



■ TRAUMA

Outcomes following fractured neck of femur in an Australian metropolitan teaching hospital

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Objectives

To determine the morbidity and mortality outcomes of patients presenting with a fractured neck of femur in an Australian context. Peri-operative variables related to unfavourable outcomes were identified to allow planning of intervention strategies for improving peri-operative care.

Methods

We performed a retrospective observational study of 185 consecutive adult patients admitted to an Australian metropolitan teaching hospital with fractured neck of femur between 2009 and 2010. The main outcome measures were 30-day and one-year mortality rates, major complications and factors influencing mortality.

Results

The majority of patients were elderly, female and had multiple comorbidities. Multiple peri-operative medical complications were observed, including pre-operative hypoxia (17%), post-operative delirium (25%), anaemia requiring blood transfusion (28%), representation within 30 days of discharge (18%), congestive cardiac failure (14%), acute renal impairment (12%) and myocardial infarction (4%). Mortality rates were 8.1% at 30 days and 21.6% at one year. Factors predictive of one-year mortality were American Society of Anesthesiologists (ASA) score (odds ratio (OR) 4.2 (95% confidence interval (CI) 1.5 to 12.2)), general anaesthesia (OR 3.1 (95% CI 1.1 to 8.5)), age > 90 years (OR 4.5 (95% CI 1.5 to 13.1)) and post-operative oliguria (OR 3.6 (95% CI 1.1 to 11.7)).

Conclusions

Results from an Australian metropolitan teaching hospital confirm the persistently high morbidity and mortality in patients presenting with a fractured neck of femur. Efforts should be aimed at medically optimising patients pre-operatively and correction of pre-operative hypoxia. This study provides planning data for future interventional studies.

Cite this article: *Bone Joint Res* 2013;2:162–8.

Keywords: Hip fracture, Neck of femur, Anaesthesia, Complications, Morbidity, Mortality

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10.1302/2046-3758.28.2000177.2.00

Bone Joint Res 2013;2:162–8.
Received 18 March 2013; Accepted after revision 17 June 2013

Article focus

■ What are the current morbidity and mortality associated with fractured neck of femur in an Australian tertiary centre?

Key messages

- Similar to findings of other developed nations, patients with fractured neck of femur in Australia are at high risk of post-operative complications and mortality
- Following admission, one in ten patients died within 30 days, and one in five within one year
- Strategies aimed at improving peri-operative care require further evaluation

Strengths and limitations

- This is the first study conducted in an Australian context to report on detailed peri-operative related complications and outcomes
- The external validity of our findings is limited as it is a single-centre study

Introduction

Fractured neck of femur is common, with a reported 16 500 hospitalisations in 2006 to 2007 for osteoporotic hip fracture among Australians aged > 40 years.¹ Patients are usually elderly and frail with multiple medical comorbidities, and at high risk of peri-operative

cardiac morbidity and mortality.² The mortality rate within one year of a fractured femoral neck is reported as to lie between 22% and 29%,³ with a 30-day mortality of between 8% and 10%.⁴ Locally available data has shown a one-year mortality rate of 24.9% in a Queensland regional centre.⁵ Mortality at one year is 10% to 20% above that expected for age- and gender-matched groups, and most of this excess occurs within the first four months after fracture.⁶ Many survivors never regain their previous level of physical activity. Although the incidence of hip fractures are on the decline, the actual number of admissions for hip fracture is still rising due to population growth.^{1,7} Therefore fractures of the hip will continue to be a major burden on peri-operative and orthopaedic services well into the future.

Unfortunately, there is a lack of data reflecting the quality of care given to patients admitted with fracture of the hip in an Australian context. This lack of information makes it difficult to plan rational and feasible interventions and/or design suitably powered trials to evaluate protective strategies. A greater understanding of peri-operative treatment, morbidity and outcomes in patients admitted with fractured neck of femur will enable peri-operative clinicians to identify areas of practice needing improvement.

