Theme: Process Management

Risk Analysis of Re-fractures of Elderly Patients-A New Zealand Retrospective Study

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Abstract
Most of the past studies on hip fractures focused on assessment of fracture risk of women. The primary objective of this study was to analyse the re-fracture risk and identify healthcare quality improvements necessary to reduce the re-fracture risk of elderly men and women who undergo fragility hip fractures. Computation of incident rates of fragility fractures for benchmarking was the secondary objective of the study. A retrospective analysis was conducted on patients (≥ 65 yrs) who suffered a fragility hip fracture—a fragility fracture is operationally defined as a fracture caused by forces equivalent to a fall from standing height or less—during the five-year period from 15 September 2006 through to 15 September 2011, in the district of Manawatu, New Zealand (n = 492). The incident rate risk measures calculated show that these figures were less than those of Norway and the USA (two OECD countries that have highest hip-fracture rates) but higher than those of UK and Australia. Establishment of a clinic for inpatient falls, establishment of a community-based exercise/physiotherapy programme, and deployment of a full-time community nurse specialist were the recommendations provided to the district health board to improve the current performance.

Authors’ Biographies
Dileepa Jayamaha is a geriatrician and a physician attached to the Palmerston North hospital, New Zealand. She holds a Doctor of Medicine degree and is also a fellow of the Royal Australasian College of Physicians.

Nihal Jayamaha, the presenting author, is a lecturer in quality assurance at Massey University, New Zealand. Nihal has published his research in several international journals and conferences. His research interests include statistical modelling, quality control, healthcare quality, and business excellence. He holds a PhD (technology), and masterates in engineering and business administration.
Presentation Experience
Nihal pas presented papers on topics such as structural equation modelling (2012, NZ), the Toyota Way (2011, Australia), Patient Admissions (2011, Australia), Hospital Falls (2009, Australia) etc.

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1. INTRODUCTION

Due to an aging population and increased probability of health-related incidents, the elderly population (> 65yrs) has become an important customer segment in the healthcare industry. Among the chronic disorders that affect the elderly population, hip fractures, which cause substantial morbidity and mortality, is emerging as a major public health issue in the Western countries (Nguyen et al., 2007). For example, in 2007, New Zealand spent NZS 105 Million for hip fracture care with an average of 312 patients per day in hospital beds (Osteoporosis New Zealand, 2012).

Notwithstanding the increased awareness of the need to treat hip fractures of the elderly (> 65 years), relatively a small proportion of the patients do receive treatment (Rabenda et al., 2008). Studies show that patients with a history of any type of prior fracture have a 2 to 6 fold increased risk of subsequent fractures compared to those without a previous fracture and are at risk of a significant disability as a result (Van Staa, Leufkens, and Cooper, 2002). Hence assessment of re-fracture risk, that is the risk of a second fracture after sustaining a low-trauma fragility (osteoporotic) hip fracture¹ earlier, and understanding the ways to manage re-fracture patients have been well researched topics in the medical field, although no such study involves New Zealand. However, unfortunately, very few past studies—some of the key studies covering the past 6 years are described in this section—have focused on assessment of fracture risk of men (Center, Bliuc, Nguyen, & Eisman, 2007; vanStaa, Leufkens, & Cooper, 2002).

Center, Bliuc, Nguyen, and Eisman (2011) conducted a retrospective study involving elderly (> 60 years) community-dwelling Australian men and women to determine the absolute risk and relative risk² of a subsequent fracture (i.e. a re-fracture) based on the age group and gender. They found that for all age groups they selected (all groups ≥ 60 years), both men and women returned similar absolute risk values, which suggests that women are at no greater risk than men in sustaining a re-fracture.

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1 In medical research the term low trauma (or minimal trauma) fracture refers to a fracture “resulting from a fall from a standing position or lower” (Hider et al., 2005). Almost invariably a low trauma fracture happens in fragile/osteoporotic patients.

2 In epidemiology the term relative risk is used to refer to the risk (probability) of contracting a certain disease by one group of people relative to another group of people (expressed as a ratio or a percentage), over a defined period of time, for example, the risk of contracting cancer (at the age of 60) by smokers relative to the non-smokers. The term absolute risk, which invariably refers to one group only, is the actual risk (probability) of contracting the disease, over a defined period of time (Kenny, 2012).
Through a prospective Australian cohort study, Center, Bliuc, Nguyen, Nguyen, and Eisman (2011) examined the effect of treatment for osteoporosis on the risk of mortality (mortality is highly correlated with fragility fractures and hence the rationale of the study). They found that therapy appears to reduce the risk of mortality in women (statistically significant) but less certainly so (statistically nonsignificant) in men. Their study thus suggests that osteopathic therapy is one option for reducing the mortality risk (e.g. through falls and fractures) of the elderly in general.

