Mortality after admission to hospital with fractured neck of femur: database study

(+Intraoperative intravascular volume optimisation and length of hospital stay after repair of proximal femoral fracture: randomised controlled trial
Susan Sinclair)

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The death rate within one year of fractured neck of femur is typically reported as between 20% and 35%.[1-3] Performance indicators based on mortality after hospital admission for such fractures have been promoted.[4] The only measure of mortality in routine hospital statistics, however, is "in-hospital mortality"death during the initial admission for the fracture. We analysed inpatient statistics that had been linked to death registration data in the former Oxford NHS health region (population 2.5 million) from 1994 to 1998.

Methods and results

We selected emergency admissions in people aged 65 years and over who had been admitted to eight main acute trusts and for whom fractured neck of femur was the principal diagnosis (international classification of diseases, ninth revision (ICD-9), codes 820, 821.0, and 821.1). We calculated standardised mortality ratios after fracture by applying the age and sex specific mortality in five-year age groups in the whole population of the region ("standard" population) to the number of people with fractured neck of femur in the equivalent age and sex strata, in successive months up to one year after fracture. For each hospital, we calculated case fatality rates for in-hospital deaths within 30 days and for all deaths within 30, 90, and 180 days of admission. We calculated age and sex standardised case fatality rates for each hospital by applying the age and sex specific rates in each hospital to the number of people in each age-sex stratum in the total inpatient population. We calculated case fatality rates separately for deaths certified as fractured femur and for all deaths.

In total, 8148 people aged 65 and over were included (80.2% women; mean (SD 7.2) age 82.2 years). In the first month after fracture the standardised mortality ratio was 1246 (95% confidence interval 1164 to 1331; general population 100). The standardised mortality ratios, adjusted for person months at risk, were 451 (397 to 509) in month 3, 238 (197 to 283) in month 6, and 187 (149 to 230) in month 12. Fractured femur was certified as the underlying cause in 16%, and as a cause anywhere on the death certificate in 43%, of deaths occurring in the first month.

As the table shows, the mortality ranking of hospitals varied with definitions and time frames. Death rates for all causes showed that three hospitals (B, C, and H) had significantly lower rates than hospital A for in-hospital mortality within 30 days, and two (B and C) had significantly lower rates for 30 day mortality regardless of place of death. By 90 and 180 days, differences between hospitals were not significant. Hospitals also changed rank depending on whether deaths from all causes or only those certified as fractured femur were included (table).

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Case fatality rates per 100 admissions and ranks (95% confidence intervals) for each hospital, adjusted for age and sex, showing different definitions and time intervals from admission

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The standardised mortality ratios show that mortality is much higher in people after fractured neck of femur than in the general population of comparable age, and they remain raised for many months after fracture. The persistently increased standardised mortality ratio may indicate continuing sequelae of the fracture or that people fracturing their neck of femur are more frail and ill than the general population of similar age.

Measures of prognosis after fracture and comparisons between hospitals are substantially affected by whether death registration data are included, whether time intervals are extended beyond 30 days, and whether deaths that are not certified as fractured femur are included. When death registration data are available, one option is to confine analyses of mortality to the deaths attributed by the certifying clinician to the fracture. Our study confirms, however, that the fracture is often not recorded on death certificates even when death occurs soon after fracture.[5] Studies of mortality after fractured femur will be misleading unless they include deaths after discharge from the initial admission and consider all causes of death.

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Footnotes

Contributors: MJG designed the study and jointly wrote the manuscript. SER contributed to the design, analysed the data, and jointly wrote the manuscript. DY extracted the data, contributed to the design, and commented on the manuscript. MJG and SER are guarantors for the paper.

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A table with further data is available on bmj.com

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Intraoperative intravascular volume optimisation and length of hospital stay after repair of proximal femoral fracture: randomised controlled trial

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Abstract

Objectives: To assess whether intraoperative intravascular volume optimisation improves outcome and shortens hospital stay after repair of proximal femoral fracture.
Design: Prospective, randomised controlled trial comparing conventional intraoperative fluid management with repeated colloid fluid challenges monitored by oesophageal Doppler ultrasonography to maintain maximal stroke volume throughout the operative period.
Setting: Teaching hospital, London.
Subjects: 40 patients undergoing repair of proximal femoral fracture under general anaesthesia.
Interventions: Patients were randomly assigned to receive either conventional intraoperative fluid management (control patients) or additional repeated colloid fluid challenges with oesophageal Doppler ultrasonography used to maintain maximal stroke volume throughout the operative period (protocol patients).
Main outcome measures: Time declared medically fit for hospital discharge, duration of hospital stay (in acute bed; in acute plus long stay bed), mortality, perioperative haemodynamic changes.
Results: Intraoperative intravascular fluid loading produced significantly greater changes in stroke volume (median 15 ml (95% confidence interval 10 to 21 ml)) and cardiac output (1.2 l/min (0.1 to 2.3 l/min)) than in the conventionally managed group (-5 ml (-

10 to 1 ml) and -0.4 l/min (-1.0 to 0.2 l/min)) ($P<0.001$ and $P<0.05$, respectively). One protocol patient and two control patients died in hospital. In the survivors, postoperative recovery was significantly faster in the protocol patients, with shorter times to being declared medically fit for discharge (median 10 (9 to 15) days *v* 15 (11 to 40) days, $P<0.05$) and a 39% reduction in hospital stay (12 (8 to 13) days *v* 20 (10 to 61) days, $P<0.05$).

