Long-term survival of surgically treated hip fracture in an Australian regional hospital.

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"**Long-term survival of operated hip fracture**"

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Summary

Objectives: To determine factors influencing outcome in elderly patients operated for hip fracture. In particular, this study demonstrates correlates with mortality at least 30 months post fracture. Design: Analysis of hospital records and death registrations for 463 patients aged 60 or more years treated for hip fracture at a Queensland regional hospital between 1997 and 2001. Results: The overall mortality for surgically treated patients was 13.7% at 100 days and 24.9% at 1 year. Patient factors including age, gender, health status and place of residence were predominant influences on mortality. Non-patient and process factors including delay to surgery, type of operation and type of anaesthetic had minimal impact on mortality. No dominant determinants of length of hospital stay were identified. Patient health status was the main determinant for surgical delay. Conclusions: Our results confirm the high, persistent mortality in this group of patients and suggest that the main determinants of outcome are patient- rather than process-related. We discuss the most appropriate use for further health resources and directed changes to the model of care for this difficult group of patients.

Introduction

Hip fracture is a relatively common injury in the elderly population and has substantial impact on both the patient and the health care system. Around 20 000 patients with hip fractures are treated annually in Australian Hospitals utilising some 230 000 hospital bed days.[1]

The current study retrospectively explores the associations between patient demographics, health status, treatment processes and outcomes in elderly patients treated surgically for fractured hip over five years at an Australian regional centre.

Toowoomba is the largest inland non-capital city in Australia and is the principal orthopaedic referral centre for south-west Queensland. Toowoomba Hospital is a public, acute care hospital with 261 beds and an estimated catchment population of 240 000. Hip fracture surgery is performed as early as practicable in an emergency theatre but generally is not started after 8 pm. Two private hospitals are together responsible for approximately half of the hip fracture surgery performed in Toowoomba and their patients are not considered in the current work for logistic reasons.

Methods

Interrogation of the hospital computer system produced a list of all patients aged at least 60 years old who were discharged with an ICD diagnosis code indicating hip fracture (ICD9 820 codes or ICD10 S72.0 and S72.1) between January 1997 and December 2001. This list was cross-checked against the operating room information management system and the medical records of patients on the combined list were retrospectively reviewed by the investigators. Patients with pathological fractures and patients who had initial surgical treatment at other hospitals were excluded. Data from patients with more than one episode of care for fractured hip in the five year study period were included only once.

The date of death or the last known survival time was collected from the medical records for each patient. Details of patients whose medical record did not contain such data were forwarded to the Registrar General of Births, Deaths and Marriages for clarification. Patients not known to have died by either of these means were assumed to have survived.

ASA category as determined by the attending anaesthetist was retrieved from both anaesthetic records and the theatre information management system.

Variables describing treatment process time intervals were constructed using data obtained from the hospital patient information system and the operating theatre information management system. “Delay to operation” was defined as the difference between recorded commencement of anaesthesia care and recorded admission to this hospital. “Operating room time” began at the commencement of anaesthesia care and finished with transfer to the post-anaesthesia care unit (PACU). “Post-operative length of stay” began with PACU admission and finished with recorded discharge from acute care at this hospital.

Data analysis

Data was analysed using SPSS software. Bivariate relationships between patient demographics, severity, processes of care and outcome variables were sought. F-statistics were produced when analysing the relationship between variables using linear regression and when examining predictors of survival time using Cox regression. Chi-square statistics were produced when examining the relationship between categorical variables (Pearson's Chi-Square test) and when examining the improvement in fit in survival curves associated with predictor variables (log-rank test). Kaplan-Meier survival curves and 95% confidence intervals support statistically important findings.

Natural logarithmic conversion was used to allow parametric analysis of "delay to operation", "operating room time" and "post-operative length of stay" whose distributions were otherwise skewed to the right in our data. Where necessary, the results have been back-transformed to allow presentation of results in original units.

Some data was grouped to avoid small cell sizes and to facilitate analysis. Specifically, ASA categories 1 and 2 and categories 3 and 4 have been combined in some comparisons. Delay to operation has also been dichotomised as surgery on the first or second day of the admission or surgery at a later time.

Stepwise multiple regression and Cox regression were used to identify the models most predictive for survival and for post-operative length of stay from the available data. Excess mortality due to hip fracture alone was calculated using Australian Bureau of Statistics data for age-matched expected mortality.[2]

Results

463 fracture episodes were treated during the study period. Operative care was avoided in 16 cases (3.6%), which have been excluded. Seventeen (4.0%) of the remaining 447 episodes of care were for repeat fractures in patients already considered. The time between repeat episodes of hip fracture varied from 24 days to 27 months with a median of around 14 months. One of each pair of repeat episodes was randomly selected for inclusion and the final analysis describes 430 independent patients.

