referent	referent
New RAC transfer	295 (-296, 913)	3179 (2154–4262)	N/A
Other transfer	3291 (2041–4647)	3365 (1932–4919)	4282 (871–8721)
Death	-220 (-1066, 683)	173 (-1034, 1485)	276 (-690, 1336)
Rehabilitation	9265 (8359–10210)	9382 (8241–19579)	7197 (5708–8821)
Surgery	5765 (4751–6837)	5036 (3853–6291)	9230 (7379–11272)
Intensive Care	5360 (4023–6837)	5454 93781–7276)	4869 (2731–7373)
Comorbidities			
Cardiac failure	–	1157 (67–2325)	–
Diabetes	1296 (409–2234)	1266 (73–2552)	–
Parkinson's	2525 (872–4371)	3548 (1121–6338)	–
Cerebrovascular	1577 (482–2759)	259 (697–3974)	
Complications			
Anaemia	1682 (893–2516)	1643 (570–2786)	1520 (498–2638)
Delirium	2364 (1395–3399)	2187 (873–3609)	1917 (697–3369)
Pressure ulcer	3232 92369–4142)	3824 92646–5081)	2095 (975–3327)
Chest infection	1237 9357–2174)	1423 (179–2768)	–
Urinary infection	2417 91639–3235)	2338 (1304–3436)	2862 (1724–4108)
Wound infection	4942 (3336–6703)	5254 (3295–7421)	3936 (1090–7483)

[1] Baseline = LOS for female <80 years with cervical fracture: no surgery, rehabilitation, intensive care, comorbidity or complications: separated to usual residence

[2] Additional cost above baseline value

VI (3). Outcomes at hospital separation.

The identified outcome measures were for death, transfer to RAC, transfer between or within hospitals and discharge to residence other than RAC. In the mean interval of 19.7 days between the end of the (unlinked) acute phase and final discharge the profile of these separations changed markedly as shown in Research Study 1, Table V1-D, and in Figure VI-1. The high proportion of transfers into other hospital episodes after the acute phase (50.9 per cent) were almost all reclassified at final discharge, when a small number of further transfers were to unidentified facilities. Only 23 per cent of patients were discharged directly from the acute phase to private homes. At final discharge 58 per cent of patients were initially assigned separation code 9 ("to usual residence"). This was reduced to 44 per cent after linkage with RAC data caused all but 14 of code 9 separations for RAC patients to be reclassified as returning to residential aged care. Among community patients 60 per cent returned to non-institutional living.

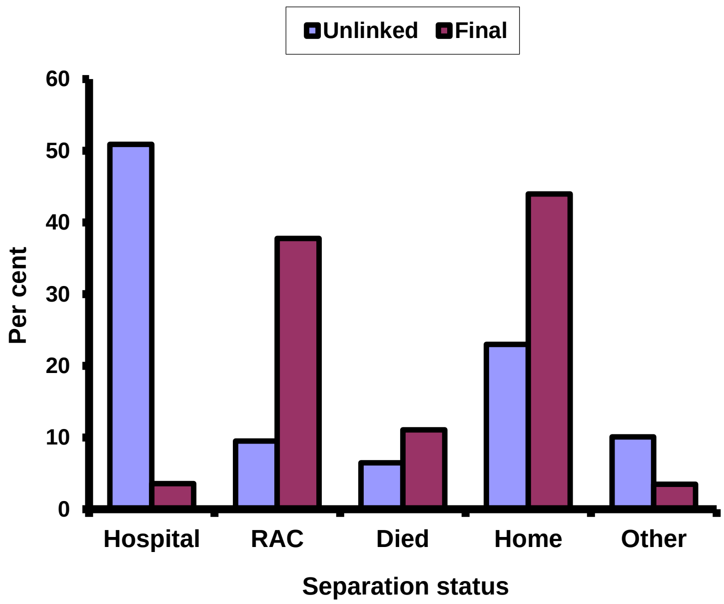

Figure VI-1. Separations from unlinked acute episodes and at final discharge

Overall, men were less likely to be transferred to RAC than women (34.9 per cent vs 39.6 per cent (P=0.02)). Mortality rates at final hospital discharge were higher for men (16.9 per cent vs 7.6 per cent).

At final discharge 60 per cent of community patients returned to private accommodation, 9.5 per cent had died and 21 per cent were transferred to RAC (although almost half of these were short term residents only). Small proportions were discharged to other health facilities to unidentified locations. Among RAC patients, 80 per cent (97 per cent of hospital survivors) returned to RAC, 15 per cent died in hospital and 14 patients returned to non-institutional living. The different separation profiles are shown in Figure VI-2.

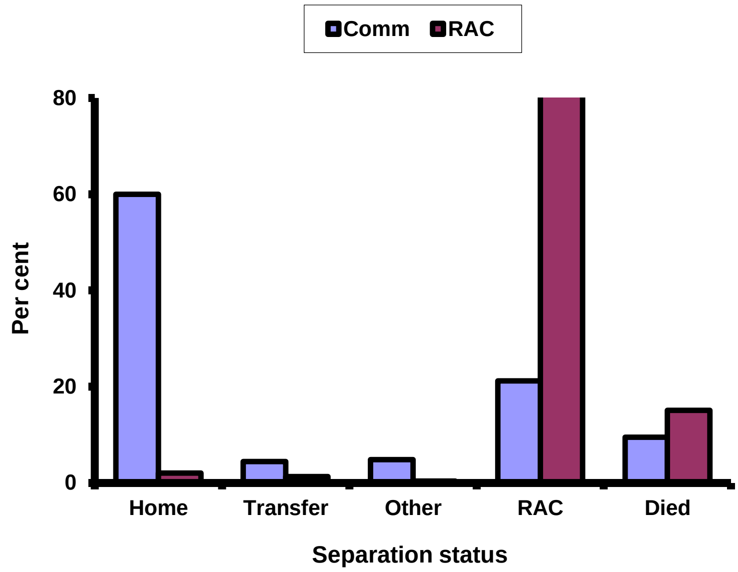

Figure VI-2. Outcomes at final discharge for RAC and community patients

VI (4). Mortality

Research Study 3 addressed mortality rates and the factors associated with greater or lesser survival at intervals from 3 months to two years after hip fracture. Comparative mortality rates between hip fracture patients and a standard DVA population for 4 years after fracture have also been calculated. These results were in response to the requirements of Objective 4.

