Post-operative mortality rates for neck of femur fracture at Waitemata District Health Board

Reuben J Kirk, Carlene MM Lawes, William Farrington, Peter Misur, Matthew L Walker, Michal Kluger, Min Yee Seow, Penny Andrew

ABSTRACT

AIM: Mortality rates of up to 38% at one year have been reported following surgery for neck of femur fractures. The aim of this review is to evaluate the post-operative mortality rates and trends over time for patients with fractured neck of femur at Waitemata District Health Board.

METHOD: A retrospective cohort study of all patients who received surgery following a neck of femur fracture at Waitemata District Health Board between 2009 and 2016. Inpatient data was retrieved from electronic hospital records and mortality rates from the Ministry of Health, New Zealand. Analyses included crude mortality rates and trends over time, and time-to-theatre from presentation with neck of femur fracture.

RESULTS: A total of 2,822 patients were included in the study; mean age 81.9 years, 70.4% female and 29.6% male. Overall post-operative crude rates for inpatient, 30-day and one-year mortality were 3.7%, 7.2% and 23.8% respectively. Adjusted analyses showed a statistically significant decrease in mortality rates between 2009 and 2016 at inpatient (p=0.001), 30 days (p<0.001) and one-year (p<0.001) time periods. There was also a significant association between time-to-theatre and mortality at inpatient (p=0.002), 30 days (p=0.0001), and one-year (p=0.0002) time periods.

CONCLUSION: Mortality rates following surgery for fractured NOF have significantly improved over recent years at Waitemata District Health Board. Reduced time-to-theatre is associated with decreased inpatient, 30-day and one-year mortality.

Fractured neck of femur (NOF) is the most common cause for orthopaedic admission in older adults, and is associated with significant morbidity and mortality.1 The incidence of NOF fracture in New Zealand is reported to be 218 per 100,000 per year,2 and is rising in parallel with the ageing population. Due to significant costs associated with acute management, interim care placement, rehabilitation and outpatient support services, NOF fractures represent a significant burden upon the national healthcare system.

High mortality rates following surgery for NOF fracture have been well documented, and range between 5.3–12% at 30 days and 17–38% at one year.3–10 Certain factors including male gender, increasing age, frailty, high American Society of Anesthesiologists (ASA) score and delayed time-to-theatre, are associated with increased early mortality.4,5,7,11,12 A history of congestive heart failure, chronic obstructive pulmonary disease, dementia and malignancy increases the one-year mortality three-fold in NOF fracture patients.13

Guidelines and recommendations have been developed internationally aiming to reduce mortality rates following hip fracture, particularly in those who are most vulnerable.14–16 The American Academy of Orthopaedic Surgeons (AAOS) and the United Kingdom’s National Institute for Health and Care Excellence (NICE) have both provided comprehensive, evidence-based guidelines that emphasise the importance...
of early surgery and coordinating care through a multidisciplinary hip fracture programme to help patients recover more quickly and regain their mobility.14,15 Many hospitals in New Zealand have implemented Enhanced Recovery After Surgery (ERAS) protocols that embody these guidelines,17,18 and there is a growing body of evidence to suggest that ERAS protocols reduce length of hospital stay and improve functional outcome.19 The evidence to suggest that ERAS protocols reduce mortality rates remains limited.19,20 The purpose of this retrospective audit is to assess mortality rates in patients following surgery for NOF fracture between 2009–2016 at Waitemata District Health Board (Waitemata DHB), Auckland, New Zealand. Secondary aims are to assess trends in mortality rates over time, and with respect to age, gender, ASA grade and time-to-theatre.

Method

This is a retrospective cohort study of all patients who had operative management of a fractured NOF under the Orthopaedic service at Waitemata DHB from January 2009 to December 2016 inclusive. Waitemata DHB encompasses two hospital sites (North Shore Hospital and Waitakere Hospital) that provide public health services to more than 580,000 residents of the North Shore, Waitakere and Rodney districts of Auckland, New Zealand.