Female patients represented 72.3% of the sample. Females were a mean of 81.2 years of age (95% CI: 80.3 - 82.1) compared with 78.8 years (95% CI: 77.2 - 80.4) for males. 36.7% of patients resided primarily in a nursing home at the time of their hospital admission.

40.5% of patients were coded as ASA category 1 or 2 with 51.4% coded as ASA category 3 and just 8.1% as ASA category 4. No patients were deemed ASA status 5. ASA category 4 was over-represented in the group of males (12.6% of males compared to 6.4% of females) but this difference was not statistically significant. Patients in ASA categories 1 and 2 were slightly younger at 79.3 years (95% CI: 78.3 - 80.5) than patients in ASA category 3 at 81.4 years (95% CI: 80.3 – 82.5) and ASA category 4 at 81.6 years (95% CI: 78.7 – 84.6; $p=0.032$). There was a highly significant relationship between residence and ASA status ($p<0.001$) with 46.9% of ASA 4 patients and 46.2% of ASA 3 patients coming from nursing homes compared to just 23.6% of ASA 1 and 2 patients.

The median delay to operation was 23 hours. 21.6% of operations were conducted on the same day as admission and 47.4% were conducted on the day after admission. Delay to operation was much shorter for patients judged to be ASA 1 or 2 at 16.2 hours (95% CI: 14.1 - 18.6) than for ASA 3 patients at 26.5 hours (95% CI: 22.6 – 31.0) and ASA 4 patients at 56.9 hours (95% CI: 38.7 – 83.8; see figure 1). Multiple regression analysis confirmed that ASA category was the only statistically significant predictor of delay to surgery but this model only explained 8.6% of the observed variation in delay. Neither gender nor residential status nor day of the week was associated with delay to operation.

A specialist anaesthetist attended 70.5% of the operations, with the remainder attended by a registrar. In contrast, 78.5% of surgery was performed by a surgical registrar without direct specialist supervision. The median operating room time was 65 minutes. The most common operations were pin-and-plate (59.1%) and hemi-arthroplasty (36.7%). One total hip replacement was performed and has been excluded from analyses by operation type. Spinal anaesthesia was used in 85.9% of cases. Three patients underwent epidural anaesthesia and are excluded from analyses by anaesthesia mode. The remaining cases received general anaesthesia.

Males were more likely to undergo general anaesthesia (19.3%) than females (11.4%, $p=0.031$) and tended to undergo pin-and-plate repair (67.2%) more often than females

(56.3%, p=0.067). Specialists tended to operate on older patients (82.4 years) than did surgical registrars (80.0 years; p=0.017) and patients undergoing general anaesthesia tended to be younger at 77.6 years (95% CI: 75.3 - 79.9) than those undergoing spinal anaesthesia at 81 years (95% CI: 80.2 - 81.9; p=0.004). Sicker patients tended to require hemiarthroplasty more frequently (40.4%) than their ASA 1 and 2 status counterparts (30.5%; p=0.015). Delay to surgery was not predictive for any of the surgical or anaesthetic processes.

The median post-operative length of stay was 8.6 days with 25% staying less than 4.9 days and 25% staying more than 14.8 days. The regression line predicts length of stay variation by age from 7.3 days for a 60 year old through 9.0 days for an 80 year old to 11.2 days for patients 100 years of age (p=0.031). Mean post-operative length of stay for nursing home residents was 8.1 days (95% CI: 7.1 - 9.3) compared to 9.7 days (95% CI: 8.7 - 10.7 days) for other patients (p=0.041). Patients operated by specialists had significantly longer postoperative stays (95% CI: 9.1 - 13.0 days) than patients operated by registrars (95% CI: 7.9 - 9.5 days; p=0.02). ASA 1 and 2 patients had a shorter post-operative length of stay at 8.6 days (95% CI: 7.6 – 9.8) than ASA 3 patients at 10.2 days (95% CI: 9.1 – 11.4) and ASA 4 at 17.3 days (95% CI: 12.7 – 23.4; $p < 0.001$).

Multiple regression analysis found that the best model for describing post-operative length of stay consisted of ASA category, age, surgeon grade and residential status but only described 6.6% of the observed variation.

Of the 430 patients, 59 (13.7%) died within the first 100 days and 107 (24.9%) died within 12 months of admission. The mortality at 12 months in excess of age- and sex-matched population mortality (and thus attributable to hip fracture alone) was 17.2%. Females have higher survival rates than males at 100 days (p=0.046) post surgery. Evidence of this benefit persists at one year (p=0.003) and at three years (p=0.001) post surgery. Males had 1.7 and 1.8 times the odds of dying at 100 days and one year post surgery respectively (see figure 2).