The data presented for the DVA study population in 2008-09 showed 30-day mortality of 11 per cent, one-year mortality of 34 per cent, 47 per cent at two years and only one-third of patients surviving 4 years. Within these overall data there was wide diversity in mortality. At all listed time points the mortality rate for males was significantly higher ($P < 0.001$). Admission from RAC and multiple comorbidities (Quan score ≥ 2) also increased the risk of death. The very large combined impact of these predictors is shown in Figure VI-3. Women aged below 85 years from the community and with no recorded comorbidity had one-year mortality of 10 per cent, while the rate for men aged 85 years or older from RAC with multiple comorbidities was 89 per cent.

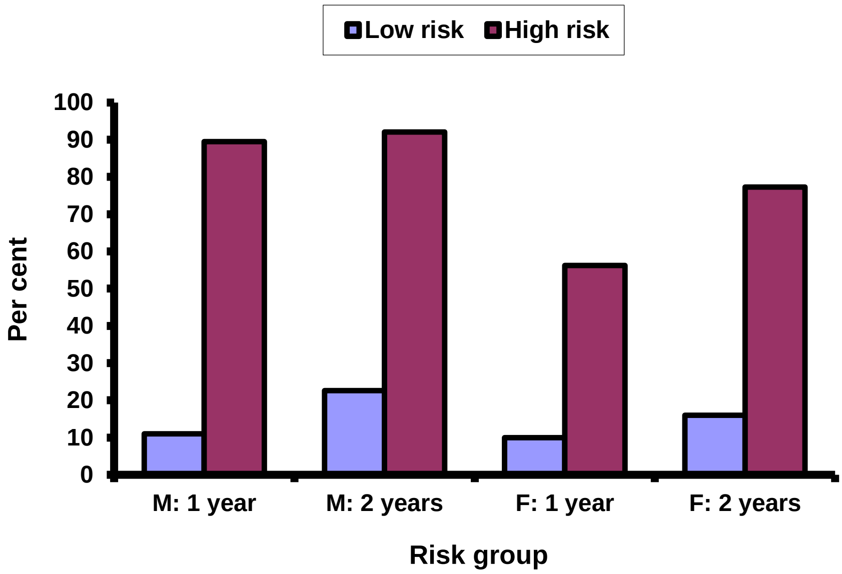

Figure VI-3. Mortality rates by sex and risk status [1]

[1] RAC patients aged ≥ 85 years with multiple comorbidities are high risk group for mortality

Predictors of mortality

In multivariate models the profiles of significant predictors varied across time (Research Study 3, Table V3-C). In the first 30 days, the mortality rate was approximately doubled by male sex, older age and admission into intensive care, and patients from RAC had a 50 per cent greater risk of dying. Patients selected for surgical treatment or rehabilitation were much less likely to die in this period. Cardiac failure, non-AMI ischaemic heart disease and renal disease all increased mortality risk by approximately 50 per cent.

Between 30 days and one year, RAC patients were three times more likely to die than were community patients. Male sex and age over 80 years continued to carried increasingly high risk. (Study 3, Table V-3-C). Admission into intensive care, comorbid cardiac failure and renal disease continued to impart a higher risk as earlier. Patients with cerebrovascular disease, cancer and pressure ulcers prior to or at the time of hip fracture had increased risk of death between 30 days and one year after fracture. Rehabilitation continued to be associated with lower mortality, but the lower mortality among patients treated surgically was no longer evident. Patients who had additional or 'other' episodes within the index admission had similar mortality rates at one year and two years to those of the rest of the study population, even though comorbidity measured by mean Quan scores was higher in this sub-group.

Direct transfer of community patients from hospital to RAC (new RAC transfer) was also associated with higher mortality after 30 days (Study 3, Table V3-C). At 90 days, 36 of 391 such patients (9.2 per cent) had died and at the end of one year 26.1 per cent had died. Corresponding values for community patients discharged elsewhere were 2.7 % and 12.1 per cent (P<0.001).

In the second year following hip fracture, 335 patients died (20% of 12-month survivors). Males were 40 % more likely to die, and risk for those aged 90 years or older was nearly three times that for persons younger than 80 years. Patients from RAC were more than three times more likely to die. Diabetes with complications, cardiac failure, cancer and dementia were, in descending order, associated with increased mortality, the latter having borderline significance (Research Study 3, Table V3-C).

The higher mortality for RAC patients is again illustrated in Figure V3-A, which shows survival curves for four identified risk groups. Females from the community had one-year mortality of 19 per cent while 72 per cent of males from RAC had died. The addition of extra variables for age and comorbidity further widened this disparity. Of 216 community females aged below 85 years and with no comorbidities, 10 per cent were dead at one year, compared with 89 per cent of RAC males aged 85 years or older with two or more comorbidities.

Table V3-D in Study 3 shows mortality rates for males and females standardised against the DVA TPOP for each of the four years following fracture. Comparison rates are higher for all four years, being substantially higher in year 1, then essentially stable. Males and females had similar ratios. Higher than expected mortality was sustained into the fourth year after fracture for all patients except for males aged 90 years or older.

VI (5). Hospital readmission

Hospital readmission within one year of the index fracture occurred in 52 per cent of 2269 patients who survived the initial hospitalisation (RAC patients 47 per cent, community patients 53 per cent). Total readmission episodes were 4499 (2.0 per patient) for a total of 31,069 bed-days (13.7 per patient). Further details are summarised in Table VI-3.