Inpatient data was retrieved from electronic hospital records at Waitemata DHB. Patients were identified using the International Classification of Disease, Tenth Revision, Australian Modification, Eighth Edition (ICD-10-AM 8th Ed.) coding system.21 Data includes all patients admitted to Waitemata DHB with a diagnosis of fracture of the hip using the ICD-10-AM 8th Ed. codes S72.00–S72.08 (fractures of the neck of femur) and S72.10–S72.2 (peritrochanteric fractures). Specific causes of hip fracture, such as pathological and periprosthetic fractures, were not identified in this study. Hip fractures sustained as an inpatient, as well as those in the community were included. Given mortality rates were being assessed in NOF patients following surgery, those patients who did not receive surgery were excluded. There were insufficient numbers for subgroup analyses in the non-surgical group. Mortality data was obtained from the Ministry of Health, and included inpatient and outpatient date of death to one year, but did not include cause of death.

Mortality at each time point was analysed using logistic regression modelling and included admission year (2009 to 2016 inclusive) in the model. The consistency of results was assessed by the following subgroups: gender, age groups and ASA. The association between mortality and time-to-theatre was assessed using logistic regression modelling. Analyses were also adjusted for gender, age groups and ASA. There were no adjustments for multiplicity. All statistical analyses were performed using SAS version 9.4.

Results

Between January 2009 and December 2016, 2,822 patients underwent surgery for fractured NOF at Waitemata DHB. Patient demographics are presented in Table 1. Over 70% of patients were female (70.4%) and the mean age was 81.9 years. More than 70% of patients had an ASA score of 3 or more. There were similar proportions of ASA 3 scores for males and females, but more

Table 1: Demographics of Waitemata DHB patients that underwent surgery for NOF fracture (2009–2016).

<table>
<thead>
<tr>
<th>Total patients</th>
<th>2,822</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1,988 (70.4)</td>
</tr>
<tr>
<td>Male</td>
<td>834 (29.6)</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
</tr>
<tr>
<td>&lt;60</td>
<td>113 (4)</td>
</tr>
<tr>
<td>60–69</td>
<td>220 (7.8)</td>
</tr>
<tr>
<td>70–79</td>
<td>548 (19.4)</td>
</tr>
<tr>
<td>80–89</td>
<td>1,298 (46)</td>
</tr>
<tr>
<td>≥90</td>
<td>643 (22.8)</td>
</tr>
<tr>
<td>ASA score*</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>119 (4.2)</td>
</tr>
<tr>
<td>2</td>
<td>689 (24.4)</td>
</tr>
<tr>
<td>3</td>
<td>1,566 (55.5)</td>
</tr>
<tr>
<td>4</td>
<td>435 (15.4)</td>
</tr>
</tbody>
</table>

*An ASA score of 3 is defined as a patient with severe systemic disease that is not incapacitating, and an ASA score of 4 is defined as a patient with severe systemic disease that is a constant threat to life.22
males had an ASA score of 4 (20% compared to 15% of females).

Crude mortality rates following surgery for fractured NOF at Waitemata DHB from 2009–2016 are presented in Table 2. Overall, a total of 104 (3.7%) patients died in hospital pre-discharge, 204 (7.2%) within 30 days of surgery (including inpatient deaths), and 671 (23.8%) died within one year of surgery. Inpatient mortality rates for non-surgical patients were 9.9%, and at 30 days they were 15.1%. Further subgroup analyses were not possible due to small numbers. Crude mortality rates for females were 5.5% and 21.2% for 30 days and one year respectively; and for males were 11.4% and 29.8% for 30 days and one year respectively.

Crude mortality rates by age and ASA score are presented in Table 3. At one year crude mortality rates ranged from 11.0% in those aged 60–69 years to 41.8% in those aged ≥90 years. Over 80% of the patients that died by one year following surgery were aged 80 years or older. Crude mortality rates increased with rising ASA score. Patients with an ASA score of 3 or 4 had the highest mortality rates of 23.6% and 53.8% at one year respectively.

Between 2009 and 2016 inclusive, mortality rates following surgery for NOF fracture decreased at inpatient, 30-day and one-year time points (Table 2). There was a statistically significant decrease in mortality over time in analyses adjusted for gender, age groups and ASA in each time period, with odds ratio (OR) ranging from 0.86–0.92 (Table 4). At Waitemata DHB the mean time from admission with NOF fracture to surgery decreased from 41 hours in 2009 to 31 hours in 2016. There was a statistically significant association between time-to-theatre and inpatient (p=0.002), 30-day (p=0.0001), and one-year (p=0.0002) mortality adjusted for gender, age groups.

