Audit

Incidence and causes of mortality following acute orthopaedic and trauma admissions

HB Tan, DA Macdonald, SJ Matthews, PV Giannoudis

Department of Orthopaedics and Trauma, St James's University Hospital, Leeds, UK

Purpose: To analyse the incidence and causes of mortality of orthopaedic and trauma patients.

Methods: Between March 1995 and October 2000, there were 594 (404 females) in-patient deaths (2.8%) with a mean age of 82.14 years (range, 21–102 years) out of 21,122 acute admissions. The cause of death and details of the acute episode were collected from the hospital records, death certificates and postmortem examinations. Data collected were computerised and analysed using the Astute statistical package, University of Leeds.

Results: The most common primary diagnosis on admission was fracture neck of femur 392 (69.1%; $P = 0.001$). In total, 443 (78.1%) patients underwent surgical intervention of their injuries prior to mortality with 21 patients (4.7%) dying on the same day of the operation. The mean number of days between the initial surgical intervention and death was 22.3 days (range, 0–154 days). Of the patients who were treated non-operatively, 124 died due to poor medical condition (4 [3.2%] died within 24 h, 66 [51.6%] died within the first week and the rest died thereafter). In the death certificate, the most common primary cause of death recorded in the group of patients of 64 years of age and below was cancer followed by multi-organ failure. In the age group of 65 years and above, the most common primary cause of mortality was pneumonia followed by heart failure and myocardial infarction.

Conclusions: In orthopaedic and trauma patients below the age of 65 years, the most common cause of death appears to be cancer followed by multiple system organ failure; in the elderly, pneumonia predominates followed by heart failure and myocardial infarction. Proximal femoral fractures accounted for 70% of the deaths.

Key words: Trauma – Mortality – Neck of femur – Elderly

In the financial year 1998/1999, there were 3.8 million acute admissions in hospitals throughout the UK and acute admissions for orthopaedics and trauma patients constituted 8% of these.¹ These admissions ranged from simple fractures to polytrauma cases, covering a whole

spectrum of age and added co-morbidities. Many of these injuries could lead to surgical and medical complications, with mortality being one of them. The National Confidential Enquiry into Perioperative Death report for the same year stated that, for all postoperative mortality,

Correspondence to: PV Giannoudis, Consultant and Honorary Senior Lecturer in Trauma, Department of Orthopaedic and Trauma, St James's University Hospital, Beckett Street, Leeds LS9 7TF, UK. Tel: +44 113 206 5084; Fax: +44 113 206 5156; E-mail: pgiannoudi@aol.com

Table 1 Age distribution of patients

Age group (years)	Number of patients
18–30	4 (0.7%)
31–64	29 (5.1%)
65–79	136 (24%)
> 80*	398 (70.2%)

* $P = 0.0001$.

78% of the cases were from acute admissions with the speciality of orthopaedics and trauma making up 18.5% of that figure.²

There have been various studies looking at causes of mortality within the speciality of orthopaedics and trauma. For instance, many papers have been published looking at the outcomes and mortality in fracture neck of femur and hip arthroplasty.^{3–7} Gomberg *et al.*⁸ looked at the trends and outcomes in acute orthopaedic trauma by age, but neither analysed nor reported on the causes of death. A Boston study reported a 0.92% acute in-patient postoperative mortality, which included acute, elective and paediatric cases.⁹

To our best knowledge, there exists no study investigating the mortality of patients in the orthopaedic speciality as a whole. The purpose of this study, therefore, was to analyse the incidence, causes and differences in mortality between the younger (< 65 years) and older adults from acute admissions in the orthopaedic and trauma unit of a university teaching hospital.

Patients and Methods

Between March 1995 and October 2000, we retrospectively studied patients presenting to Leeds Teaching Hospitals, who were acutely admitted and subsequently died. Demographic details of the patients were recorded including the primary diagnosis on admission (major injury for which the patient required admission to hospital), type and timing of surgical intervention performed, therapeutic interventions, intensive care unit stay, complications and timing of mortality. Causes of mortality as recorded in the death certificate were also acquired. Furthermore, permission was obtained from the coroner to ascertain causes of mortality of patients requiring postmortem examinations.