Readmission rates were significantly higher for community patients than for RAC patients (60.4 per cent vs 44.6 per cent, $P < 0.001$). Lower rates for RAC patients were partly offset by their shorter average survival time within the first year (220 vs 299 days). Among community patients who survived the acute phase of the index admission, patients referred to REH had marginally higher readmission rates as shown in Research Study 5, (60.3% vs 55.6 %, $p=0.05$). Readmission status was not a significant variable in regression models for the three defined outcomes for REH against non-REH patients. Within each subgroup, higher two-year mortality for readmitted REH patients (31% vs 18 %, P<0.001) was the only instance in which readmission was significantly associated with outcomes. For all causes of readmission, occupied bed days and costs per capita were not different for REH and non-REH patients (Table V2-B). There were 635 readmission episodes coded as rehabilitation within the first year, for 239 patients. Of these 580 episodes and 199 patients came from the REH group.

Table VI-3. Hospital readmissions within one year for 2269 survivors of initial hospitalisation for hip fracture

	All (N=2269)	**Community (N=1668)**	**RAC (N=601)**
Readmitted patients	1276	1008	268
Per cent survivors	56	60	45
Episodes	4499	3913	586
Per patient	2.0	2.3	1.0
Per readmitted patient	3.5	3.9	2.2
Bed-days	31069	27174	3895
Per patient	13.7	16.3	6.5
Per readmitted patient	24.3	27.0	14.5

VI (6). Association between resource outlay and patient outcomes: comparative data for Australian States

This relationship was examined in Research Study 4, by comparing hospital stay and costs in the different states of Australia with one year outcomes for death and measures of independent living. The results of this study address the requirements for Objective 5. For the purposes of this analysis, data in respect of the Australian Capital Territory was combined with that for New South Wales and Northern Territory data with that for South Australia. The patient demographics, proportions of patients treated surgically and of those with significant comorbidity were not significantly different between the six populations.

Hospital services and costs

As shown in Study 4, Table V4-A, the proportions of patients referred to intensive care and rehabilitation units varied significantly across Australia. Both of these services are associated with significant and substantial cost increments in the data for this thesis (Table VI-2). The range for identified intensive care admission rates was from zero to 14 per cent (P<0.001), and for rehabilitation between 32 per cent and 50 per cent (P=0.003). Mean acute phase LOS was between 9 and 15 days (P<0.001) and total LOS was between 25 and 36 days (P<0.001). Both the frequency and duration of rehabilitation episodes varied widely and significantly (Study 4, Figure V4-A). The sum of costs for hospital accommodation, theatre, prosthesis and package fees negotiated by DVA with individual providers, plus charges for medical, allied health, and diagnostic services, ranged from $24,052 to $36,247, a spread of more than 50 per cent around the mean of $31,028 (Figure V4-A).

Post-hospital services

Data were collated for episodes of service by community nursing and by Veterans' Home Care, the latter providing a basket of personal and domestic services and also both institutional and in-home respite. The density of service provision and the currency of services at the end of the one year follow-up were identified. The total days in RAC after hospital discharge and the number of surviving patients who were RAC residents at year's end were also tabled for community patients. Again the differences in provision of these items differed substantially and significantly among the states.

Outcome measures

Rates for mortality, current RAC residency and a defined level of independence were compared at one year from the index hospital admission in both univariate and multivariate models adjusted for sex, age group comorbidity weight, pre-fracture RAC status, rehabilitation during initial hospitalisation and receipt of nursing and/or VHC services in the post-hospital period. Patients who were alive, not in RAC and not currently receiving nursing or VHC services were deemed to be living independently. In multivariable models there were no significant differences in rates of defined outcomes between Australian states. Mortality varied from 31 per cent to 41 per cent (P=0.71), RAC residency was between 32 and 38 per cent (P= 0.56) and defined independence between 33 to 39 per cent (P=0.20). The same state recorded the most favourable values for all three outcome measures, being also the state with the lowest cost for initial hospitalisation. (TablesV4-A,C)

VI (7). Association of in-hospital rehabilitation with short-term and long-term outcomes in community patients.

Research Study no. 5 compared hospital resource outlay and one-year rates of mortality, RAC residency and defined independence for community patients with and without evidence for in-hospital rehabilitation (REH) during the index hospitalisation. This analysis addressed the requirements of Objective 6.

The population for this study comprised 1724 community patients who survived the acute phase of hospital care of which 1050 received REH. The characteristics of patients REH and non-REH patients were not significantly different with respect to age, sex and comorbidity weight as shown in Table V5-A. Patients with comorbid dementia and those with subtrochanteric fractures were under-represented in the REH group, while patients treated surgically, and with complicating anaemia, urinary and surgical site infections were more frequently referred to REH.

Comparative hospital utilisation data are shown in Table V5-B. REH patients had shorter time in the acute phase, and only half as many days per capita in 'other' episodes. These results were overshadowed by the 26,312 days in rehabilitation (mean LOS=25.1 days) for REH patients. As a result the mean total LOS was 14.1 days longer for REH patients (42.4 vs 28.3 days, $P<0.001$). Total hospital cost was higher for REH patients by $14,197 ($40,439 vs $26,242, $P<0.001$).

At final discharge from the index hospitalisation, the distribution of immediate outcomes was significantly different between REH and non-REH patients as shown in Table VI-4 below. The difference in mortality would remain significant throughout the two year follow-up period as shown in Study V, Table V5-C. The significantly higher proportion of non-REH patients discharged to RAC did not maintain significance at or beyond 90 days from the index admission. There was a trend towards lower rates for defined independence for REH patients, but this only attained significance at one year. (Table V5-C).