We hypothesised that similar to the findings of institutions in developed countries,^{3,8-10} in a tertiary Australian metropolitan teaching hospital, patients admitted with fractured neck of femur, would be of advanced age (> 70 years), have comorbidities present in > 30% of cases, have a major complication rate > 30%, and a one-year mortality rate of > 20%. We tested our hypotheses by conducting a retrospective observational study determining the 30-day and one-year mortality rates in an Australian public hospital. In addition, we identified factors associated with major morbidity and mortality. This information will be a meaningful platform upon which we can improve the quality of care delivered to this high-risk patient group.

Patients and Methods

The Northern Hospital is a 300-bed acute metropolitan teaching hospital in the state of Victoria, Australia, affiliated with Melbourne University. With ethical approval from the Northern Hospital Human Research and Ethics Committee, we performed a retrospective study of adult patients admitted with the diagnosis of hip fracture from September 2009 to September 2010. Paediatric patients aged < 16 years were excluded. The hospital operates a dedicated orthopaedic and aged care rehabilitation service (OARS) during weekdays that provides coordinated treatment plans for all complex orthopaedic patients, aiming to improve clinical outcomes. Patients were identified from the hospital's Health Information System and Department of Orthopaedics' audit database.

Data of patients relating to their demographics and peri-operative characteristics were individually collected from hospital medical records, and mortality data were checked against the records from the Victorian Registry of Births, Deaths and Marriages.¹¹ Post-operative complications were identified from patients' admission histories and discharge summaries. Complications were defined based on the diagnoses written by the treating doctors in patients' progress notes, and this was independently cross-checked with laboratory and radiological data (such as raised cardiac troponin in the presence of a documented myocardial infarction). Two independent clinicians (PHC and LG) verified the data. We used the information to test the following hypotheses: 1) patients would be of advanced age (> 70 years); 2) comorbidities would be present in > 30% of cases; 3) the rate of major complication would be > 30%; and 4) the one-year mortality rate would exceed 20%.

Additionally, we sought to identify whether particular patients were at increased risk of complications and whether specific peri-operative variables were linked with unfavourable outcomes. Univariate logistic regression analysis, followed by multivariate analysis was used to identify predictors of one-year mortality.

Statistical analysis. We used the STATA 11 statistical software (StataCorp LP, College Station, Texas) to perform the univariate and multivariate logistic regression analyses to identify predictors of one-year mortality. These were expressed as odds ratios (OR) with 95% confidence intervals (CI) and p-value. A p-value < 0.05 was considered significant. Univariate analysis was employed to investigate predictors of post-operative cardiac complications.

Results

A total of 185 consecutive patients were evaluated. Patient demographics, baseline clinical characteristics and comorbidities are summarised in Table I. The majority of patients were elderly (161 patients (87.1%) aged ≥ 70 years), female (132 patients (71.4%)) with multiple comorbidities. Major co-morbidities were present in 154 patients (83.2%). Of the 183 patients who underwent surgical intervention, 105 (57.4%) were reviewed by OARS pre-operatively.

The types of surgery and anaesthesia techniques are summarised in Table II. Overall, 131 patients (70.8%) received surgical fixation within 48 hours of admission, while delay (> 48 hours) occurred in 52 (28.1%). The most common reasons for delay included unavailability of theatre time, a requirement for medical optimisation and delayed diagnostic clarification. Most patients underwent fixation with dynamic hip screw (70 patients (37.8%)) and hemiarthroplasty (66 patients (35.7%)) (Table II). Two patients did not have operative intervention. The first patient was a 51-year-old female with a peri-prosthetic fracture and history of congenital hip dysplasia, who was managed conservatively. The second was an