There is strong evidence of association between age and survival during the first 100 days (p<0.001) and during the first year (p<0.001). Cox regression modelling suggests that the risk of death in the first 100 days doubles with every additional 10.2 years of age and the risk of death in the first year doubles with every additional 14.1 years of age.

The risk of dying within the 100 days (p=0.002) and within the three years (p=0.001) immediately post-operatively is higher for nursing home residents than for other patients. People admitted from a nursing home had 2.2 times the risk of dying by 100 days and 1.6 times the risk at one year (see figure 3). ASA status predicted survival to 100 days (p=0.003) and as shown in Figure 4, there is graphical evidence that this trend continues throughout the three post-operative years. The odds of dying by 100 days for patients with ASA categories 3 and 4 were respectively 1.6 and 3.8 times those of ASA 1 and 2 patients.

Delay to operation was related to survival over the first 100 days (p=0.089) and during the first year (p=0.033) but this relationship is confounded by systemic illness.

In a model including all three parameters, ASA status was a significant predictor of mortality ($p = 0.003$) but delay to operation was not ($p = 0.687$).

The only survival curve which clearly diverged after one year post-operatively was that comparing grade of surgeon (see figure 5). In testing the assumption that this finding was due to co-morbidity, a much wider spread of long-term mortality was demonstrated for patients operated by registrars than for patients operated by consultants (see figure 6). Whilst the sample of ASA 4 patients operated by registrars was very small, the large group of ASA 1 and 2 patients operated by registrars demonstrated an enduring survival benefit over other groups ($p<0.001$).

There was no evidence of association between anaesthetist grade, anaesthesia type or operation type and survival rates. There was also no evidence of association between post-operative length of stay and survival rates. Multiple regression analysis found that the best model for describing 12 month mortality consisted of gender, age and ASA status but only described about 3.1% of the observed variation.

Discussion

Hip fractures are common in our community and bring annual costs in excess of 420 million dollars in Australia[3] and personal suffering with relatively high morbidity and mortality.[4] There is evidence that the age-adjusted rate of fracture has stabilised but our rapidly ageing population dictates that admissions for treatment of this condition will continue to rise.[5]

Given that many studies have shown differences in the outcomes after hip fracture both between hospitals in a region[6,7] and between regions and countries, [4,8,9,10] our study is a unique description of long-term predictors of mortality in a discrete population managed in an Australian provincial centre. Our sample is useful in that patient demographics, anaesthetic mode and clinician seniority are congruent with the previous published studies from the public hospital setting.[4,7] Our study would be enhanced by cohort comparison with patients treated exclusively in the private system in that care process differences associated with better outcome may be identified. Such a study is under consideration.

Peri-operative factors can be expected to have an enduring influence on survival in these patients because overall wellbeing is so dependent on successful rehabilitation and return to mobility. Indeed, prospective work by Forsen et al found that excess mortality due to hip fracture can be detected as late as five years post fracture in females under 75 years of age.[11] Survival in our sample has been confirmed to a minimum of 2.5 years and our longest survivor has now been followed for just over seven years. We are unaware of another Australian study which considers the influence of fractured neck of femur peri-operative factors for such a long period.

Hip fractures in the elderly are associated with increased short term mortality. The audit conducted within the Scottish National Health Service[7] found 21% mortality within 120 days. Similar work from New Zealand[4] used age-matched population data to attribute 15.6% of the cohort mortality at one year to the fractured hip process. Our study used a similar age standardisation technique and found 17.2% excess one year mortality.

There are striking consistencies in the predictors of mortality in these studies and in the other published experience. [3,4,7,10,12,13] Male gender, age and overall health (represented by ASA status in the current work and in the Scottish audit[7] but intentionally scored as "complication co-morbidity level" in the New Zealand study[4]) feature prominently and survive multiple regression analysis in our study – implying aetiological importance.

Delay in hospital process prior to surgery for these patients is a clinically controversial contributor to outcome after surgery.[4,14,15] The absolute pre-operative delay and the proportion of patients operated early in this study are comparable to reports by previous authors,[16,17] including those who have implicated delay in excess mortality.[4,7] Although we did not measure cause, there is evidence in the literature that as much as 75% of the pre-operative delay in elderly hip fracture patients is related to medical stabilisation and investigation.[16] Our ASA 3 and 4 patients were delayed longer than less sick patients but continued to demonstrate mortality odds 1.9 times those of ASA 1 and 2 patients. Importantly, the current analysis demonstrates the co-dependence of outcome and pre-operative delay on the patient's overall state of health; a relationship which invites premature implication of delay itself in poor outcome. The literature is mixed in this respect,[4,5,7,13,17,18,19,20] undoubtedly reflecting a balance between the ill-defined deleterious effects of delaying surgery and the benefits of treating treatable medical conditions. Since preoperative delay is dependent on ASA status as a predictor of mortality in our analyses, the current work sanctions reasonable time spent carefully optimising medical conditions.