For the purposes of the analysis, metalwork failure is defined as dislocation or breakage of prosthesis, revision of fracture reduction and fixation and need for removal of metalwork other than infective causes. Patient comorbidity was defined as the presence of pre-existing medical conditions including, congestive heart failure, diabetes, chronic obstructive pulmonary disease, previous myocardial infarction within 3 months of

admission, previous cerebrovascular accident (stroke), chronic renal failure, liver disease and inflammatory bowel disease.

Data collected were computerised and analysed using the Astute statistical package, University of Leeds. Assumption of normality was tested with a one-sample Kolmogorov-Smirnov test. Parametric and non-parametric data were compared, using the unpaired Student's *t*-test and Mann-Whitney U-test, respectively. Where appropriate, the χ^2 was used. Differences were considered significant at $P < 0.05$.

Results

There were 594 (404 females) deaths (2.8%) out of 21,122 acute admissions to our unit giving a 1:2 male/female ratio. The mean age of the patients was 82.14 years (range, 21–102 years). We could not obtain sufficient data for 27 of these patients; therefore, they were excluded from the final analysis. In total, 567 cases were analysed. Analysis of mortality by age group revealed the majority of patients (94%) to be in the elderly age group (> 65 years; $P = 0.0001$). Table 1 shows details of the age breakdown of the patients.

Primary diagnosis

The most common primary diagnosis on admission was fracture neck of femur with 392 cases (69.1%; $P = 0.0001$). This was followed by fracture shaft of femur with 32 (5.6%) cases (4 patients had cancer, 13 died from pneumonia, 9 from heart diseases, 3 died from pulmonary embolus, 2 from septicaemia, and 1 had a cerebrovascular accident). Forty-six patients were admitted for complications from previous surgery (13 infected prosthesis, 15 osteomyelitic or pyogenic joints and 18 metalwork failures). The primary diagnoses recorded on admission are shown in Table 2.

Table 2 Primary diagnoses recorded on admission

Pathology/injury	Number of patients
Fracture neck of femur*	392 (69.1%)
Fracture shaft of femur	32 (5.6%)
Spinal pathology	20 (3.5%)
Lower limb injuries	18 (3.2%)
Metalwork failure	18 (3.2%)
Bone metastasis	16 (2.8%)
Upper limb injuries	15 (2.6%)
Osteomyelitic/pyogenic joints	15 (2.6%)
Infected prosthesis	13 (2.3%)
Pelvic/acetabular fractures	10 (1.8%)
Head injuries	9 (1.6%)
Multiple injuries	6 (1.1%)

* $P = 0.0001$

Table 3 Days between initial surgical intervention and death according to age group

Age range (years)	Number of patients	Mean (days)
18–30	2	26.5 (2–51)
31–64	22	13.1 (0–32)
65–79*	93	22.9 (0–154)
> 80*	326	22.7 (0–135)

*P = 0.0001

Surgical intervention group

In total, 443 patients underwent surgical interventions prior to mortality with 21 patients (4.7%) dying on the same operative day. The mean duration of time between the initial surgical intervention and death was 22.3 days (range, 0–154 days). Table 3 shows details according to age group. With regards to the causes of death, 3 (0.7%) died as a result of head injuries, 10 (2.3%) died of multi-organ failure, 26 (5.9%) had cancer, 39 (8.8%) had septicaemia, with the rest dying of pneumonia (36%), heart diseases (24.3%) and other medical complications such as chronic obstructive pulmonary disease, renal failure, cerebrovascular disease, liver failure, *etc.* (21.6%).

Non-surgical intervention group

A total of 124 patients were treated non-operatively. Of these, 4 (3.2%) died within the first 24 h of admission, 66 (51.6%) within the first week and the rest thereafter. Causes of death in this group of patients included 9 (7.3%) cases as a result of head injuries, 17 (13.7%) patients died due to cancer, 2 (1.6%) died of multi-organ failure, 4 (3.2%) had septicaemia and the rest died of pneumonia (40%), heart diseases (19.4%) and other medical complications (14.8%).

ICU and length of hospital stay

The length of hospital stay prior to mortality is illustrated in Table 4. Overall, 50 patients (average age, 71.9 years) required admission to the intensive care unit (ICU) or high dependency unit (HDU) with a mean stay of 13.7 days (range, 1–79 days) prior to mortality.