Table I. Patients demographics and baseline characteristics

| Characteristics | n = 185 |
|--|--------------------|
| Mean age (yrs) (SD; range) | 80 (11; 39 to 100) |
| Female (n, %) | 132 (71.4) |
| Age group (n, %) | |
| 30 to 39 years | 1 (0.5) |
| 40 to 49 years | 5 (2.7) |
| 50 to 59 years | 7 (3.8) |
| 60 to 69 years | 11 (5.9) |
| 70 to 79 years | 39 (21.1) |
| 80 to 89 years | 95 (51.4) |
| 90 to 100 years | 27 (14.6) |
| Medical comorbidities on admission (n, %) | |
| Congestive cardiac failure | 36 (19.5) |
| Ischaemic heart disease | 53 (28.6) |
| Atrial fibrillation | 42 (22.7) |
| Hypertension | 111 (60.0) |
| COPD* /asthma/pulmonary fibrosis | 35 (18.9) |
| Diabetes mellitus | 48 (25.9) |
| Chronic renal impairment | 31 (16.8) |
| Cerebrovascular disease | 42 (22.7) |
| Dementia | 62 (33.5) |
| Malignancy | 32 (17.3) |
| Others† | 175 (94.6) |
| Weekend admission (n, %) [‡] | 69 (37.3) |
| Seen by OARS pre-operatively (n, %) [§] | 105 (57.4) |
| Followed up by OARS in 48 hours from last review (n, %) [§] | 81 (44.3) |
| Requiring pre-operative medical intervention (n, %) [¶] | 63 (34.4) |
| ASA grade (n, %) ^{**} | |
| 1 | 2 (1.1) |
| 2 | 34 (18.4) |
| 3 | 124 (67.0) |
| 4 | 25 (13.5) |

* COPD, chronic obstructive pulmonary disease

† any medical conditions apart from those listed above

‡ any presentation to emergency department from Friday 0600 hours to Sunday 2400 hours

§ OARS, Orthopaedic and Aged care Rehabilitation Service

¶ including any infection, myocardial infarction, rapid atrial fibrillation, hypovolaemia, cardiac failure, delirium, correction of electrolytes, requiring blood transfusion, or requiring medical review on admission

** ASA, American Society of Anesthesiologists

Table II. Timing of surgery and intra-operative surgical and anaesthesia details for the 185 patients

| Characteristics | n = 185 |
|---|--------------------|
| Time to surgery (n, %) [*] | |
| ≤ 24 hours | 57 (30.8) |
| 24 to 48 hours | 74 (40.0) |
| > 48 hours | 52 (28.1) |
| No surgery | 2 (1.1) |
| Timing of surgery (n, %) [†] | |
| In-hours | 105 (57.4) |
| Out-of-hours | 78 (42.6) |
| Types of surgery (n, %) | |
| Dynamic hip screw | 70 (37.8) |
| Hemiarthroplasty | 66 (35.7) |
| Intramedullary device (gamma nails) | 30 (16.2) |
| Total hip replacement | 5 (2.7) |
| Cannulated screw | 4 (2.2) |
| None | 2 (1.1) |
| Other (revision hemiarthroplasty) | 8 (4.3) |
| Type of anaesthesia (n, %) | |
| General anaesthesia | 99 (54.1) |
| Neuraxial anaesthesia | 84 (45.9) |
| Regional block (n, %) | 69 (37.7) |
| Type of regional block (n, %) | |
| Fascia iliaca block | 61 (88.4) |
| Femoral nerve/3-in-1 block | 8 (11.6) |
| Regional block by co-administration with anaesthesia (n, %) | |
| General anaesthesia + regional block (n = 99) | 63 (63.6) |
| Neuraxial anaesthesia + regional block (n = 84) | 6 (7.1) |
| Length of stay in recovery room > 2 hours (n, %) | 8 (4.4) |
| Mean hospital stay (days) (SD; range) | 7.7 (7.2; 1 to 90) |
| Discharge destination (n, %) | |
| Home | 15 (8.1) |
| Sub-acute centres (GEM [‡] /Rehabilitation) | 126 (68.1) |
| Nursing home | 32 (17.3) |
| Other hospital | 4 (2.2) |
| Death | 8 (4.3) |

* expressed as hours from time of arrival to emergency department

† in-hours, weekdays from 0800 to 2200; out-of-hours, weekdays after 2200 hours and weekends

‡ GEM, Geriatric Evaluation and Management

87-year-old female with extremely poor pre-morbid function whose family elected for non-surgical management.