The relatively poor prognosis for males with fractured hip has been a consistent finding[3,13,21,22,23] and our study confirms male gender to be an independent predictor of mortality. There remains no good explanation for this finding but it may be that men must sustain more systemically significant injury to fracture bones of higher bone density. It may also be that men who fall are biased by disease which is not recognised by simplistic categorisations such as ASA status.

Explanation was sought for the unexpected finding that surgeon seniority negatively influences longer-term outcome in the ASA 1&2 group (see figure 6). Consultants were involved much more often early in each calendar year, presumably in a training capacity (35% first quarter versus 9% last quarter). This did not influence mortality. Operating room time was shorter for consultants at 61.9 minutes than for registrars at 72.3 minutes ($p<0.001$). No other independent associations were found. We speculate that patients with technically challenging fractures requiring consultant surgeon input are subject to difficult rehabilitation with consequences for long-term mortality. This effect may be masked in the systemically less fit (ASA 3&4) patients who face high risk regardless of the nature of their fracture. We are unable to meaningfully investigate this proposition with the current dataset.

The other extreme of long-term mortality seen in ASA 4 patients operated by registrars also invites comment (see figure 6). The number of patients in this category is too small for independent conclusions but our survival curves support intuition in asking senior surgeons to operate when patients are in poor general health.

In keeping with published data,[24] 3.6% of our cases did not undergo operative treatment, invariably when overall poor health precluded surgery. This group demonstrates a 30 day mortality of 75% in the current sample. It is likely that such high mortality reflects pre-morbid status rather than inherencies in the non-operative care path.[24]

The literature is incomplete with regards the optimal anaesthesia mode after hip fracture but spinal anaesthesia is recommended in recently published clinical pathways[25] and in the Cochrane Library.[26] Spinal anaesthesia was used in 85.9% of our patients but the study was not randomised and was underpowered to investigate the influence of anaesthesia type on mortality and length of stay. Nevertheless, our observation that no apparent advantage was conferred by a regional technique is supported by existing data,[27,28,29] at least some of which has been randomised for anaesthetic type.[27] It is our feeling that the choice of anaesthetic should be based on patient factors and not indicated by the fracture itself.

The economic and human cost of femoral neck fractures to our community is immense and is forecast to increase in coming years.[3,11,30,31,32,33] Despite years of enquiry and countless attempts to define best care, outcome in this group has remained poor in the short and medium term.

It is increasingly obvious that this self-selected elderly and vulnerable group would do better if addressed outside the normal models of surgical care. Perhaps profound mortality improvements are too lofty a goal and our limited resources would be better directed with quality of life, mobility, length of stay and cost of care higher on our clinical agendas. After all, there is no published work suggesting remediable risk factors for mortality which responsible anaesthetists do not already seek to correct. Perhaps new efforts should be directed towards process efficiency – correcting the correctable in a timely fashion, reaching the desired state of "optimisation" with the least number of "wrong-turns" and the most consistency of approach. Whilst the data suggest that mortality will not directly benefit from the streamlining of pre-operative care, it seems likely that the organisational and social consequences of extended length of stay and delayed rehabilitation may be realistic goals for improvement. Certainly, there is evidence that recent reductions in hospital length of stay by as much as five days have not been attended by increases in inpatient death rates.[5] Prospectively measuring outcome in the longer term after implementation of economically-driven process efficiencies is a much bigger project.

Our preferred model for improvement has consultant anaesthetic, surgical and medical staff involved as early as possible from the time of admission.[16] The goal is appropriate assessment and triaging with reduced delay to operation for those who are fit and directed, timely medical treatment with realistic endpoints in mind for those deemed to be at high risk. At an organisational level, the costs of this escalation in level of care are proper and frequent inter-departmental communication and the time taken by senior staff to provide an early opinion. The latter can be mitigated by operating within normal working hours and is justifiable in terms of likely reduced total length of stay. Both legitimations are supported, albeit indirectly, by the current work.