Conclusions: Proximal femoral fracture repair constitutes surgery in a high risk population. Intraoperative intravascular volume loading to optimal stroke volume resulted in a more rapid postoperative recovery and a significantly reduced hospital stay.

Key messages

* Patients undergoing hip fracture repair constitute a high risk group with considerable mortality and morbidity and an often protracted postoperative hospital stay
* These patients often have depleted intravascular volume in the perioperative period and rarely receive either invasive haemodynamic monitoring or high dependency care
* Haemodynamic optimisation guided by pulmonary artery catheter in the perioperative period has been shown to improve outcome in high risk patients undergoing major surgery, but this is not considered routinely practicable for hip fracture repair
* Intravascular volume optimisation directed by minimally invasive oesophageal Doppler monitoring in the intraoperative period significantly reduces hospital stay

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The Audit Commission estimated that each year 57 000 patients undergo surgical correction of fractures of the femoral neck in England and Wales.[1] The East Anglian hip fracture audit revealed a median hospital stay of 20 days and hospital mortality of 5-24%.[2] These data indicate a high risk population and major resource implications. Patients who present with femoral fracture are often in poor general health, and surgery represents a huge physiological challenge; this is reflected in the complications experienced and poor recovery. Using fluid or inotrope therapy, or both, to optimise cardiac output and tissue oxygen delivery has been shown to influence outcome and reduce hospital stay in high risk patients having major surgery.[3] [4] [5] The technique used in these studies, pulmonary artery catheterisation, is not practicable in femoral fracture repair. Oesophageal Doppler ultrasonography permits rapid, minimally invasive, and continuous estimation of cardiac output.[6] [7] We examined the possible benefits of intraoperative circulatory optimisation using this minimally invasive technique in patients with fractured neck of femur.

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All patients presenting with fractures of the femoral neck were considered. Exclusion criteria were age less than 55 years, fracture secondary to neoplasm, fractures occurring during hospitalisation for an acute illness, fracture through the site of a previous surgical correction or associated with instability of a previous prosthesis, planned regional anaesthesia (which would preclude placement of the oesophageal Doppler probe), and refusal of consent or inability to contact next of kin in the case of patients unable to give consent themselves. The approval of the University College London Hospitals Ethics Committee was gained before starting the study.

All patients received any medical intervention deemed appropriate by the admitting orthopaedic team, including fluid resuscitation on admission and restoration of an adequate haemoglobin concentration. Maintenance intravenous fluid therapy (1000 ml dextrose-saline 12 hourly) was given from the time of oral fluid restriction until the time of operation and after operation until the patient's oral fluid intake was adequate. Preoperative analgesia was dictated by the patient's need and continued if needed until the time of surgery. The American Society of Anaesthesiologists' grading of health status[8] was estimated, and the Goldman cardiac risk index[9] was calculated.

All patients received a standardised anaesthetic. Premedication with temazepam 10-20 mg orally was given if the patient had not received intramuscular analgesia within the previous two hours. The patient was induced with etomidate, intubation was facilitated by vecuronium, and anaesthesia maintained by oxygen, nitrous oxide, and enflurane. Perioperative analgesia was provided with a combination of lateral femoral cutaneous nerve block with 0.5% bupivicaine, nitrous oxide, and intravenous fentanyl. Because of the age and frailty of some of the patients, the anaesthetist remained free to titrate these drugs according to the needs of the individual patient. In addition to routine monitoring, a 6 mm diameter oesophageal Doppler ultrasound probe (ODM2, Abbott, Maidenhead) was passed through the mouth immediately after induction of anaesthesia. By use of a monitor displaying blood flow velocity waveforms, the probe was oriented to measure the velocity of the descending thoracic aortic blood flow continuously at a distance of 30-35 cm from the teeth.[6] [7] The area of each velocity-time waveform relates to total left ventricular stroke volume, which can be approximated by a calibration factor utilising a nomogram incorporating the patient's age, height, and weight. The systolic flow time can be corrected for heart rate with Bazett's equation; this corrected flow time value is a good index of systemic vascular resistance.[10] Heart rate was monitored continuously and blood pressure was measured by an automatic sphygmomanometer at 3-5 minute intervals. Estimated cardiac output and stroke volume, corrected aortic systolic flow time, and volume of fluid infused were noted every 15 minutes.