### Table 2: Post-operative NOF fracture crude mortality rates at Waitemata DHB 2009–2016.

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of post-op NOF patients</td>
<td>327</td>
<td>371</td>
<td>306</td>
<td>320</td>
<td>362</td>
<td>389</td>
<td>388</td>
<td>359</td>
<td>2,822</td>
</tr>
<tr>
<td>Post-op inpatient deaths n (%)</td>
<td>17 (5.2)</td>
<td>17 (4.6)</td>
<td>12 (3.9)</td>
<td>12 (3.8)</td>
<td>17 (4.7)</td>
<td>10 (2.6)</td>
<td>15 (3.9)</td>
<td>4 (1.1)</td>
<td>104 (3.7%)</td>
</tr>
<tr>
<td>Post-op deaths at 30 days n (%)</td>
<td>33 (10.1)</td>
<td>38 (10.2)</td>
<td>22 (7.2)</td>
<td>22 (6.3)</td>
<td>20 (6.8)</td>
<td>20 (4.6)</td>
<td>22 (5.7)</td>
<td>21 (5.8)</td>
<td>204 (7.2%)</td>
</tr>
<tr>
<td>Post-op deaths at one year n (%)</td>
<td>82 (25.1)</td>
<td>109 (29.4)</td>
<td>69 (22.5)</td>
<td>71 (22.2)</td>
<td>87 (24)</td>
<td>91 (23.4)</td>
<td>80 (20.6)</td>
<td>82 (22.8)</td>
<td>671 (23.8%)</td>
</tr>
</tbody>
</table>

### Table 3: Overall crude mortality rates by age and ASA score at Waitemata DHB 2009–2016.

<table>
<thead>
<tr>
<th>Age* (years)</th>
<th>30-day mortality (%)</th>
<th>One-year mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60–69</td>
<td>2.6</td>
<td>11.0</td>
</tr>
<tr>
<td>70–79</td>
<td>4.1</td>
<td>16.0</td>
</tr>
<tr>
<td>80–89</td>
<td>8.6</td>
<td>26.9</td>
</tr>
<tr>
<td>≥90</td>
<td>12.7</td>
<td>41.8</td>
</tr>
<tr>
<td>ASA score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.8</td>
<td>3.4</td>
</tr>
<tr>
<td>2</td>
<td>1.6</td>
<td>8.0</td>
</tr>
<tr>
<td>3</td>
<td>5.9</td>
<td>23.6</td>
</tr>
<tr>
<td>4</td>
<td>21.7</td>
<td>53.8</td>
</tr>
</tbody>
</table>

*Patients <60 years of age have been excluded due to small numbers (one death).
and ASA. The decreasing mean time-to-theatre and decreased mortality rates at Waitemata DHB during the study period is illustrated in Figure 1.

**Discussion**

In this large retrospective cohort study we have shown that overall, 23.8% of patients died within the first year following surgery for fractured NOF at Waitemata DHB. Patients of male gender, ASA score ≥3, and age 80 years and older, were less likely to survive beyond one year following a surgical procedure for NOF fracture. Our results demonstrated a statistically significant decrease in mortality rates at inpatient, 30-day and one-year time periods from 2009 to 2016. Further to this, we have found a significant association between reduced time-to-theatre and lower mortality rates at inpatient, 30-day and one-year timeframes.

The results of our study concur with much of the literature, indicating that mortality rates following surgery for NOF fracture remain between 17–38% at one year.4–10 Previous studies investigating hip fracture mortality rates within New Zealand hospitals have presented similar results. Wimalasena et al (2016) reported 30-day mortality of 5%, and 120-day mortality of 15% at Auckland City Hospital.23 Davidson et al (2001) reported that from 329 patients in Christchurch hospitals, the one-year mortality rate was 26%.24 Walker et al (1999) found in a range of New Zealand hospitals that mortality rates following hip fracture were 8% at 35 days and 24% at one year.25 Many studies have investigated the relationship between demographic factors and mortality rates in hip fracture. Increasing age has been highly associated with increased mortality.11

### Table 4: Post-operative NOF fracture mortality over time at Waitemata DHB 2009–2016.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Analysis</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inpatient mortality</td>
<td>Unadjusted</td>
<td>0.89 (0.82–0.97)</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>Adjusted*</td>
<td>0.86 (0.79–0.94)</td>
<td>0.001</td>
</tr>
<tr>
<td>30-day mortality</td>
<td>Unadjusted</td>
<td>0.90 (0.85–0.96)</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Adjusted*</td>
<td>0.87 (0.82–0.93)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>One-year mortality</td>
<td>Unadjusted</td>
<td>0.95 (0.91–0.98)</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Adjusted*</td>
<td>0.92 (0.88–0.96)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

*Adjusted for gender, age groups and ASA.