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Figure 1 – Delay to operation by ASA status (mean +/- 95% confidence interval)

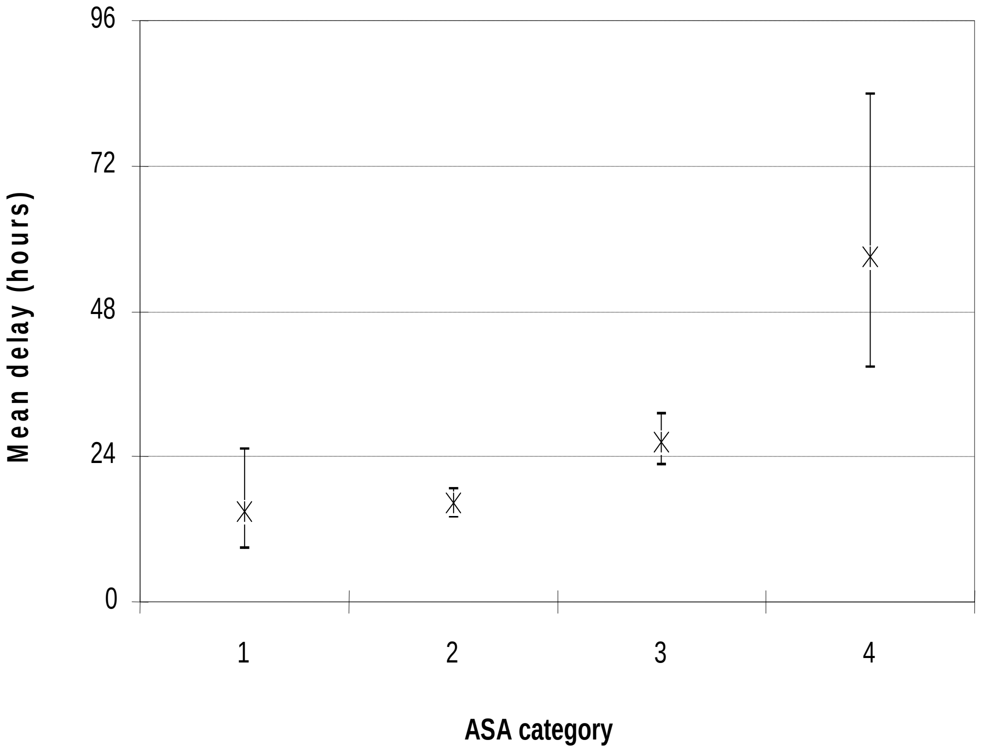

Figure 2 – Long-term survival by patient gender.