Table VI-4. Separations from index hospitalisation by rehabilitation selection

Outcome	Rehabilitation patients		Non-rehabilitation patients		*P*
	Per cent	95 % CI	Per cent	95 % CI	
Died	2.6	1.6–3.6	5.2	3.5–6.9	0.004
RAC transfer	19.1	16.7–21.5	28.0	24.6–31.4	0.007
Home	72.1	70.4–75.8	49.9	46.1–53.7	<0.001
Other	5.1	3.8–6.4	16.9	14.1–19.7	<0.001

The number of days in RAC and the number and costs of hospital readmissions over the first year were examined as indirect assessments of health or functional status. Total time in RAC was 68.3 days per capita for REH patients and 71.5 days for non-REH patients. The proportions of patients readmitted at some stage during the first post-fracture year, and the proportion of total readmission episodes were not significantly different. Non-REH patient had a higher mean number of admitted days (17.9 vs 14.8, $p=0.003$) but the mean cost of readmission did not differ ($14,156 vs $14,728, p=0.17). When costs were compared in a multivariable model adjusted for sex, age group, comorbidity, and length of survival, the same lack of significance (p=0.17) was found.

The proportions of patients who were resident in RAC after 90 days were not different in either unadjusted or multivariate models. Similarly, there was no significant difference in rates of patients who were alive, not in RAC and not receiving community services in unadjusted analyses; in multivariate models there were significantly fewer independent non-REH patients at one year but not at two years.

VI-8. Australian trends for prevalence and incidence of hip fracture

At present there is no precise method for identifying annual numbers of hip fractures and hence the incidence in the general Australian population. The material presented in Section III (1-5) of this Thesis addresses these questions in response to the requirements of Objective 7.

Between 1993-94 and 2012-13 hospital episodes for hip fracture increased by 63 per cent from 14,200 to 23,600. Application of the DVA-derived episode: patient ratio of 1.25 as described in Section III (Table III-4) resulted in a total of 21,266 episodes in 2008-09, representing 17,012 hip fracture patients. By 2012-13 these numbers had risen to 23,600 and 18,600 respectively. Men comprised 29 per cent of patients and just under 50 per cent of all patients were aged 85 years or older. Age specific incidence for nearly all age-sex groups fell across the period from 1998-99 to 2012-13, with the age-standardised rate being reduced by 16 per cent for women and by 8 per cent for men. In the four years since 2008-09, there was a suggestion that incidence rates were stabilising except for persons aged 75-79 years.

A caseload projection to the year 2051, applied a further reduction in age-specific incidence, commensurate with that described for the period 1998-99 to 2012-13, to the mid-range demographic projections of the ABS. [63] The resulting estimate was for 50,000 patients, of whom 34 per cent would be males and patients aged 85 years or older would comprise 60 per cent. (Table III-6)

Hospital utilisation

Since 1993-94 the mean LOS for episodes coded to hip fracture fell from 17.3 days for men and women to 10.2 days for men and 9.7 days for women. These reductions were seen for all age-groups (Table III-3). It was not possible in these AIHW datasets to sum the LOS data for all episodes which comprise hospital care for hip fracture to identify any trends in the total hospital resource burden. Given that almost 50 per cent of hip fracture patients are referred for hospital based rehabilitation (Table V2-B), it was pertinent that LOS for rehabilitation (all reasons) also fell by approximately 25 per cent between 1998-99 and 2012-13 (Table III-4).

VI-9. Data linkage and assessment of complex conditions

The new findings within this Thesis are entirely due to the capacity for patient-level linkage within DVA databases. The defining of the total burden of the index hospitalisation in both bed-days and costs required concatenation of line-by-line data items identified to the same patient. The same processes were necessarily applied to generate the descriptions of separation status at eventual discharge and to patient outcomes following discharge. The many and complex predictive factors for all of these elements were rarely if ever available within a single database.

The identification of the many patients who were RAC residents at the time of fracture provided particular insights. Not only was the index hospitalisation shorter, and less costly for these patients, but values for ongoing survival, independence and post-hospital costs were all significantly below of those for community patients.

Section VII. Context and Discussion

In this section the key objectives and findings of this Thesis are discussed in the context of the recent Australian and international literature.

VII-1. Length of Stay

The DVA-based finding of 11.1 days for length of the acute phase matched the result reported by AIHW for all Australia in 2008-09, as did the difference of 0.5 days between men and women.[1] At the time of collating the figures (2011) there were no comparable data within Australia and few international comparisons in respect of total hospital LOS for hip fracture. Values ranging from 17 to 44 days were reported [37,79,80,81] but the definition or composition of "hospital care" also varied widely, especially with respect to whether rehabilitation was included in the initial hospital stay or provided elsewhere.

Values for total LOS have varied enormously over time and between different health systems. Sixty years ago, the accepted practice of delaying weight-bearing until there was evidence of bony union meant 3 to 9 months of bed rest and then further delays to achieve discharge.[21] In 1980, patients in Dundee, Scotland had an average LOS of 26 days for men and 36 days for women (two outlier values excluded).[32] At the same time, a population-based study of hip fracture patients in Denmark reported mean total LOS in the acute setting of 24 days.[23] In 2001-2005 more than one quarter of English patients were in hospital for at least 32 days [82] and mean total LOS in Scotland was 36 days in 2007,[69] both results being inclusive of rehabilitation. In the United States, where rehabilitation is mostly provided outside the hospital system, separation from the acute hospital setting usually occurs within one week. [70]

Contemporary data report mean total LOS of 29 days in New South Wales,[84] 20 days for English hospitals reporting to the NHFD [85] and 17 days in Sweden.[37] Progress towards more efficient hospital management is being achieved in many locations, but again the variable definition of 'hospital care', particularly with regard to rehabilitation, means that comparisons must be drawn with caution.

Determinants of LOS

The lack of a substantial age-related trend for LOS as evident in Table V1-1, is unusual for hospital patients. In two large British studies of primary total hip replacement for arthritis, LOS for patients older than 80 years was 30-40 per cent higher than that for patients in their seventies. [86,87] It would seem that the event of hip fracture defines a certain degree of frailty (and possibly biological age) which may itself determine care requirements, independent of chronological age.

The different hospital trajectory for hip fracture patients admitted from aged care institutions has been recognised for 40 years. A Danish study in 1980 reported total hospital time of 22.7 days for a sample of 518 patients, which included 134 patients from nursing homes with LOS of only 7 days. [88] Thirty years later a Swedish study reported total hospital stay of 7.5 days for RAC patients and 33.6 days for patients admitted from their own homes.[4] This Thesis found 35.4 days and 18.8 days respectively.