**Figure 1:** Trends of mean time-to-theatre and inpatient, 30-day and one-year mortality rates (2009–2016).
found that mortality rates increased with each decade of life after 60 years of age, and unsurprisingly the highest mortality rates afflict those aged 90 years and older. With respect to gender, rates of hip fracture have been reported as much higher in the female population than in males. This is likely due to increased incidence of osteoporosis in females. More than 70% of the patients in our study were female. Interestingly, we found that males had higher mortality rates (29.8% compared to 21.2% at one year) following surgery. Similar findings have been reported by Berggren et al (2016) and Roche et al (2005) who also found male mortality to be higher than their female counterparts. It is unclear why men have higher mortality rates following NOF fracture, perhaps this is due to increased comorbidity and increased prevalence of post-operative complications. Kastanis et al (2016) reported that ASA score is strongly correlated with post-operative complications, and that males exhibited greater ASA scores. In our study there are similar proportions of ASA 3 scores across genders, but slightly more males are ASA 4 (20% compared to 15% of females). Despite this, international guidelines have not recommended gender-specific strategies to address this inequality.

Our study found there to be a statistically significant decrease in inpatient, 30-day and one-year crude mortality rates over time at Waitemata DHB between 2009 and 2016. Two large systematic reviews have investigated mortality trends over time in surgically treated hip fractures. The findings are in contrast to our results. Mundi et al (2014) reviewed 70 randomised controlled trials published between 1981 and 2012 that measured mortality. They found mortality rates to be similar over a 31-year period. Haleem et al (2008) performed a systematic review of all articles published on outcome after hip fracture over a four-decade period from 1959 to 1998, which preceded our study. They concluded that one-year mortality rates have remained essentially static, ranging from 22–29%. We speculate that decreasing mortality rates over time in our study may be contributed to by implementation of the ERAS pathway for NOF fractures at Waitemata DHB in 2013.

ERAS pathways are evidence-based, multimodal, accelerated clinical pathways aimed at improving patient outcomes. The ERAS pathway initiated at Waitemata DHB aims to provide optimal analgesia from time of presentation, surgery within 48 hours, perioperative antibiotics for infection prophylaxis, inpatient antiocoagulation for thromboembolism prophylaxis, and early mobilisation after surgery. While ERAS protocols have been associated with decreased morbidity and reduced length of hospital stay in patients undergoing major surgery, there is limited evidence to suggest they reduce mortality rates in NOF fracture patients. Proudfoot et al (2017) found there to be no change in the average length of stay for fractured NOF patients following the implementation of ERAS protocols at 18 DHBs across New Zealand. A meta-analysis by Neuman et al (2009) reported that deep vein thrombosis, pressure ulcers, surgical site infection and urinary tract infection declined by using ERAS protocols for hip fracture patients. However, the study did not demonstrate a decrease in inpatient or 30-day mortality. Macfie et al (2012) performed an audit on hip fracture patients that were either managed using an ERAS pathway or conventional care. The authors reported that while the ERAS group had fewer complications, there was no significant difference between the two groups with regards to 30-day mortality.

Although time-to-theatre has been gradually declining over time, since the implementation of the NOF fracture ERAS pathway at Waitemata DHB in late 2013 we have observed a further decrease in mean time-to-theatre from 40 hours in 2013 to 31 hours in 2016. Adjusted analyses performed in our study confirm the association between time-to-theatre and crude mortality to be statistically significant. This supports the notion that reduced time-to-theatre provides a mortality benefit for patients with NOF fractures at Waitemata DHB in 2013.