Of those 183 patients undergoing surgery, 99 (54.1%) received general anaesthesia (GA) compared with 84 (45.9%) receiving neuraxial anaesthesia. Of the 99 patients who received GA, 30 patients (30%) did not have any reasons recorded for the anaesthetic choice and this was assumed to be the anaesthetist's preference. Other reasons for GA were altered coagulation in 30 patients (30%), patients being uncooperative or mentally incapable in 20 (20%), unsuccessful neuraxial anaesthesia in 11 (11%), patient's preference in seven (7%), aortic stenosis in two (2%) and anticipated prolonged surgery in two (i.e. revision surgery; 2%). Spinal anaesthesia was the main modality used for neuraxial anaesthesia. Regional nerve blocks were administered in combination with a much greater proportion of patients

with GA (63.6%) compared with neuraxial anaesthesia (7.1%) (Table II). Of the various regional nerve blocks performed, fascia iliaca block was the main technique used (88.4%), followed by 3-in-1/femoral nerve block (11.6%).

Observations of patients' vital signs showed that more patients were hypoxic on arrival to the emergency department (31 patients (16.8%)) compared with the immediate pre-operative period (16 patients (8.7%)). There were also more patients with abnormal vital signs in the emergency department (46 patients (24.9%)) compared with pre-operatively (26 patients (14.2%)). Intra- and post-operative temperatures were examined to identify the prevalence of hypothermia. Unfortunately, the analysis of intra-operative temperature was flawed due to limited recordings. The incidence of hypothermia among patients in the recovery room during the immediate post-operative period was high. Of the 155 patient recordings available, 57 patients

Table III. Post-operative complications for the 183 patients undergoing surgery

| Post-operative complications (n, %) | n = 183 |
|---|-----------|
| Acute myocardial infarction | 7 (3.8) |
| Rapid atrial fibrillation | 6 (3.3) |
| Congestive cardiac failure | 26 (14.2) |
| Pulmonary embolism | 2 (1.1) |
| Unclear cause for hypoxia with possible atelectasis | 8 (4.4) |
| Deep-vein thrombosis | 1 (0.6) |
| Acute renal impairment | 21 (11.5) |
| Oliguria | 26 (14.2) |
| Anuria | 1 (0.6) |
| Anaemia requiring transfusion | 52 (28.4) |
| Pneumonia | 22 (12.0) |
| Urinary tract infection | 7 (3.8) |
| Wound infection | 0 (0.0) |
| Other infection | 9 (4.9) |
| Delirium | 46 (25.1) |
| Decreased GCS* | 23 (12.6) |
| MET Call† | 23 (12.6) |
| Code Blue | 5 (2.7) |
| Minor surgical complication‡ | 17 (9.3) |
| Major surgical complication | 0 (0.0) |
| Representation within 30 days | 33 (18.0) |
| Inpatient death | 8 (4.4) |
| Others§ | 57 (31.2) |

* GCS, Glasgow Coma Scale

† MET, Medical Emergency Team

‡ including wound haematoma and wound ooze

§ including dehydration, hypotension, hypertension, urinary retention, uncomplicated fall, post-operative ileus, syncope, seizure, hyponatraemia, hypokalaemia and hyperkalaemia

(36.8%) were hypothermic with temperatures < 36.0°C, while 19 patients (12.3%) had temperatures < 35.6°C, and three patients (1.9%) had temperatures < 35.0°C. The lowest post-operative temperature recorded was 34.6°C. The majority of patients had a short post-operative stay in the recovery room, and only eight patients (4.4%) stayed beyond two hours. Post-operative opioid use in the recovery room was well controlled. Out of 181 available patient recordings, 148 patients (81.8%) required no opioid, 31 patients (17.0%) required morphine, one patient (0.6%) required fentanyl, and another patient (0.6%) needed pethidine. However, all 33 patients who received post-operative opioids had GA, of whom 19 patients (57.6%) also received regional anaesthesia.