Whether or not post-fracture rehabilitation is included in the measure of hospital stay is another defining element. The data of Study 2, Table V2-B make this explicit for the Australian situation, where rehabilitation is almost exclusively performed in hospital. The European experience [69, 81, 82] finds that stay in an acute hospital phase is 40 per cent or less of 'total institutionalised days'. The contemporary English data shows 20 hospital days, inclusive of rehabilitation,[85] while in the United States, fewer than 10 acute hospital days are followed, in at least 60 per cent of instances, by up to six weeks in various post-acute facilities.[70]

In the past 20 years a variety of orthogeriatric models have been trialled, and are now widely recognised as contributing to best practice for hip fracture.[57,58] Although the factors used to assess efficacy of these multidisciplinary models are far from standardised, [89] acute phase LOS is frequently reduced. [67,90] A systematic review[89] found that for 13 studies which appeared to measure total hospital stay, this value was in the range 23-28 days for co-managed patients and 27-33 days for patients managed otherwise. In 5 of 13 individual studies there was a significant reduction in total LOS.[89] A recent study of nearly 10,000 patients in New South Wales produced an apparently contrary result, reporting mean acute LOS of 12.9 days and total LOS of 30.1 days for patients within orthogeriatric services and 11.2 days and 28.7 days respectively for patients treated otherwise.[84]

The understanding of hospital LOS for hip fracture, and particularly the comparison between different care systems, requires knowledge of many predictors. Prior RAC residency, referral to rehabilitation, complication rates, post-acute destination and the model of care delivery are all key drivers of both acute and total LOS.

VII-2. Mortality

Both early and later mortality rates after hip fracture increase with increasing age and are higher for men. [91,92] Using adjustment factors for age and sex based on published studies, [92,93] the one year mortality of 33.9 per cent reported in Research Study 3 of this Thesis reduces to 29.3 per cent for a more representative Australian hip fracture sample with mean age 83 years and with 27 per cent of males.[1] While age and sex are evidently of high significance, the 1979 statement that they are the exclusive determinants of mortality after hip fracture [23] is no longer supported.

Early mortality

The wide range of variation in definitions of hospital care and therefore its duration, results in equally wide variations in mortality rates at the point of discharge. The futility of comparing in-hospital mortality rates between series with widely different LOS was evidenced by Jensen in 1979.[23] In the United States, a series with mean acute LOS of 4.6 days had in-hospital mortality of 1.6 per cent.[94] In a major Australian hospital, median LOS was 7.7 days and hospital mortality was 4.3 per cent.[95] Conversely, a large English sample found 14.3 per cent deaths where median total LOS was 20 days and one-quarter of patients stayed more than 5 weeks.[83] It has therefore become conventional to report 30-day mortality as a comparable measure of hospital performance.

The 30-day mortality reported from regional or single hospital studies in Australia are commensurate with international findings within the range of 5 per cent to 10 per cent. [59,84,96] Prior to this Thesis there had been no description of mortality rates based upon a nation-wide sample.

Many studies report only patients who have been treated surgically. [84,97,98] This excludes patients who are judged too frail to undergo surgery and therefore may have an inferior prognosis. The databases for this Thesis showed that 13 per cent of non-operated patients were dead by 7 days after admission and that 30-day mortality for this group was 22 per cent, or more than twice the rate for other patients. A recently published database study in Japan found more than 400 per cent greater in-hospital mortality (mean LOS =38 days) among patients treated without surgery.[99] Unoperated hip fracture patients in English hospitals at the start of this century had 30-day mortality of 30 per cent, the rate for operated patients being less than 8 per cent.[83]

Patients admitted from RAC have higher short-term mortality. At a Sydney hospital, 12 of 104 RAC patients (12 per cent, compared with 6 per cent of other patients (p=0.04) had died within 30 days.[100] The data for Research Study 3 in this Thesis showed a hazard ratio of 1.5 (95% CI 1.2-1.9) for RAC patients in respect of 30-day mortality, with nearly 21 per cent of patients having died by this time.

The various formats of orthogeriatric care for hip fracture almost universally reduce short-term mortality. In an orthopaedic service in Genoa, Italy introduction of shared care did not alter LOS but reduced in-hospital mortality to 4.8 per cent compared with 9.9 per cent. [101,102] Analysis of almost 10,000 hip fracture patients in New South Wales found 30-day mortality of 6.5 per cent in hospitals providing an orthogeriatric program and 8.1 per cent in those which did not.[84]

However the establishment of the Geriatric Fracture Center in Rochester, while reducing LOS and complication rates, did not impact 30-day mortality.[103] A meta-analysis of 4637 patients in 9 settings[104] similarly failed to demonstrate reduction in short-term mortality. As stated in Research Studies 3 and 5 the data available to this Thesis provided nothing by which to distinguish orthogeriatric care from other formats of care delivery.

Mortality at 30 days after hip fracture has declined steadily over the past 10 years. The English NHS data for 2001-2004 reported 9.7 per cent mortality at 30 days. [83] Within the same large sample, with the top quartile for total LOS being above 32 days, in-hospital mortality was 14.3 per cent. [83] In 2013, after six years of increasing compliance with best-practice guidelines,[24] the 30-day mortality reported in the NHFD was 8.1 per cent. [85] A referral hospital in Newcastle, NSW has seen 30-day mortality reduced by 50 per cent to 8.2 per cent between 2002 and 2011, even though multidisciplinary acute care was not universal. [96] In South Australia 30-day mortality fell approximately 20 per cent to 8.1 per cent between 2002-03 and 2007-08. [59]