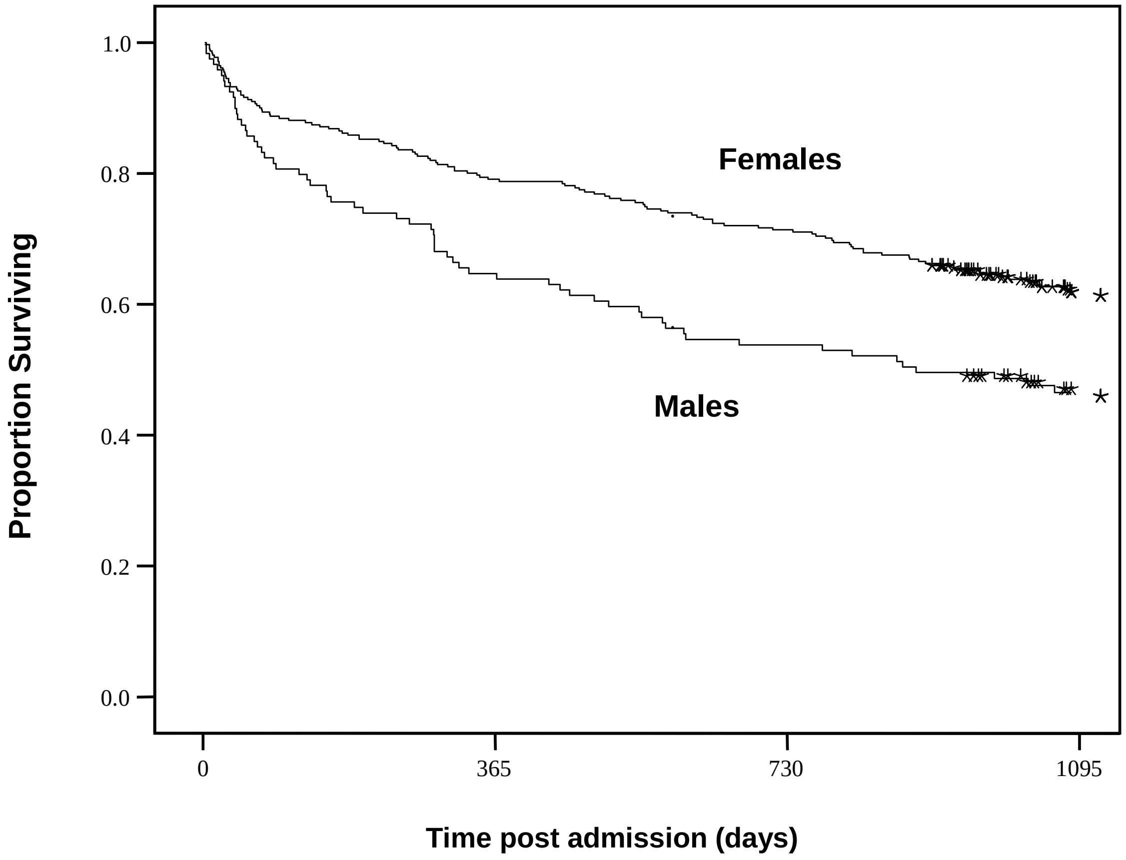

Figure 3 – Long-term survival by place of primary residence

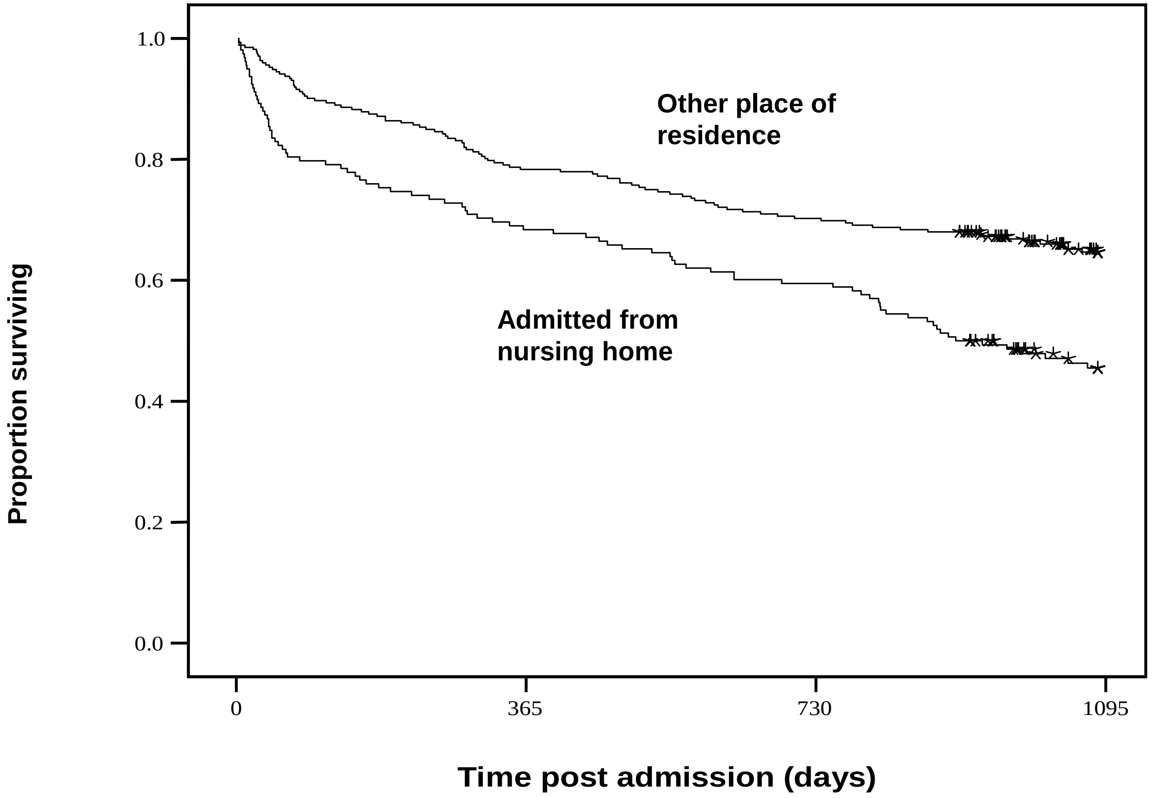

Figure 4 – Long-term survival by ASA status.