Diamantopolous et al (2012) studied the incident rates of fragility hip fractures of all men and women over the age of 50 (inclusive) in southern Norway during the two year period 2004-2005 ($n = 271$ for men and $n = 680$ for women). The age-adjusted incidence rate for men was found to be 34.6 per 10,000 person-years while the age-adjusted incidence rate for women was found to be 75.8 per 10,000 person-years. The age specific incident rates for both men and women were the same (statistically nonsignificant difference) for all age groups up to the age of seventy (they selected 5-year class intervals for their study) but thereafter, the incidence rates of women begun to exceed those of men for all age groups. They also studied the effect of time of the year on the incident rates (fragility fracture) and found that the incident rates in winter were higher than those in the other three seasons. The study is important from a quality/operations management point of view because it indicates to where resources should be directed to in the right amount at the right time for health care quality improvement.

Nguyen et al. (2007) followed up a large sample of elderly ($\geq 60$ years) Australian men ($n = 850$) and women ($n = 1358$) over a period of 15 years to ascertain the residual lifetime risk\(^3\) of a low trauma fracture (mortality adjusted). The residual lifetime risk of a fracture was found to be 44% for women and 25% for men. They also found that low bone mineral density (BMD) interacts with gender in that for those with low BMDs ($T$ score $< -2.5$), the risk increased to 65% in women and 42% in men. Diamond, Thornley, Sekel, and Smerdely (1997) conducted a cohort study (51 men and the same number of women matched by age for comparison purposes) to examine prognostic factors and outcomes of elderly men ($\geq 60$ years) after a hip fracture. They found that men have a higher mortality rate and more risk factors for osteoporosis compared to women. Both these studies are important from an operations management perspective because they help the clinicians and policy makers to target high risk groups for medical intervention.

While gender is a factor that interacts with age in causing fractures (when the age increases beyond 65 women become more vulnerable than men to sustain a fracture as found in previous studies), overlooking men (or lack of significant findings for men) in most studies remains a significant void in published research. This study is aimed at addressing the aforementioned void (the absence of a New Zealand study and scarcity of studies involving both men and women). Moreover, this study may help in revealing the New Zealand situation compared to other comparable OECD countries such as Norway and Australia, which are known to have high incidences of fragility hip fractures and re-fractures. Currently the efforts to reduce fragility re-fractures in New Zealand are fragmented (Osteoporosis New Zealand, 2012) and it

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\(^3\) Residual lifetime risk is the cumulative absolute risk of fracture during an individual’s lifetime begging from the counting period (Nguyen et al., 2007).
is hoped that this study does help in some way to establish a coordinated healthcare service for prevention and management of hip fracture patients in New Zealand.

1.1 Objectives of the Study

The primary objective of the study was to analyse the re-fracture risk and identify quality improvement efforts (in hospital processes) that are necessary to reduce the re-fracture risk of elderly men and women in New Zealand who undergo a low trauma (fragility) hip fracture. Computation of incident rates of fragility fractures for benchmarking purposes was the secondary objective of the study.

2. METHODOLOGY

Elderly patients (> 65 years) who sustained fragility (low trauma) hip fractures and admitted to the Palmerston North Hospital (PNH) from 15 September 2006 through to 14 September 2011 (5 years) were chosen for this retrospective study. Palmerston North is the capital city of the district of Manawatu, New Zealand. The PNH is by far the largest hospital (230 beds) belonging to the Mid-Central District Health Board (MidCentral DHB). This DHB is responsible for the primary, secondary and tertiary health of the district of Manawatu. There were two categories of hip fracture patients in the study sample: patients who have had only a hip fracture (i.e. no subsequent fracture) and patients who have had a subsequent fracture (i.e. a re-fracture) after a hip fracture occurred at an earlier occasion. Subsequent fractures included a variety of fracture types: proximal femur, distal femur, pelvis, proximal tibia, ankle, vertebral, multiple rib, wrist and humerus. The hospital electronic diagnosis registers were used to identify all hip fracture patients in the 5-year period coded as S72 according to the ICD-10 (WHO, 2011).

The following were excluded from the study: fractures that cannot be defined as low trauma fractures (i.e. high trauma/velocity fractures, periprosthetic fractures and pathological fractures), patients who were transferred from other DHBs, and patients who were unable to be followed-up (e.g. those discharged to another DHB). This resulted in having a total number of 492 patients of whom 365 were females and 127 were males.