Causes of death

From the death certificates and postmortem examinations, the most common primary cause of death recorded in the group of patients of 64 years of age and below was cancer (22.7%) followed by multi-organ failure (18.2%). In the age group of 65–79 years, the most common primary cause of mortality was pneumonia (24.2%) followed by myocardial infarction (11.6%). The 10

Table 4 Duration of hospital stay prior to mortality

Duration of stay	Number of patients	Mean age (years)
Within 24 h	8 (1.4%)	67 (35–82)
Between 24 h and 7 days	181 (31.9%)	82.8 (21–102)
Between 8–30 days	223 (39.3%)	81.9 (35–97)
More than 31 days	155 (27.3%)	83.4 (29–98)

most commonly cited causes of death in the death certificate are displayed in Table 5.

Discussion

Of patients who died in our unit, 94% were elderly (> 65 years old). This is not a surprise as, according to the Office for National Statistics, the death per 1000 population in the age group below 65 years is 10.5 persons; however, this rises 8-fold to 79.8 persons in the age group between 75–84 years of age.¹⁰

Elderly patients usually have medical conditions and reduced physiological reserve, which may lead to peri- and postoperative complications.¹¹ The spectrum of trauma in the elderly ranges from simple isolated fractures of the extremities to multiple fractures affecting different parts of the axial skeleton. The most common mechanisms for polytrauma in the elderly are falls and motor vehicle accidents.¹² It is of note that the risk of fatality in the elderly patient with polytrauma is 3 times greater at the age of 70 years than at 20 years of age.¹³

Bhattacharyya *et al.*⁹ identified five critical risk factors associated with increased postoperative orthopaedic mortality: (i) an age of greater than 70 years; (ii) hip fracture; (iii) chronic renal failure; (iv) congestive heart failure; and (v) chronic obstructive pulmonary disease. A linear increase in the mortality rate was observed with an increasing number of critical risk factors. Patients with four critical risk factors were 39.8 times more likely to die

Table 5 The ten most commonly cited causes of death in death certificates

Cause of death	Number of patients
Bronchopneumonia	181 (32%)
Ischaemic heart disease	83 (14.4%)
Heart failure	76 (13.4%)
Myocardial infarction	52 (9.2%)
Stroke	48 (8.5%)
Immobility	43 (7.6%)
COPD	38 (6.7%)
Pulmonary embolus	33 (5.8%)
Old age	33 (5.8%)
Coronary atherosclerosis	25 (4.4%)

Figure 1 Operative versus non-operative length of hospital stay prior to mortality.

in the postoperative period than were patients with no risk factors.⁹ For patients, with none of these critical factors, a mortality rate of only 0.25% was recorded.⁹

In this study, all patients with fracture neck of femur as primary diagnosis who subsequently died were aged 65 years and above. This group of patients makes up a disproportionately high fraction (70%) of the mortality group. Svensson *et al.*⁷ reported that patients who sustained a hip fracture with three or more additional medical diagnoses had a mortality of 24% compared to 0% of patients with no other medical conditions. Analysis of the fracture neck of femur group in this study revealed that 61.8% of the patients had one or more medical co-morbidities. Where no co-morbidity was recorded, 16.6% died of pneumonia, 6.8% of pulmonary

embolus, 5.9% of the patients died from old age (mean age 91 years [range, 80–98 years]), 3.2% from septicaemia, 3% died of stroke, and 2.4% died of myocardial infarction.

All the patients under 30 years of age who died were males and half of them sustained head injuries and required ICU supported care. This finding is consistent with the study of Nast-Kolb *et al.*¹⁴ who also reported that severe brain injury is the leading cause of death in young patients with multiple injuries admitted to ICU.

From the death certificates, it was observed that the causes of death divided into two main groups according to age. For the younger age group (64 years and under), cancer and multi-organ failure were the most commonly cited primary causes. On the other hand, in the older age group (65 years and above), pneumonia emerged as the primary cause of death, followed by cardiovascular disease.

There was no significant difference with regard to causes of mortality between the operative and non-operative group of patients. However, analysis of the incidence of co-morbidities between the two groups revealed a significant difference with two or more co-morbidities in the non-operative versus the operative group of patients ($P < 0.05$). In addition as shown in Figure 1, the timing of mortality amongst these two groups of patients (operative versus non-operative) was different in distribution with the operative group peaking at 8–30 days (42%) while the non-operative group peaked at 1–7 days (54%). The incidence of more co-morbidities in the non-operative group may account for the earlier peak of mortality seen in this group of patients. The most commonly cited cause of death in the peak operative and peak non-operative group was pneumonia (27.7%), followed by cardiorespiratory failure (19.1%) and myocardial infarction (16.8%).