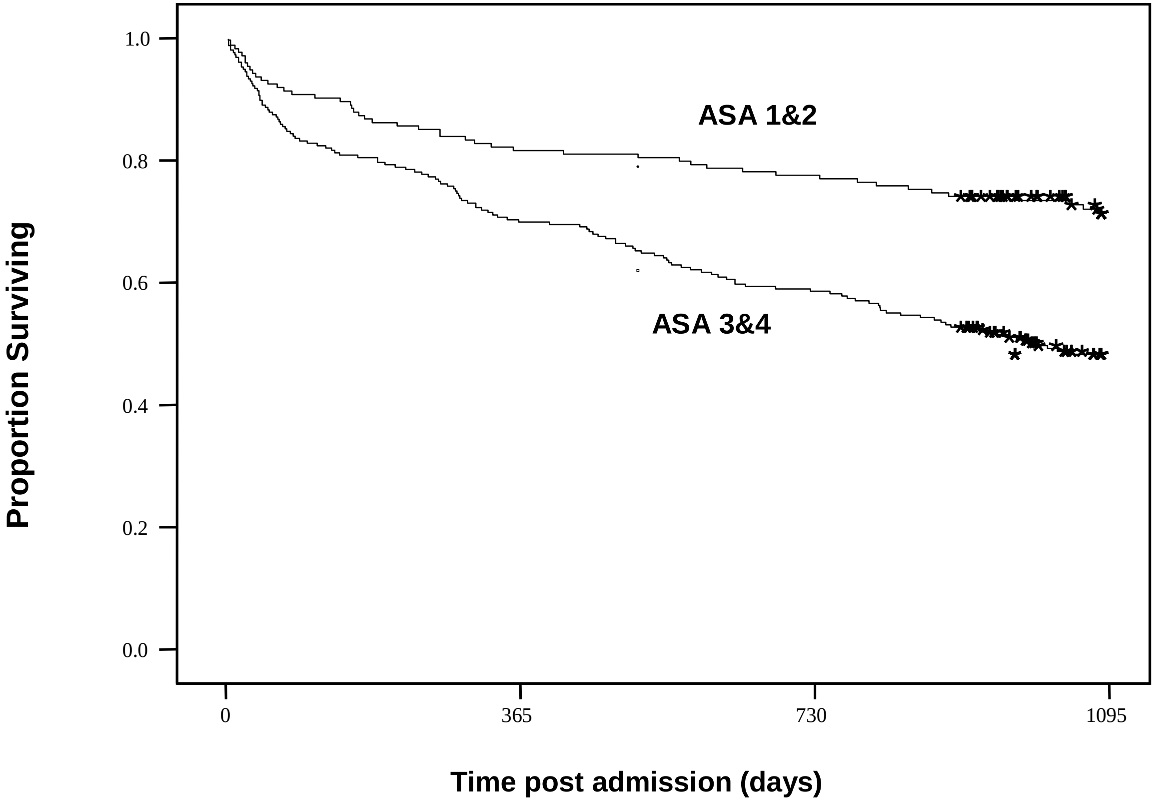

Figure 5 – Long-term survival by seniority of operator.