Data were collected from the patients’ medical records, except the age-specific demographic data (for age-adjustment of risk measures) of men and women in the district of Manawatu. The latter were collected from the performance and planning unit of the MidCentral DHB. The statistical analysis was performed using the Med Calc 12.2.1.0 and Minitab 16 software packages. The statistical significance level ($\alpha$ risk) for the study was taken as 5%.

3. RESULTS AND DISCUSSION

3.1 Results on the initial fracture group

Figure 1 shows that out of the 492 patients in the study sample, 170 (35%) died since the occurrence of the initial fracture during the 5 year monitoring period covered. Of those died, 115 (67%) died within the first three months since sustaining the first fracture suggesting that
the mortality rate for elderly patients is invariably high after sustaining a fracture. The above mortality rates were higher than UK and Australian benchmark data (Medicare Australia, 2006; NICE, 2009). The implication of this finding is simple: prevention is better than cure!

Three most cited remedies for fragility fracture prevention are establishment of efficient falls management programmes (this includes effective falls prevention clinics) and osteoporosis treatment and lack of control of medication (over-medicatin) (Center et al., 2007; Osteoporosis New Zealand, 2012). The study shows that it pays to audit the existing fragility fracture prevention programmes (beyond the scope of the project reported in this paper) to ascertain what improvements needs to be made in the services for the elderly New Zealanders.

![Pie chart showing mortality of fracture patients by time since the initial fracture](image)

Total died = 170 (35%) 

**Figure 1:** Mortality of fracture patients by time since the initial fracture
Figure 2 shows that the frequency distribution of the male patients who died \((n = 61)\) is similar to that of female patients who died \((n = 109)\).

Figure 3 shows that the incidence rate of fragility hip fracture of women starts to overtake that of males after the age group 80-85 years (up to this age group there is no apparent difference between the two genders). The age-adjusted incidence rate\(^4\) for males was calculated to be 20.81 per 10,000 person-years while the corresponding figure for females was calculated to be 52.66 per 10,000 person-years. The crude (age unadjusted) incidence rate for males was calculated to be 22.66 per 10,000 person-years while the corresponding figure for females was calculated to be 54.00 per 10,000 person-years.

\(^4\) The age adjustments were done based on the male and female demographic data for the district of Manawatu provided to us by the planning and performance unit of the hospital/district health board concerned. Age adjustment is necessary (for comparison purposes) when the age distributions of the two populations are different.
Figure 3: Age-specific incidence rates of hip fractures

Table 1: The $T$ test Results for Difference between Gender for Age-Specific Incidence Rates

<table>
<thead>
<tr>
<th>Age Group</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>65-70</td>
<td>0.6819</td>
</tr>
<tr>
<td>70-75</td>
<td>0.5757</td>
</tr>
<tr>
<td>75-80</td>
<td>0.0778</td>
</tr>
<tr>
<td>80-85</td>
<td>0.0056</td>
</tr>
<tr>
<td>85-90</td>
<td>0.0094</td>
</tr>
<tr>
<td>$\geq$ 90</td>
<td>0.0045</td>
</tr>
</tbody>
</table>
3.2 Results on the Re-fracture Group

Figure 4 shows that out of the 48 re-fractures, 27 (56%) were hip fractures (neck of femur abbreviated as NoF). The hip (56%), pelvic (13%) and vertebral fractures (8%) accounted for about 80% of re-fractures.

![Pareto chart](image)

**Figure 4:** The Pareto chart for number of re-fractures by the fracture type

Figure 5 shows that 79% of re-fractured patients were on antiresorptive (osteoporotic treatment Bisphosphonates) therapy.
Figure 5: Treatment being given for osteoporosis at the time of re-fracture

Table 2 shows that there were a significantly higher proportion of smokers and steroid users in the re-fracture group compared to the reference group.

Table 2: Comparison of the Re-fracture Group with the Reference Group Based on Age, Proportion of Smokers and the Proportion of Steroid Users

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Re-Fracture Group (n = 48)</th>
<th>Reference Group (n = 274)</th>
<th>p Value for Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Age</td>
<td>86.48 yrs (SD = 7.15)</td>
<td>85.03 yrs (SD = 7.63)</td>
<td>0.205</td>
</tr>
<tr>
<td>Proportion of Smokers</td>
<td>31.25%</td>
<td>17.34%</td>
<td>0.049</td>
</tr>
<tr>
<td>Proportion of Steroid Users</td>
<td>45.83%</td>
<td>26.20%</td>
<td>0.000</td>
</tr>
</tbody>
</table>
The term ‘reference group’ is used here to mean the patients who haven’t had a re-fracture (i.e. those who have had only the initial fracture).