Figure 2 Causes of mortality in relation to age.

Baker *et al.*¹⁵ described a trimodal incidence of post-traumatic death, with the first peak (45%) dying at the scene of accident, second peak (10%) within the first day and third peak (45%) days or weeks following injury. In this study, 1.4% of patients died within 24 h of admission with the rest dying thereafter (Fig. 1). The findings of this study also confirm a trimodal pattern of in-patient hospital mortality in the elderly with the second peak being the highest at 8–30 days.

Conclusions

Our mortality population could be divided into two groups – the younger (18–64 years) and the older (> 65 years). Of the younger age group, 50% died as a result of multiple injuries while 37.5% died as a result of bony metastasis and cancer. This is in contrast with the older age group, with only 2.5% dying as a result of road traffic accidents and 7.5% dying from cancer, with the remaining 90% of the older population dying as a result of medical complications such as pneumonia and heart diseases associated with neck of femur fractures (Fig. 2).

Acknowledgement

We are grateful to the Corporate Data and Information Technology Department of the Leeds Teaching Hospitals NHS Trust for their support collecting the data for this study.

References

1. Department of Health. *Hospital In-Patient Data based on Hospital Episode Statistics (HES)*. <<http://www.doh.gov.uk/hes/>>.
2. National Confidential Enquiry into Perioperative Death. *Then and Now 2000*. <<http://www.ncepod.org.uk/20001.htm/>>.
3. Dunsmuir RA, Allan DB, Davidson LAG. Early post-operative mortality following primary total hip replacement. *J R Coll Surg Edinb* 1996; **41**: 185–91.
4. Eisler J, Cornwall R, Strauss E, Koval K, Siu A, Gilbert M. Outcomes of elderly patients with nondisplaced femoral neck fractures. *Clin Orthop* 2002; **339**: 52–8.
5. Iorio R, Healy WL, Lemos DW, Appleby D, Lucchesi CA, Saleh KJ. Displaced femoral neck fractures in the elderly: outcomes and cost effectiveness. *Clin Orthop* 2001; **383**: 229–42.
6. Katz JN, Losina E, Barrett J, Philips CB, Mahomed NN, Lew RA *et al.* Association between hospital and surgeon procedure volume and outcomes of total hip replacement in the United States Medicare population. *J Bone Joint Surg Am* 2001; **83**: 1623–9.
7. Svensson O, Stromberg L, Ohlen G, Lindgren U. Prediction of the outcome after hip fracture in elderly patients. *J Bone Joint Surg Br* 1996; **78**: 115–8.
8. Gombert BFC, Gruen GS, Smith WR, Spott MA. Outcomes in acute orthopaedic trauma: a review of 130,506 patients by age. *Injury* 1999; **30**: 431–7.
9. Bhattacharyya T, Iorio R, Healy WL. Rate and risk factors for acute inpatient mortality after orthopedic surgery. *J Bone Joint Surg Am* 2002; **84**: 562–72.
10. Office for National Statistics. Table 3.14 Age Specific death rates: by sex, 2000: Regional Trends 37 (RT37314). <<http://www.statistics.gov.uk/>>.
11. Trembl J, Kroker PB. Orthopaedic surgery in the elderly. *Hosp Med* 2000; **61**: 417–9.
12. Lonner JH, Koval KJ. Polytrauma in the elderly. *Clin Orthop* 1995; **318**: 136–43.
13. Finelli FC, Jonsson J, Champion HR, Morelli S, Fouty WJ. A case control study for major trauma in geriatric patients. *J Trauma* 1989; **29**: 541–8.
14. Nast-Kolb D, Aufmkolk M, Rucholtz S, Obertacke U, Waydhas C. Multiple organ failure still a major cause of morbidity but not mortality in blunt multiple trauma. *J Trauma* 2001; **51**: 835–41.
15. Baker CC, Oppenheimer L, Stephens B, Lewis FR, Trunkey DD. Epidemiology of trauma deaths. *Am J Surg* 1980; **140**: 144–8.