The effect of hospital type and surgical delay on mortality after surgery for hip fracture


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Hip fractures are among the most devastating medical problems experienced by the elderly and impose a considerable burden on health care.1-5 Their incidence increases exponentially after the age of 70 years, and projections indicate that the number will rise over the coming decades because of an ageing population.6-8 A study which used data from the Canadian Hospitals Injury Reporting and Prevention Program, showed that hip fractures are the most common type of hospitalised injury in both men and women aged 65 years or older.9

There is significant mortality during the first year after a hip fracture. In Ontario, Canada, the overall in-hospital mortality rate is estimated to be 6.9%, and is significantly higher for men (10.3%) than women (5.8%).10 This is about seven times the mortality of other elderly people10 and independent of age and comorbidities.11-13 Two years after a hip fracture, the mortality rate approaches the expected rate for individuals in the same age group.14 This pattern of mortality has remained unchanged over the years14 and is different to that seen in patients with other fragility fractures such as vertebral fractures.15 The mechanism by which hip fractures cause older people to die remains obscure and requires further research.11,13

Studies show that the type of hospital in which a patient receives treatment for a variety of conditions can influence both the cost of services and patient survival with mortality being lower in teaching than non-teaching hospitals.16,17 The most striking difference in survival was for hip fracture patients.17 Moreover, a gradient of decreasing risk was noted through the categories of for-profit non-teaching hospitals, government, non-profit, minor teaching hospitals and major teaching institutions.17

To our knowledge, there are no comparable Canadian data. However, it is reasonable to suggest that mortality rates in Canadian teaching hospitals may also be lower than in community hospitals, considering the existing data from other studies.

A factor which may be related to both hospital status and mortality is the time delay before surgery. Delay in surgical treatment for a hip fracture can be caused by numerous factors which range from the time required to stabilise a patient’s medical condition to the availability of operating theatres. Regardless of the cause, surgical delay increases the time which a patient spends in bed. Furthermore, patients awaiting surgery are fasted which may adversely affect their nutritional status and the eventual outcome.

Nevertheless, studies that have assessed the effect of non-medical causes of surgical delay on outcome report conflicting results. Some have demonstrated detrimental18-20 and others beneficial21 effects from surgical delay. Methodological limitations, including lack of
sufficient statistical power and inadequate adjustment for comorbidities, may have contributed to the lack of a relationship between surgical delay and outcome in many studies.\textsuperscript{22-28}

Our objectives were to determine whether mortality after a hip fracture is related to the type of hospital in which a patient is treated, examine the relationship between surgical delay and mortality after a hip fracture and determine whether surgical delay contributes to the differences in outcome between the hospital types.

**Patients and Methods**

We identified patients aged 50 years or older, who were admitted to hospital in Ontario, Canada between 1993 and 1999 for surgical treatment of a hip fracture (International Classification of Diseases, Ninth Revision (ICD-9) diagnostic code 820, fracture of neck of femur) from the Canadian Institute for Health Information (CIHI) Discharge Abstracts Database (DAD). The DAD contains information on admission and discharge dates, diagnostic procedures based on the Canadian Classification of Procedures which were performed during an in-patient stay, history of transfer from another acute care facility, age, sex, hospital identifier and postal code. Independent comparisons of the accuracy of the CIHI database against hospital medical records have determined that the database is accurate for procedures, primary admission diagnoses and major complications.\textsuperscript{29}

Patient data were collected for the fiscal years between 1993 and 1999. The fiscal year is between April 1 of the identified year and March 31 of the following year. Our analysis therefore extended to 31 March 2000. Sex and age at the time of the index procedure were obtained from the DAD. Surgical delay was determined by subtracting the date of operation from the patient's date of admission while their length of stay was calculated by subtracting the date of discharge from the date of admission.

A modified Charlson-Deyo index\textsuperscript{30} was used to adjust for comorbidity. This is a validated scale, which can be calculated from administrative data, based upon the presence of certain diagnostic codes that are related to various disease states.

An algorithm, similar to that used in earlier research\textsuperscript{31,32} was used in order to identify any major complications after hip fracture surgery. These complications included infection, deep vein thrombosis, intra-operative surgical complications and significant medical complications (urinary tract infection, acute myocardial infarction, confusion, pneumonia). The complications were chosen based upon their clinical effect on patient outcome and their reduced risk of misclassification.