One-year mortality

The one-year crude mortality in the study population (34 per cent) was high by world standards, but the age-sex adjusted value of 29 per cent, was similar to that for many European series. [59,82,91] Another Australian study also found one-year mortality of 29 per cent in a series with 25 per cent males and 44 per cent of patients age ≥ 85 years. [105] An American study of 43,165 Veterans' Health Administration beneficiaries found 32.2 per mortality after one year: the mean age was 80 years, with 20 per cent of subjects aged 85 years or older and patients under 65 years excluded: 87 per cent of subjects were men. [106] By contrast a report from South Korea found one-year mortality of 16.6 per cent in a population of mean age 75 years, inclusive of those aged 50-64 years and with only 15 per cent aged 85 years or older. Men comprised 30 per cent of this latter study which was confined to patients who were treated surgically. [107] These disparities in reported mortality rates have been declared chiefly due to differences in patient demographics and inclusion / exclusion criteria of such dimensions that meta-analyses of mortality rates were declared to be impractical. [108]

A Norwegian orthogeriatric service reported 46 per cent one-year mortality for RAC patients compared with 14 per cent for community patients,[92] and corresponding values from a unit in Holland were 45 per cent and 17 per cent.[109] In this Thesis pre-fracture RAC residency was the most powerful predictor of mortality after the first 30 days (Table V3-C).

Excess mortality

A number of studies have demonstrated that mortality after hip fracture exceeds expected rates based on patients' age and sex.[41,110] The excessive mortality is greatest in the first few months after injury, but continues for at least 10 years, and is more evident for men and for younger patients.[111,112] Excessive mortality from hip fracture also results among residents of aged care institutions, although the effect is not detectable beyond 9 months.[113,114] This Thesis found excessive mortality rates of slowly declining dimensions to the end of four years, excepting for males aged 90 years or older (Table V4-D)

VII-3. Service provision, resource outlays and patient outcomes

Hospital expenditure

The question of whether more or different resource outlays in the initial hospital treatment would equate with different medium term outcomes was examined in Research Study 4. The Australia-wide database available to this Thesis provided the opportunity to compare practice and outcomes for six different state jurisdictions. As presented in (Figure V-1) and summarised in Section VI (6), there were differences in the order of 50 per cent in acute and total LOS, rates of rehabilitation referral and total hospital costs. Patient characteristics were not significantly different between the states, but apart from the proportion receiving surgical treatment, unadjusted rates for all other listed in-hospital and post-hospital services showed significant differences.

One-year outcomes showed no significant differences in either unadjusted or adjusted models in respect of mortality, residence in RAC or in a defined measurement of independence.

A number of studies of hospital services have shown that higher expenditure is associated with lower mortality at the point of discharge and at one year, and also lower 30-day readmission rates.[115,116,117] However, calculations based upon data within two national databases in Britain suggest that subsequent mortality is not related to LOS (often a surrogate for cost) for the primary hospital admission.[69,85] The data presented in Research Study 4 would appear to strongly support the latter view, that higher resource outlays do not equate to improved clinical outcomes, especially in the longer term.

Orthogeriatric programs

The extensive research into the efficacy of various forms of orthogeriatric care shows that in most, but not all cases, acute hospital stay is reduced, there are fewer complications and in-hospital or 30-day mortality is also improved, but outcomes beyond 6 months are not affected. [102, 104,118,119] Isolated reports found significant reduction in one-year mortality [101] and functional gains sustained at one-year follow-up. [120] A large database study in New South Wales found orthogeriatric care associated with lower 30-day mortality but with no substantial impact upon overall hospital stay, and presumably costs.[84] A non-randomised cost-utility study of 3114 patients in a single hospital in Israel,[120] found that comprehensive orthogeriatric care reduced initial hospital costs by 30 per cent, while achieving lower one-year mortality rates (14.8 per cent vs 17.3 per cent, P=0.016). This Thesis, while acknowledging the advantages of multispecialty management for at least the acute phase of hospital care, possessed no data which could identify orthogeriatric practice.

VII-4. Rehabilitation: costs and outcomes

The results of Research Study 5 point to substantially increased costs in the order of $14,000 for Australian patients who have rehabilitation as admitted hospital patients after hip fracture. Costs attributable to rehabilitation in Ontario, Canada were between $CAN 5000-$6000 in 2010 dollars. [7] Death, failure to return home and hospital readmission are the accepted markers for defining better or worse outcomes, especially in database studies.[121] In this Thesis the provision of community support services over the first post-fracture year was also documented. Mortality rates were lower for rehabilitation patients at 90-days and one year, although the causes of this are not clearly attributable to the interventions provided. There were no significant differences with regard to defined markers for independent living (Table V5-C). Several systematic reviews covering a wide range of rehabilitation programs [121,122] have not provided convincing evidence of sustained functional benefits. Alternative modes of delivery of rehabilitation: day-hospital, hospital outpatient or domiciliary are variably reported as producing similar outcomes to those for hospital patients.[123,124,125] An analysis of Medicare (USA) data for 2002-03 showed that in-hospital rehabilitation after hip fracture carried a cost impost of more than $US7000 over rehabilitation in skilled nursing facilities. The mortality at 120 days was lower for hospital patients but the two patient groups had differing risk factor profiles.[123] A study of hip fracture patients in Tuscany found 10-fold differences in cost between inpatient and outpatient rehabilitation, but comparable 6-month mortality rates.[124] An intensive home-based program in Sydney showed improvement in both survival and rates of independent living after one year.[125] The findings of these international studies would appear to support the conclusions of Research Study 5 that hospital-based REH, while costly, does not infer lasting advantages with respect to patient independence.

VII-5. Incidence, prevalence and projections

This Thesis calculated the number of hip fractures in Australia in 2008-09 as 17,012, being the number of uniquely identified patients hospitalised for the first time in 2008-09 with a principal diagnosis of hip fracture. The various adjustments to NHMD records to compensate for double counting [40, 53, 54, 62] appear to have both excluded some legitimate hip fracture patients while accepting a degree of double counting.