Of the 183 patients treated surgically, major post-operative complications occurred in 83 patients (45%). A detailed overview of all post-operative complications is summarised in Table III. Multiple medical post-operative complications were observed, with the most common being anaemia requiring blood transfusion in 52 patients (28.4%), delirium in 46 (25.1%), representation within 30 days of discharge in 33 (18.0%) and acute renal impairment in 21 (11.5%). Among the post-operative cardiac complications, 26 patients (14.2%) had decompensation of congestive cardiac failure, seven (3.8%) had acute myocardial infarction and six (3.3%) had atrial

Table IV. One-year mortality after admission with fractured neck of femur

| Mortality (n, %) | |
|---|-----------|
| Deaths post-admission (of total 185 patients) | |
| In-hospital | 8 (4.3) |
| Anywhere within 30 days | 15 (8.1) |
| Anywhere within 90 days | 23 (12.4) |
| Anywhere within 180 days | 33 (17.8) |
| Anywhere within one year | 40 (21.6) |
| One-year mortality classified by gender | |
| Female patients (n = 132) | 25 (18.9) |
| Male patients (n = 53) | 15 (28.3) |
| One-year mortality classified by age | |
| < 70 years (n = 24) | 1 (4.1) |
| 70 to 79 years (n = 39) | 4 (10.3) |
| 80 to 89 years (n = 95) | 23 (24.2) |
| 90 to 100 years (n = 27) | 12 (44.4) |

fibrillation with a rapid ventricular response rate. Inpatient death was recorded in eight patients (4.4%). Following the acute admission most patients were discharged to either a sub-acute centre for rehabilitation (n = 126, 68.1%) or a nursing home (n = 32, 17.3%).

Mortality after admission with fractured neck of femur is summarised in Table IV. A total of 15 patients died within 30 days of admission and 40 died within one year, giving all-cause mortality rates of 8.1% and 21.6% at 30 days and one year, respectively.

Using the univariate followed by multivariate logistic regression analysis as shown in Table V and Table VI, respectively, the following four factors were significantly associated with one-year mortality: 1) ASA classification; 2) general anaesthesia; 3) age > 90 years; and 4) post-operative oliguria. We examined the pre-operative characteristics of these patients using the univariate analysis and found the following features associated with 30-day mortality: 1) ASA classification; 2) abnormal vital signs in emergency department; and 3) abnormal vital signs in the immediate pre-operative period.

Given that cardiac complications are a common the cause of post-operative mortality,¹² we also performed a univariate analysis to determine factors associated with all post-operative cardiac complications, including acute myocardial infarction, rapid atrial fibrillation and decompensation of heart failure. Factors associated with cardiac complications were age, ASA classification, pre-operative hypoxia, and post-operative anaemia requiring blood transfusion. We did not proceed to a multivariate analysis due to insufficient events and lack of statistical power.

Discussion

We performed a retrospective study of patients admitted to an Australian metropolitan teaching hospital with the diagnosis of hip fracture. We found that, as

Table V. Univariate logistic regression analysis: factors predicting 30-day and one-year mortality. Statistically significant values are bolded (OR, odds ratios; CI, confidence interval)