Hospitals were classified as teaching (a member of the Ontario Council of Teaching Hospitals) or non-teaching. Non-teaching (community) hospitals were further classified as urban (located in communities with population \(\leq 10,000\)) or rural (located in communities with population \(\leq 10,000\)) according to the most recent census data from Statistics Canada. All of the teaching hospitals were in urban areas.

The cohort was linked to the Registered Persons Database, which contains information on all deaths in Ontario, in order to obtain complete information about patient deaths. Deaths were categorised as in-hospital, and death within three, six or 12 months.

It has been argued that sicker patients are delayed because they must be medically stabilised before their surgical treatment and are thus more likely to die. To explore this, we confined our analysis to those patients whose surgical delay was less than seven days after admission. Seven days was chosen arbitrarily in order to exclude those patients whose surgery may have been delayed primarily because of medical problems. We considered that delays beyond seven days because of non-medical reasons were unlikely.

**Statistical analysis.** Descriptive analyses were performed with routine statistical procedures. Odds ratios (OR) were calculated using logistic regression for in-hospital mortality, mortality at three, six and 12 months and the presence of a major complication associated with hospital type and length of time to surgery. In all analyses urban community hospital and surgery performed on the same day as admission are the reference categories. Other covariates assessed were age, sex and the Charlson-Deyo index. In order to assess the fit of the models, we compared the deviances from fitting the models with and without the covariate. The differences in the deviances were assumed to follow a chi-square distribution.

Ordinary least squares regression analysis were used to assess the relationship between the hospital type and length of stay. Covariates assessed were age, sex, Charlson-Deyo index, complications and length of time to surgery. Interactions were assessed in all models. Analyses were performed using the SAS statistical software (SAS Institute Inc, Cary, North Carolina) for the Unix environment, release 8.2. Values for \(p < 0.05\) were regarded as significant.

**Results**

Of the 57,315 hip fracture patients who were identified from the DAD, 75% were women. Men (mean age 77.7 years \(\pm 10.2\)) were significantly younger than women (mean age 81.4 years \(\pm 8.8\), \(p < 0.05\)). Men also experienced a higher percentage of deaths both in hospital and at other times during the first year after surgery. The overall in-hospital mortality was 7% (men 10%; women 6%) but by 12 months after surgery the overall mortality had risen to 24% (men 31%; women 21%).

Univariate analyses comparing urban teaching, urban community and rural community hospitals indicated that the time to surgery and the length of hospital stay differed among the three types of hospital (Table I). Urban teaching hospitals had the longest surgical delay and urban community hospitals had the shortest. The length of hospital stay...
was significantly longer in rural community hospitals than in either urban teaching or urban community hospitals. Patients in urban teaching hospitals had more medical comorbidities than those in either urban or rural community hospitals. Urban community hospitals reported a lower complication rate than either urban teaching or rural community institutions.

A multiple regression analysis indicated that patients in rural community hospitals had a significantly longer length of stay (p < 0.0001), after adjusting for significant covariates and their interactions, than those treated in either urban teaching or urban community hospitals. However, when adjusted for significant covariates no difference in the length of stay was noted between urban teaching and urban community hospitals.

Rates of death at three, six and 12 months after surgery differed by hospital type (Table I). In-hospital mortality was 2% lower in urban teaching hospitals compared with rural community institutions (p < 0.05). Although the difference between urban and rural community hospitals did not reach statistical significance, there was lower in-hospital mortality in the urban institutions (p = 0.06). At three months and beyond, patients who were treated in urban teaching hospitals consistently had a better outcome than those treated in urban community or rural community hospitals.

Of the patients, 20,303 (35%) experienced no surgical delay and underwent surgery on the day of their admission. However, 25,320 (44%) had a one-day delay, 7,314 (13%) had a two-day delay and 8% (4,378) had a delay of between three and seven days (Table II). Older age, a higher Charlson-Deyo index, male gender and teaching hospital status were all factors which were significantly associated with longer surgical delays.