The requirement for an associated code for relevant surgery excludes hip fracture patients who are treated without operation. In the DVA study population this represented 13 per cent of cases: other studies identified a proportion of non-operated patients between 3 per cent and 13 per cent. [73,99] It is also apparent that such patients may be regarded as too frail for surgery or have died prior to operation. In both instances their exclusion may bias the reported results in favour of better outcomes, particularly for in-hospital mortality. [83]

The exclusion of patients whose first episode coded to hip fracture also indicates an inter-hospital or inter-service transfer may also exclude patients who fracture while already in hospital for an episode coded to another condition. There is good evidence [126,127] that these patients have significantly worse outcomes. The requirement for associated code for a low impact fall would have excluded nearly 18 per cent of the study population for this Thesis. It would appear that accurate case finding from an administrative database is dependent upon a unique patient identifier. One Australian estimate of hip fracture prevalence [62] almost exactly matched the finding of this study by both excluding patients without coded falls but including some instances of readmission.

The importance of establishing an accurate base population becomes paramount when attempting to plan future service demands. By the middle of this century the hip fracture caseload is projected to at least double and possibly treble the current dimension. [128]

Potential inaccuracies which apply to data derived from comparatively small regional study populations and from existing national databases are discussed. In particular the latter, reporting numbers of hospital episodes coded as hip fractures are known to include multiple entries for a substantial proportion of patients. While the dimension of this error would appear to range between 20 and 30 per cent, [38,40] systematic audits of databases for large populations against patient-identified datasets do not appear to have been published.

In 1999, an estimate of 60,000 hip fractures in Australia by 2051 was based upon the projections for the Australian population then current, together with the expectation that the rising trend in age-specific incidence for hip fracture would continue. Since then the incidence of hip fracture has fallen substantially across the age-range, and the projected population to 2051 has increased by 50 per cent above 1999 projections, to 38 million. [63] Two calculations, one based upon continuation of 18-year trends in age-standardised incidence and the other using projections of age-sex specific rates, produce estimates of between 38,000 and 50,000 hip fractures (Table III-6).

A recent set of calculations for New South Wales [128] using both static and reducing age-specific incidence rates would suggest that the lower of these estimates is more likely. By any measure, the proportion of patients aged 85 years and older will increase by at least 10 per cent. Substantial downward trends in hospital LOS (acute episodes) for hip fracture, and also for (all cause) admitted days for rehabilitation may mitigate but not eliminate a rising cost burden. [78]

VII-6. Strengths and limitations

This Thesis was based upon linked administrative databases provided by DVA for a patient sample which included one-seventh of the Australian hip fracture population in the study year. How accurate and complete were the data, and how representative was the sample?

Databases were compiled within DVA from data submitted by the various state health services for the purpose of billing surveillance. Patient identity and service items were cross-checked against billing and other Departmental records. These features accord with higher data quality in administrative databases. [129] While the accuracy of diagnostic coding within administrative data is far from absolute, the sensitivity of coding for hip fracture was 95 per cent in an audit of ICD-10-AM data in Victoria. [49] This was the highest level of sensitivity for any diagnosis other than cancer of the breast or lung, a level that was confirmed by the systematic review of Hudson. [51]

Databases are generally unsuitable for identifying prevalence or incidence of medical conditions on a population basis. Hip fracture, for which hospital admission is essentially universal in Australia, is one condition for which this reservation does not apply. Across the world, as referenced throughout this work, administrative databases suitably adjusted to minimise double counting of patients, are accepted as the source for estimating caseloads and incidence rates. [23, 37, 41]

The levels of ascertainment for comorbid diagnoses and complications within administrative databases fall well short of those extracted from clinical records or direct clinical observation. Little is known about levels of accuracy of secondary or comorbid diagnoses. Rates of ascertainment for key comorbidities compare favourably with those in other database studies. [83, 91] The likelihood of under-reporting has the effect that the impact of any particular comorbidity as a predictor variable may also be under-represented, but is unlikely to have been exaggerated.

As with other administrative data, there are no clinical details which can identify physiological markers for disease severity. Neither was there any specific information describing physical or cognitive functionality, such as assessed by the 21-point Functional Independence Measure (FIM). Such assessment ratings have been shown to be useful in assessing risk status for undesired outcomes such as death, long and expensive hospitalisation, or entry into residential aged care.

While sharing these limitations, the DVA databases available to these studies possessed additional strengths, including a very extensive list of demographic, clinical service and administrative descriptors. The particular and unique strength of the DVA databases was the capacity to link all other health service data with hospital data. Linkage with data describing periods of residence in aged care facilities, with data for hospital and community-based services following the initial (index) hospital admission and with date of death provided a comprehensive description of hip fracture management and its aftermath. Such detail is usually possible only for much smaller studies in which personal contact with patients or their clinical records can be maintained across time.

In some instances, these linkages could identify surrogates for frailty or functional state, derived from the density and timing of provided services, such as community nursing and Veterans' Home Care together with hospital readmissions and time in RAC facilities. Pharmaceutical dispensing and provision of mobility and other aids to physical function could also have assisted to create a profile of patient needs

The study population of veterans and war widows was atypical of the Australian demographic for hip fracture patients. The mean age of both men and women was higher by at least 3 years and the proportion of men was greater by 10 per cent than in 'non-DVA' patients at the time. As noted when discussing projection models for hip fracture incidence and service demands, the DVA demographic in this study population was very similar to that which is expected for the national population some thirty years hence.

More than 90 per cent of subjects were in receipt of the DVA Gold Card, a close equivalent of private health insurance. This status, together with access to some enhanced services provided and even promoted by DVA may have resulted in atypical treatment experiences and potentially different outcomes. Where service utilisation could be directly compared with that of non-DVA patients, as in comparisons of episodes for acute care, there was little or no apparent difference in rates of service, length of stay or costs. Care has been taken to report results according to suitable age-sex groupings which are therefore comparable with matching demographic groups within non-DVA populations. Age-standardised data are also reported where appropriate. However caution has been exercised in extrapolating findings to the general population.

VII-7. Opportunities and priorities for ongoing research initiatives

Additional analyses of the current datasets

The datasets and linkage processes of this thesis provide scope for a number of further analyses. Two studies are currently being performed.