| Predictors* | Unadjusted 30-day mortality | | Unadjusted one-year mortality | |
|--|-----------------------------|--------------|-------------------------------|--------------|
| | OR (95% CI) | p-value | OR (95% CI) | p-value |
| Age | 1.1 (0.99 to 1.12) | 0.111 | 1.1 (1.03 to 1.14) | 0.001 |
| Gender | | | | |
| Male | 0.9 (0.27 to 2.96) | 0.859 | 1.7 (0.81 to 3.54) | 0.165 |
| Female | 1.1 (0.34 to 3.67) | 0.859 | 0.6 (0.28 to 1.24) | 0.165 |
| Length of hospital stay | 0.9 (0.74 to 1.05) | 0.160 | 1.1 (0.98 to 1.11) | 0.145 |
| Requiring pre-operative medical intervention | 2.8 (0.91 to 8.36) | 0.072 | 4.3 (2.05 to 9.05) | 0.000 |
| OARS first review | | | | |
| Pre-operatively | 4.9 (1.06 to 22.58) | 0.041 | 0.8 (0.41 to 1.70) | 0.615 |
| Post-operatively | 0.3 (0.05 to 1.14) | 0.073 | 1.0 (0.49 to 2.09) | 0.976 |
| Delay in surgery > 48 hours | 0.9 (0.28 to 3.04) | 0.897 | 1.1 (0.52 to 2.43) | 0.764 |
| Surgery performed in-hours | 2.0 (0.59 to 6.46) | 0.276 | 1.2 (0.60 to 2.57) | 0.554 |
| Surgery performed out-of-hours | 0.5 (0.15 to 1.98) | 0.351 | 0.8 (0.38 to 1.78) | 0.609 |
| Weekend admission | 0.4 (0.11 to 1.45) | 0.161 | 0.8 (0.36 to 1.61) | 0.479 |
| ASA classification | 3.9 (1.46 to 10.38) | 0.007 | 5.6 (2.64 to 12.05) | 0.000 |
| Abnormal vital signs | | | | |
| In emergency department | 3.0 (1.00 to 8.62) | 0.049 | 2.6 (1.21 to 5.41) | 0.014 |
| Pre-operatively | 3.9 (1.20 to 12.80) | 0.024 | 1.8 (0.72 to 4.54) | 0.208 |
| Hypoxia | | | | |
| In emergency department | 2.8 (0.88 to 8.76) | 0.083 | 2.0 (0.84 to 4.61) | 0.119 |
| Pre-operatively | 3.3 (0.81 to 13.22) | 0.096 | 1.8 (0.58 to 5.46) | 0.315 |
| General anaesthesia | 3.4 (0.91 to 12.53) | 0.069 | 2.3 (1.06 to 4.78) | 0.035 |
| Hypothermia in recovery | | | | |
| < 36.0°C | 6.7 (1.77 to 25.65) | 0.005 | 2.2 (1.00 to 4.75) | 0.051 |
| < 35.6°C | 2.4 (0.59 to 9.50) | 0.226 | 2.5 (0.89 to 6.88) | 0.084 |
| Post-operative complications | | | | |
| Acute myocardial infarction | 11.3 (2.23 to 56.65) | 0.003 | 10.4 (1.94 to 56.13) | 0.006 |
| Congestive cardiac failure | 2.7 (0.77 to 9.26) | 0.121 | 3.4 (1.40 to 8.14) | 0.007 |
| Acute renal impairment | 2.3 (0.58 to 8.98) | 0.235 | 2.6 (0.99 to 6.82) | 0.052 |
| Oliguria | 5.6 (1.76 to 17.77) | 0.004 | 4.1 (1.72 to 9.90) | 0.002 |
| Pneumonia | 2.2 (0.55 to 8.41) | 0.270 | 1.5 (0.53 to 4.01) | 0.469 |
| Anaemia requiring transfusion | 0.7 (0.18 to 2.50) | 0.549 | 1.8 (0.86 to 3.81) | 0.120 |
| Delirium | 1.2 (0.36 to 4.06) | 0.758 | 2.0 (0.91 to 4.20) | 0.084 |
| Decreased GCS | 9.6 (2.98 to 30.73) | 0.000 | 4.3 (1.73 to 10.78) | 0.002 |
| MET Call | 6.7 (2.08 to 21.63) | 0.001 | 4.3 (1.73 to 10.78) | 0.002 |
| Code Blue | 9.2 (1.40 to 60.60) | 0.021 | 2.5 (0.41 to 15.77) | 0.317 |
| Representation in 30 days | 1.3 (0.33 to 4.81) | 0.731 | 1.5 (0.63 to 3.56) | 0.358 |

* OARS, Orthopaedic and Aged care Rehabilitation Service; ASA, American Society of Anesthesiologists; GCS, Glasgow Coma Scale; MET, Medical Emergency Team; Code Blue, denotes emergency response for cardiac or respiratory arrest