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of time” from presentation to surgery, in respect of best morbidity and mortality benefit. Pincus et al (2017) have reported that among adults undergoing hip fracture surgery, a wait time greater than 24 hours is associated with increased 30-day mortality and complications (myocardial infarction, deep vein thrombosis, pulmonary embolus and pneumonia).30

International guidelines recommend that surgery should occur within 48 hours of admission.14,15 However, the evidence within the literature is mixed, and based on variable strength data.14 Studies by Major et al (2016) and Forni et al (2016) both found no correlation between surgical intervention within 48 hours and survival rates.9,31 The authors suggested that early surgery might actually have a negative impact on survival, as more time is needed to medically stabilise complex patients. Holt et al (2010) demonstrated that patients with major clinical abnormalities whose surgeries were postponed to allow for correction of these abnormalities were more likely to survive than those whose operations were not delayed. However, patients whose operations were delayed but abnormalities were unable to be reversed had the poorest survival.22 In a retrospective cohort study of 42,230 patients, Pincus et al (2017) found a 24-hour wait time threshold: a wait time of greater than 24 hours was associated with a greater risk of 30-day mortality and other complications; after this time, complications increased irrespective of the complication, follow-up period or subgroup assessed.30 We suggest that individual patient factors and the potential for reversibility of medical problems needs to have a structured, coordinated management plan using anaesthesia, orthogeriatric medicine and surgical input prior to fast-tracking NOF fracture patients to theatre.

Anaesthetists and orthogeriatrists play a crucial role in assessing and resolving medical obstacles to timely surgery; and are integral to the multidisciplinary care of NOF fracture patients. The International Fragility Fracture Network recently developed a consensus statement on the principles of anaesthesia for patients with hip fracture, recommending that anaesthetists should be involved in designing and implementing formal hip fracture pathways, particularly with regard to preparation for theatre and pain management.35 At the beginning of 2018 a ward-based orthogeriatrion has been appointed full-time to oversee the medical management of NOF fracture patients both pre- and post-operatively at Waitemata DHB. In this integrated care model, patients benefit by receiving specialised geriatrician treatment in collaboration with the orthopaedic service. Grigoryan et al (2014) performed a meta-analysis to determine if orthogeriatric models improve patient outcomes. Results of this study supported orthogeriatric collaboration to reduce length of stay and improve short-term mortality after NOF fracture repair.34 A study by Förch et al (2017) found orthogeriatric care to be successful in reducing short-term mortality without showing effect on one-year mortality. However, the authors reported that surviving patients seem to benefit from an improved functional outcome.35 There appears to be a paucity of studies providing evidence that the integrated care model has a long-term mortality benefit.

Our study has a number of strengths. The simple methodology makes it easily reproducible for future studies. While the study has a limited number of variables, the data presented is considered to be accurate. Further to this, the eight-year study period captured high patient numbers, allowing for statistically significant evaluation of mortality trends over time. There are also some limitations of this study. Firstly, retrospective cohort studies require accuracy of administrative data. It is possible that ICD-10-AM 8th Ed. diagnosis or other codes, such as ASA, were assigned incorrectly in the clinical inpatient system potentially affecting our data and rates. Secondly, we have made no adjustment for factors such as, type of operation and components used, intra-operative complications and mode of death (eg, accidental death). Thirdly, there was only limited data on patient comorbidities.

In future, more accurate data collection and linking of databases would allow inclusion of place of admission and place of discharge in analyses as an indication of functional status. Improved data collection would also enable more detailed subgroup analyses, such as evaluating mortality rates in pathological and peri-prosthetic hip fracture patients.
fractures. Future research should seek to confirm a clear reduction in mortality associated with decreasing time-to-theatre, and whether an optimal “window of time” exists offering the best mortality benefit in respect of age, gender and comorbidity status. This will aid decision-making about which patients to fast-track to theatre versus those that will benefit from delay to surgery for medical optimisation. Research is needed to identify the reasons for mortality overall, the specific causes of death (and hence potential reversibility), the effects of frailty, dementia and delirium as well as the relatively high male gender mortality rate. Finally, more research is needed to further improve NOF fracture-specific ERAS pathways and the impact of integrated anaesthetist and orthogeriatric models of care on morbidity and long-term mortality benefit.

**Conclusion**

In conclusion, crude mortality rates following surgery for NOF fracture remain above 20% at one year, but have gradually declined over recent years at Waitemata DHB. Patients of male gender, ASA score ≥3, and age 80 years and older, have poorer survival rates following surgery for NOF fracture. ERAS protocols have seen a reduction in time-to-theatre, which remains closely associated with decreased inpatient, 30-day and one-year mortality.

**Competing interests:**

Dr Misur reports personal fees from Stryker Corporation outside the submitted work.

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