(i) An additional linkage has been obtained with data collected by the Australasian Rehabilitation Outcomes Collaboration (AROC). A study is being performed together with AROC for a sub-sample of patients from Study V for whom Functional Independence Measure (FIM) scores have been provided.

This study will examine the associations of physical functional status on admission into REH, and the rate and extent of functional gains during hospital-based REH, with hospital LOS, costs and patient outcomes over the ensuing year.

(ii) Additional data describing hospital services for the full study population for up to 2 years post-fracture. Readmission rates and the features associated with more frequent readmissions are to be analysed.

(ii) General priorities and initiatives

(a)Complete the progress toward data linkage at a national level, with databases incorporating a de-identified but universally accepted patient identifier.

Database linkage is central to the work of this thesis. Research Study 1 describes the differences in both utilisation and outcome findings between analyses of unlinked episode data and those from linkage of patient-level data both within and between individual datasets. The dimensions of these differences are such as to make the findings from unlinked data not only incomplete but misleading. The linkage between hospital and RAC datasets in provided important new insights into the issues examined in Research Studies no. 2, 3, 4 and 5.

The potential value of nationally integrated reporting of core health data has been recognised for several decades. Agencies such as AIHW and ABS provide summarised reports and are able to provide a range of patient-specific or service-specific reports upon special requests which carry appropriate Ethics Committee approvals. The number of such individual requests is increasing.

In 20 years of personal experience on Commonwealth Ethics Committees there has not been a single significant breach of privacy due to the current practices of record and database linkage. The creation of a National Health Identifier for all citizens and the application of this key to all records of provided services generated by the disparate jurisdictions in Australia would enormously increase access to information which is highly relevant to the planning for and delivery of patient care.

(b). Establish consensus around the demographic, clinical and service delivery data to be recognised in all reports of hip fracture management and outcomes.

At several stages of this Thesis, in particular the work of Research Studies no.3 (mortality) and no.5 (rehabilitation outcomes), the lack of consistency in study design has frustrated attempts to definitively compare different systems of care delivery. The inconsistencies in definition of study populations, of patient care settings and selection of dependent and predictor variables is of such extent that most if not all attempts at meta-analyses provide very few, if any, definitive conclusions. The development and application of “best-practice” guidelines in both Europe and Australasia, should provide opportunities for such consensus.

(c). Identify and validate the underlying causes of the decline in hip fracture incidence in Australia, as elsewhere. (What are we doing right?)

Section III, parts 3 and 4 traced the trends in age-specific hip fracture incidence for the past 20 years of available records in Australia. The dire predictions for an epidemic of osteoporotic fractures, and hip fractures in particular, due to rapid demographic changes do not appear to be happening. A diversity of interventions in diagnosis and treatment may be contributing as suggested by numerous single-issue studies.

Even the most clinically focussed interrogation of population-based databases can only generate further questions as to the causes of identified movements in overall process or outcome results. Studies based upon audits of patient records are required to supply the answers.

(d). Further evaluate efficacy of multidisciplinary models in the acute care phase of hospital management and, if validated, promote rapid introduction of same.

The clinical complexities of hip fracture patients are displayed in detail in Research Studies no.2 and no.3. Protocol-based multi-specialty (orthogeriatric) management programs in the acute hospital setting are created to address this complexity. Short-term efficiencies and improved patient outcomes are frequently but not universally demonstrated for orthogeriatric care, while there is weaker evidence for more sustained benefits. The logical arguments in favour of multidisciplinary care and the many reports of positive outcomes suggest that the potential value of such programs be more systematically evaluated.

(e). Evaluate alternatives to hospital-based rehabilitation following hip fracture, for which Australia has a very high proportional use.

Research Studies no.2 and no.5 in particular identify the resource burdens of in-hospital rehabilitation. Australia in particular has a very low proportion of post-acute care for hip fracture delivered in ambulatory settings as a direct alternative to subacute hospital management. The apparent high differential cost of ongoing hospital care should, especially in the current Australian environment, promote further examination of non-hospital alternatives, many of which have equivalent outcomes for some patient groups.

(f). Translate the clinical experience and research data for hip fracture management for other chronic and complex conditions in the elderly.

The protocols of database linkage illustrated in this thesis could be similarly applied for the management of stroke, chronic cardiac failure, obstructive lung disease, less aggressive malignancies, arthritides and other chronic conditions with large patient populations and frequent, diverse health interventions.

VII-8. Conclusions

Despite declining age-specific incidence over the past 15 years, rapid demographic changes mean that numbers of hip fractures in Australia continue to increase.

There is a high level of heterogeneity among hip fracture patients. Differentiation by age, sex, pre-fracture accommodation, selection for rehabilitation, comorbidity and geography can identify very large differences in treatment costs and outcomes, including an 8-fold difference in one-year mortality rates.

There is similar diversity in protocols used to describe key data, such as an accurate count of hip fracture patients, immediate and ongoing treatment costs and outcomes over time. Consensus on the criteria for core elements, such as age-range, comorbidity measures, and exclusion factors, at national and preferably international levels, would greatly enhance the information dividend.

The linkage of population-based datasets has demonstrable value to identify key elements of the hip fracture population and to monitor the efficacy of interventions.

Database analyses, while lacking some important clinical detail, also pose many potentially significant questions, which can and should provoke targeted examinations in studies with direct access to clinical records.

Some predictors for inferior outcomes are potentially reversible and others may be mitigated by specific management programs. Orthogeriatric or other multidisciplinary models appear to be effective in improving short-term outcomes. Lasting benefits to patients and the wider community remain to be confirmed.

The management of hip fracture in Australia remains hospital-centric. Frequent or prolonged hospital episodes are likely to have negative consequences for the ongoing welfare of frail and elderly persons. Preliminary evidence suggests that hospital time could be reduced, and alternatives to admitted care could be selectively introduced without detriment to patient outcomes.

The methodologies of this Thesis are applicable to the study of a number of other chronic conditions. Hip fracture is, after all “the quintessential geriatric illness”. [130]

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