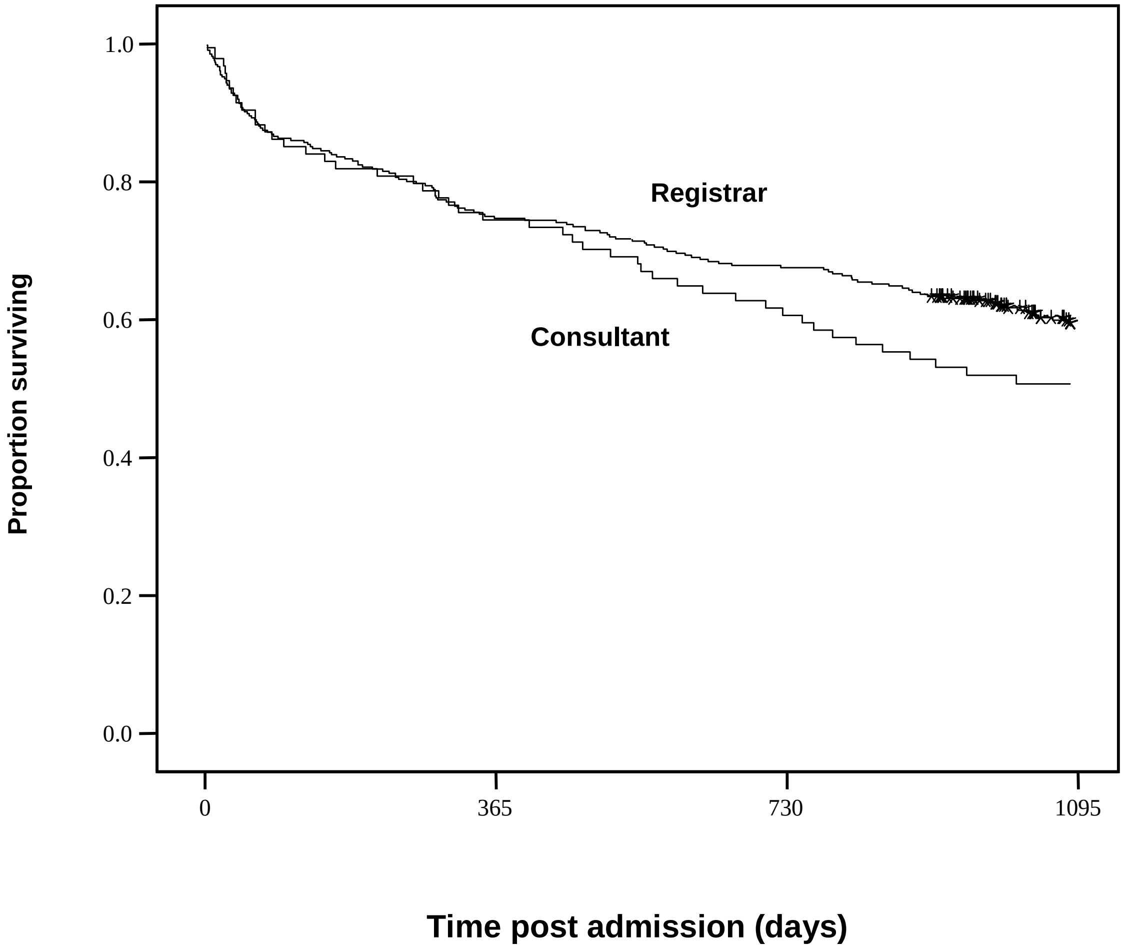

Figure 6(a) – Survival of patients operated by registrars by their ASA status.

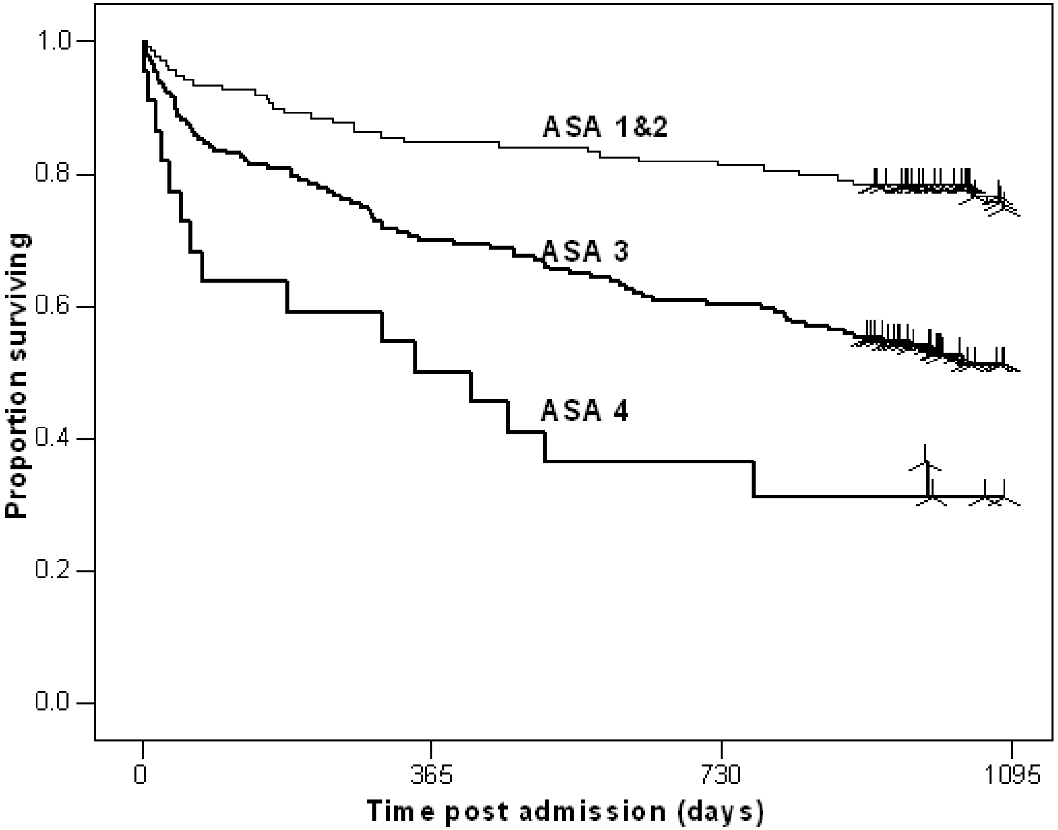

Figure 6(b) – Survival of patients operated by consultants by ASA status