Figure 6 shows that the patients who have had a subsequent fracture (re-fracture) had a significantly reduced functional status—as measured through the Modified Barthel Index (MBI)—compared to those who haven’t had a subsequent fracture ($p$ value for the $T$ test for difference $= 0.000$). MBI is an index formed from ten measures (each measure representing a basic day to day activity required by a patient). For operations management purposes a patient’s functional status is classified into five categories based on the MBI score—MBI, which ranges from 0 (completely dependent) to 100 (completely independent)—as shown in Table 2 (Medicare Australia, 2006).

Interpreting the MBI scores in Figure 6 in conjunction with the data in Table 3, it becomes clear that prevention of a subsequent fracture is desirable particularly from the patient’s perspective. This is because a re-fracture seems to cause the patient’s functional status change to a higher dependency level although this may not necessarily reflect in an increase in time expended in providing help to the patient (e.g. the increase in help required for changing the functional status from category 3 to category 2 is marginal based on estimated minimum times referred to in Table 2).

$\quad p = 0.000 \\ \quad p = 0.277$

**Figure 6:** Box plots for initial fracture versus subsequent fracture based on the patients functional status (measured via MBI) and length of stay (LoS) in the hospital

Figure 6 also implies that there is no significant change in the duration of hospitalisation (labelled Length of Stay (LoS) in Figure 5) in spite of a re-fracture. This is understandable because re-fracture patients are being handled by multidisciplinary teams at the rehabilitation ward of the PNH (physiotherapists, occupational therapists, specialist nurses, and elder health physicians etc.).
Table 3: Patient Dependency Categories and Service Levels Required (Source: Medicare Australia, 2006)

<table>
<thead>
<tr>
<th>Categories</th>
<th>MBI Total Scores</th>
<th>Dependency Level</th>
<th>Estimated Hours of Help Required per Week (maximum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 - 24</td>
<td>Total</td>
<td>27.0</td>
</tr>
<tr>
<td>2</td>
<td>25 - 49</td>
<td>Severe</td>
<td>23.5</td>
</tr>
<tr>
<td>3</td>
<td>50-74</td>
<td>Moderate</td>
<td>20.0</td>
</tr>
<tr>
<td>4</td>
<td>75 – 90</td>
<td>Mild</td>
<td>13.0</td>
</tr>
<tr>
<td>5</td>
<td>91 - 99</td>
<td>Minimal</td>
<td>&lt; 10.0</td>
</tr>
</tbody>
</table>

Figure 7: Discharge destination

Figure 7 shows that out of the 48 patients who sustained a re-fractures only 11 (23%) were institutionalised before the re-fracture while 20 (42%) had to be institutionalised after the re-fracture. This shows that patients become more dependent after a re-fracture due to the decrease in their functional status.

The re-fracture statistics shown in this section leads one to posit the following causal chain:

Re-fracture (second fracture) → Declining Functional Status → Greater Dependency → Greater Institutionalisation → Greater Healthcare Burden
The above chain forms the basis for the discussion and conclusion section shown in the next page.

4. CONCLUSION

It was observed that secondary prevention (i.e. occurrence of a re-fracture) is of paramount importance and should be implemented as soon as possible after a fragility fracture. The evidence base for prevention overwhelms concerns about possible adverse consequences of osteoporosis treatment on fracture healing (Ganda, & Seibel, 2012; Marsh et al., 2011; NICE, 2012).

It is recommended that a fracture liaison service (FLS) be established in New Zealand, similar to the ones found in the UK (Marsh et al., 2011) and Australia (Ganda & Siebel, 2012). Like in the UK and Australia, the FLS can be delivered through a nurse specialist supported by a lead clinician in osteoporosis. The nurse specialist can identify and evaluate patients with new fragility fractures. Older patients, where appropriate, can be identified and referred on to the falls management clinic.

There were two limitations in the study reported in this paper. Firstly, the study conducted by the authors is not a prospective longitudinal study. Ideally, a patient should be followed-up over a fixed length of time (10 years is typical) once the patient has sustained a hip fracture. Secondly, there was no control group in this study (thus this study is not a randomised controlled trial). For these reasons no solid causal inferences could be made by the authors.

5. REFERENCES