Table VI. Multivariate logistic regression analysis predicting one-year mortality. Statistically significant values are bolded (OR, odds ratios; CI, confidence interval)

| Predictors* | OR (95% CI) | p-value |
|--|---------------------|--------------|
| Age > 90 years | 4.5 (1.52 to 13.07) | 0.006 |
| Requiring pre-operative medical intervention | 2.1 (0.79 to 5.48) | 0.140 |
| ASA classification | 4.2 (1.46 to 12.24) | 0.008 |
| Abnormal vital signs in emergency department | 1.6 (0.58 to 4.40) | 0.362 |
| General anaesthesia | 3.1 (1.13 to 8.45) | 0.028 |
| Post-operative complications | | |
| Acute myocardial infarction | 5.9 (0.64 to 54.01) | 0.118 |
| Congestive cardiac failure | 1.2 (0.36 to 3.79) | 0.802 |
| Oliguria | 3.6 (1.11 to 11.72) | 0.033 |
| Decreased GCS | 2.4 (0.51 to 11.05) | 0.267 |
| MET Call | 1.2 (0.26 to 5.95) | 0.789 |

* ASA, American Society of Anesthesiologists; GCS, Glasgow Coma Scale; MET, Medical Emergency Team

hypothesised, patients were elderly and had multiple comorbidities. In keeping with our hypotheses, the one-year mortality rate was 21.6%. Moreover, independent

predictors of one-year mortality were pre-operative comorbidity, age > 90 years, general anaesthesia and post-operative oliguria.

Some of our patients' demographic and clinical features are broadly in keeping with other reports of hip fracture outcomes.^{13,14} Several studies demonstrated links between baseline comorbidity, male gender, cognitive impairment and institutionalisation with lower functional outcomes and higher mortality.^{13,15,16} Streubel et al¹³ concluded that dementia, heart failure, advanced renal disease, and metastasis lead to reduced survival, and proposed that the age-adjusted Charlson Comorbidity Index might serve as a useful tool to predict survival. Similarly, Maxwell et al¹⁶ collected data from almost 5000 patients and reported that advancing age, male gender, comorbidities, low mini-mental test score, admission haemoglobin < 10 g/dl, living in an institution and presence of malignant disease were independent predictors of mortality at 30 days. However, there are little data detailing peri-operative outcomes and anaesthesia interventions in relation to rates of major complication and mortality. Therefore, direct comparisons between centres are not possible. It is surprising that peri-operative management, which can be an important determinant of complications and hence amenable to improvement, is not well reported in the literature. Many of the large outcome studies have rather commented on scoring systems that predict mortality, but failed to gather meaningful peri-operative information.

This study reports important peri-operative related information that may affect the way we currently care for patients admitted with fracture of the hip. Many patients were hypoxic on arrival to the emergency department and in the immediate pre-operative period. A large percentage of patients had abnormal vital signs in the emergency department and pre-operatively. The incidence of hypothermia among patients in the recovery room during the immediate post-operative period was high. Our institution operates a dedicated in-hours orthopaedic and aged care rehabilitation service. Only 57% of patients were reviewed by this service in the pre-operative period with regular follow-up occurring in 44% of patients. Therefore, a significant percentage of patients that were admitted or remained in hospital over the weekend did not have access to this important service. While the pattern of complications in our cohort was similar to other reported studies,⁸⁻¹⁰ there do appear to be some differences. We showed a relatively high incidence of anaemia requiring blood transfusion (28.4%), representation within 30-days of discharge (18.0%), and pre-operative hypoxia (16.8%). We found that independent predictors of one-year mortality were pre-operative comorbidity, age > 90 years, post-operative oliguria, and interestingly, general anaesthesia. Over half of all patients received GA (54%). When comparing the GA group with the neuraxial group, we observed that a greater proportion of patients undergoing GA had pre-operative hypoxia (9% vs 8%), pre-operative abnormal vital signs (15% vs 13%), and requirements for pre-operative medical intervention

(37% vs 31%). Therefore, we think that the association of GA with mortality is due to the key findings of these patients being generally more unwell in the pre-operative period. While post-operative opioid use in the recovery room was well-controlled, with 81% of patients requiring no opioid, all patients receiving post-operative opioids underwent GA with the majority of these patients receiving a combined general-regional anaesthetic. This reflects the high association of opioid use with GA. Our findings therefore support the high incidence of major medical complications associated with fractured neck of femur. We emphasise the importance of pre-operative recognition of patients at high risk for adverse outcomes. This will be useful for obtaining appropriate informed consent, optimising surgery timing, and having access to higher-level care before and after surgery.