Univariate analyses indicated that a longer surgical delay was significantly related to increased mortality (Table II). In-hospital mortality increased from 5.8% for those with no delay to 9.9% for those delayed three to seven days. Similar increases were observed at three and 12 months after surgery.

After adjustment for surgical delay, gender, age and comorbidities in a logistic regression analysis, teaching hospitals continued to have a lower mortality compared with urban community hospitals. Although there was a trend towards increased mortality at three, six and 12 months after surgery in rural hospitals when compared with urban community hospitals, this did not reach statistical significance. Patients who were treated in teaching or rural hospitals were more likely to have a major complication than those treated in urban community hospitals. Increased age, male gender and a Charlson-Deyo index of greater than three were independently associated with death and major complications in all types of institution. There was an independent relationship between surgical delay and mortality at all time points (Table III).

A logistic regression analysis, which was adjusted for significant covariates, indicated that for every day that surgery was delayed the odds of dying while in hospital increased.
Death within three, six and 12 months after hip fracture surgery and the presence of one or more major complications. Each variable presented is increased surgical delay and the increased number of were treated in urban community hospitals, despite the greatest for the younger, healthier patients. Between surgical delay and mortality. The risk of death was there were two important findings in this study of elderly hip fracture patients. The first was a consistent relationship between decreased mortality after hip fracture surgery and teaching hospital status. There was a trend for decreased mortality in patients who were treated in urban community hospitals compared with those who were treated in rural hospitals. The second was an independent relationship between surgical delay and mortality. The risk of death was greatest for the younger, healthier patients.

We observed a decreased mortality in patients who were treated in teaching hospitals compared with those who were treated in urban community hospitals, despite the increased surgical delay and the increased number of patients with comorbidities and complications in these institutions. In contrast, patients who were treated in rural community hospitals experienced similar rates of complications as those treated in teaching hospitals but were more likely to die despite having fewer comorbidities.

Several studies have also shown a decreased mortality in patients treated in teaching hospitals in the United States although only one study examined mortality specifically in hip fracture patients. The results of that study, which also included patients suffering from cardiovascular disease, showed that the most striking difference in survival was for hip fracture patients. The relative risk of death after hip fracture at major teaching hospitals was 0.54 (95% CI 0.37 to 0.79) compared with for-profit non-teaching hospitals. Moreover, a gradient of decreasing risk was noted through the categories of for-profit, non-teaching hospitals; government, non-profit, minor teaching and major teaching hospitals. These analyses were adjusted for covariates such as patient characteristics. Most authors agree that it is not teaching status per se, but other characteristics of organisation and delivery of health care that are likely to influence patient outcome.

A recent meta-analysis of 15 observational studies, involving more than 26 000 U.S. hospitals indicated that there was a higher risk of death in private, for-profit hospitals than private, not-for-profit hospitals, suggesting that the necessity of achieving a profit margin may lead to limitations of care. Because teaching hospitals in the United States are not-for-profit institutions, this may account for some of the difference in outcome seen in these 15 studies. Indeed, Taylor et al noted that the costs associated with the treatment of hip fractures were significantly higher in teaching ($17 501) compared with for-profit hospitals ($14 586).

A profit motive cannot explain the difference in outcome seen in our study, because 95% of Canadian hospitals are private, not-for-profit institutions. The difference in the strength of the association observed in the U.S. data (odds
ratio 0.54)\(^{17}\) compared with our study (odds ratios between 0.86 and 0.89), suggests that although a profit motive may be the most important factor when explaining the increased mortality seen in for-profit hospitals, other hospital characteristics may also play a role.

One study that identified lower mortality in not-for-profit rather than for-profit hospitals showed that the characteristics most strongly associated with lower mortality were related to the training of the medical personnel,\(^{16}\) specifically the presence of a higher proportion of board-certified specialists and registered nurses. A higher proportion of nursing hours delivered by registered nurses has been shown to be related to better care for hospitalised patients.\(^{39}\) Consequently, the higher number of specialised personnel in teaching hospitals may positively influence patient outcomes.

There is little research available in the literature on differences in mortality between rural and urban hospitals. Studies have investigated differences in the quality of care between rural and urban hospitals although these were mainly for the treatment of heart disease. Whereas they found no differences in mortality, they did show greater compliance with treatment guidelines in urban centres.\(^{40}\) In one study, risk-adjusted death rates for small hospitals with unspecialised services were similar between urban and rural areas\(^{41}\) leading the authors to conclude that small rural hospitals make appropriate decisions to transfer severely-ill patients and provide quality care for retained patients. The results of our study appear to support the conclusion that patients with more severe comorbidity are more likely to be treated at teaching hospitals. Although there was a trend towards decreased mortality in urban community hospitals compared with rural hospitals, this did not reach statistical significance. Consequently, in our study, the difference between urban and rural hospitals appears to be driven mainly by teaching hospital status.

One possible explanation for the increased risk of death and complications in rural hospitals compared with urban community institutions could be that rural hospitals treat fewer patients. However, although studies have demonstrated a volume-related outcome for some diagnoses and procedures such as acute myocardial infarction or total hip replacement\(^{32}\) no such relationship has been found in mortality studies for hip fracture.\(^{42}\)

A factor that has not been previously considered, and which may relate to both hospital status and mortality, is the length of time that is spent awaiting surgery. However, our results suggest that patients in teaching hospitals have a lower mortality, in spite of having longer surgical delays, more complications and comorbidities. It therefore appears that the length of time spent waiting for surgery is independently associated with an increased mortality up to one year after surgery and cannot therefore explain the differences between hospitals.

Earlier studies have also shown detrimental effects of surgical delay\(^{18-20,43}\) but many have failed to show a strong relationship.\(^{22-27,44,45}\) Those studies which have shown no relationship between surgical delay and mortality have indicated a trend towards an increased mortality with delay, with odds ratio estimates which range between 1.2 and 4.2. Methodological limitations, including lack of sufficient statistical power and inadequate adjustment for comorbidities, have contributed to the lack of a relationship between surgical delay and outcome in many of these studies.\(^{18-20,43}\) We estimate that over 5000 subjects would be required to detect an odds ratio of 1.2 (80% power; \(\alpha = 0.05\)). Even more patients would be required if adjustments for confounding were to be made.

Our study was limited by the nature of the administrative data available. Known predictors of mortality in hip fracture patients, such as body mass index, pre-fracture mobility and the cognitive status of the patient, were not present in the administrative data. Nevertheless, our sample, which included 57,315 hip fracture patients, of whom 13,546 died, is larger than other studies in the literature and would be expected to provide sufficient numbers to detect associations.

One large study by Ho et al,\(^{26}\) which included 37,290 patients from areas in the United States and Canada and which used similar statistical methods to our own, reported minimal effects of surgical delay on either in-hospital mortality or length of stay. However, the observed surgical delay in their study was approximately two to three times greater than the delay in our analysis. This suggests that their analyses\(^{26}\) included sicker patients than our own and to make comparisons between the two studies is therefore difficult.

Kenzora et al\(^{21}\) in a retrospective review, reported that surgical delay had beneficial effects and demonstrated a statistically significant benefit to delaying surgery by at least one day. However, they also reported that a significant number of medically unfit patients underwent early surgery. Sick patients may benefit from a delay in order to optimise their medical condition. Consequently, to include these patients in the early surgery group may have diluted the true effect of postponing surgery.

There is no theoretical benefit for healthier patients to wait for surgery. Rather, there is potential for increased complications and poor outcome. Our results support this idea because the benefits of early surgery were highest in the younger, healthier patients and less obvious in the older, sicker ones.

Many patients experience a delay before hip fracture surgery. Our results suggest that more than 20% of patients with hip fractures are delayed by two or more days in Ontario, Canada. Although some of these delays may have been due to the stabilisation of medically unfit patients, we presume that the younger patients, with no comorbidities, were delayed for non-medical reasons and with detrimental consequences. It is clear, especially for the medically stable patient with a hip fracture, that every effort should be made to avoid delays in operative treatment.
The decreased mortality after hip fracture surgery in teaching hospitals compared to community hospitals has important implications. There is an urgent need for research in order to understand which factors associated with hospital teaching status lead to differences in outcome after surgery in patients with a hip fracture.

Supplementary material

A further opinion by Martyn Parker is available with the electronic version of this article on our website at www.jbjs.org.uk

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References