There are several limitations to our study. Our patient cohort is relatively small, with only 185 patient records reviewed over a one-year period. However, this is the first study conducted in Australia to report on detailed peri-operative related complications and outcomes. As our study was retrospective and observational in nature, it was possible that not all complications were properly recorded. However, this would simply reinforce the contention that these patients experience a high level of post-operative complications. There may also have been inaccuracies in the recording of post-operative mortality. However, mortality data from the hospital's database was checked against mortality records from the Victorian Registry of Births, Deaths and Marriages, and we consider the possibility of inaccuracy to be very unlikely. In addition, two investigators reviewed all medical records to ensure a thorough and accurate tally of complications.

We did not report any data of fluid administration and its association with adverse events. Our finding of an increasing rate of post-operative delirium correlates well with the increasing age of hip fracture patients reported in other studies.^{17,18} Nonetheless, our conclusions might be limited by the fact that recording of cognitive impairment was incomplete, without standardised assessment (with, for example, the Mini-Mental State examination score¹⁹). This is a single-centre study, which limits the external validity of our findings. However, we believe that our hospital shares similar characteristics with other tertiary hospitals in Australia. We did not investigate the effects of hip fractures and their treatment on the quality of life as perceived by the patient, as patient-reported outcomes might be better evaluated in smaller, preferably randomised studies. Likewise, we have neither made any economic assessment of our outcomes, nor reported on specific long-term orthopaedic complications, which may influence long-term morbidity and mortality. However, these circumstances in no way affect the validity of the results or the objectives of this study.

Our study also has several strengths. The collection of data on comorbid conditions, pre-operative haemodynamic variables and specific anaesthesia interventions provides a comprehensive evaluation of the baseline health characteristics of our patient population and a reflection of our outcomes. The inclusion of all patients admitted to our institution with a fractured neck of femur make the findings of this study more consistent with the experience of day-to-day clinical practice, and may encompass groups that have not yet been formally studied. By defining the complication and mortality rates in these patients, we have defined both the need for improved care and the necessary background for the power calculations needed to design future interventional trials.

In conclusion, our evaluation of patients admitted with fractured neck of femur in a metropolitan university teaching hospital has identified several important findings. Hip fracture is a traumatic injury with a high incidence of ensuing complications and mortality. Approximately one in ten patients died within 30 days of admission and more than one in five patients died within a year. The majority of patients were elderly, female and had multiple comorbidities. Factors predicting one-year mortality were ASA score, age > 90 years, general anaesthesia and post-operative oliguria. These results confirm the persistently high morbidity and mortality in this patient group. Efforts should be aimed at pre-operative medical optimisation and correction of hypoxia. Specialist medical assessment and the involvement of ortho-geriatricians are vital to ensure early identification of the medically unfit patients and early medical optimisation. These findings are of particular interest to the peri-operative clinicians as the high rates of complications and mortality necessitate an integrated and multidisciplinary approach for future prevention of adverse outcomes. Our study has outlined several opportunities to evaluate strategies aimed at improving the peri-operative care for this patient group.

The authors would like to thank Mr R. Hau and L. McLeod-Mills from the Northern Hospital Department of Orthopaedics for assisting with mortality data collection from the Victorian Registry of Births, Deaths and Marriages; Dr S. Y. Wong for helping in patient data collections; and A. Hutchinson for assisting with statistical analysis.

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Funding statement:

- None declared

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- P. H. Chia: Principle author, Study design, Literature review, Data collection, Statistical analysis, Manuscript writing
- L. Gualano: Study design, Literature review, Data collection and interpretation, Manuscript writing
- S. Seevanayagam: Study design, Data collection and interpretation, Manuscript writing
- L. Weinberg: Review of all literature, Statistical analysis, Data interpretation, Manuscript writing

ICMJE Conflict of Interest:

- None declared

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