After consent had been obtained, the patients were individually randomised before induction of anaesthesia by a sealed envelope technique to either protocol or control groups. All patients received crystalloid, hydroxyethyl starch colloid, or blood to replace estimated fluid losses and to maintain heart rate and blood pressure. In addition, protocol patients received hydroxyethyl starch fluid challenges guided by Doppler measures of stroke volume and corrected flow time. A corrected flow time value <0.35 second was taken to indicate possible hypovolaemia. Patients in the protocol group were given an initial fluid challenge of 3 ml/kg hydroxyethyl starch over 5-10 minutes. If the stroke volume was either maintained or increased after the fluid challenge but the corrected flow time remained below 0.35 second the fluid challenge was repeated. If stroke volume rose by more than 10% but the corrected flow time exceeded 0.35 second the fluid challenge was repeated until no rise in stroke volume occurred. If the corrected flow time rose above 0.40 second with no increase in stroke volume, no further fluid was given until the corrected flow time or stroke volume fell by 10%.

The anaesthetist was blinded to the Doppler measurements but was aware of the fluid volumes given as fluid challenges to the protocol group. The operating time was recorded as the skin was being closed. The Doppler values obtained 10 minutes after induction of anaesthesia and at skin closure were recorded for analysis as "initial" and "end operation" respectively.

Postoperative management was carried out on the orthopaedic ward with both medical and nursing staff blinded to the randomisation of the patient into protocol or control groups. The dates and location of death, discharge, or transfer were recorded, enabling the time spent in an acute hospital bed and total length of stay in hospital to be determined. As many such patients will have hospital discharge delayed for social reasons, the number of days before the orthopaedic staff deemed they were medically fit to return to their previous circumstances were also recorded.

Statistical analysis
Sample size (20 per group) was projected by seeking a one third reduction in hospital stay for survivors in the group with optimised fluids during operation. This figure was based on results obtained from preoperative optimisation studies.[3] [4] [5] The control group's stay was assumed to be 18.6 (SD 5) days on the basis of data taken from an internal hospital audit performed in 1990-1, with a 10% hospital mortality,[11] an value of 0.05, and a ß value of 0.9. Primary outcome measures were hospital stay and time to declaration of medical fitness for discharge. Secondary measures were intraoperative haemodynamic differences between the groups. The Mann-Whitney U test was used to compare demographic, haemodynamic, and outcome data in protocol and control groups. Hospital stay and time to declaration of medical fitness were analysed only for survivors.

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The protocol and control groups were similar in terms of age, Goldman cardiac risk index, American Society of Anaesthesiologists grading, preoperative haemoglobin concentration, and type and duration of operation performed (table 1). The duration of preoperative stay in hospital was also similar.

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Table 1 Characteristics of patients and their operations. Values are medians (interquartile ranges) or numbers of patients

Patients in the protocol group received significantly more fluid per minute of operating time than those in the control group (table 2). Stroke volume, corrected flow time, and cardiac output rose significantly in the protocol group but fell in the control group (table 1), fig 1. Heart rate and blood pressure did not change significantly in either group.

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Table 2 Haemodynamic data and volumes of infusions given during operation. Values are medians (95% confidence intervals)

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Fig 1 Median (95% confidence interval) change in stroke volume, aortic systolic corrected flow time, and cardiac output from 15 minutes after induction of anaesthesia (initial) to the end of the operation (end operation)

Three patients died during the course of the study. One patient in the protocol group died 36 days after operation from bronchopneumonia with pre-existing amyloid cardiac failure. Two patients in the control group died, one on the second day from a cerebrovascular accident and one on the 65th day from pneumonia and congestive cardiac failure, 30 days after transfer to a long stay ward for care of the elderly.

Patients in the protocol group had a significantly shorter hospital stay whether this was assessed as time spent in an acute hospital bed, the number of days after operation until being declared medically fit, or the total number of days spent as a hospital inpatient (fig 2). Seven survivors in the control group had a hospital stay exceeding 25 days but none of the survivors in the protocol group stayed longer than 24 days.

Fig 2 Acute bed stay, days before deemed medically fit for discharge, and total duration of hospital stay for survivors. Median, quartiles, and extremes are shown for 18 control patients and 19 protocol patients

Discussion

Fractured neck of femur carries a high cost in terms of mortality, morbidity, and use of hospital and community resources.[11] [12] An impressive impact on outcome was shown in the Peterborough Hip Fracture Project[13] which utilises a "surgical hip fracture team," a multidisciplinary approach to management with emphasis on the rehabilitative aspects of patient care. Early mobilisation is crucial, and this in turn depends on prompt postoperative recovery. The outcome of high risk patients undergoing major surgery was significantly improved by haemodynamic optimisation in the perioperative period;[3] [4] [5] patients with fractures of the neck of femur should be similarly managed as a high risk population. However, since Schultz et al showed that using a pulmonary artery catheter to detect and correct haemodynamic dysfunction in the preoperative and postoperative periods reduced mortality from 29% to 2.9%,[14] there has been little attempt to influence the outcome of these patients by manipulating their cardiovascular performance.

In view of the age, frailty, and perceived high cardiovascular risk in this patient population, it is likely that many remain under-resuscitated before, during, and after the operation as clinicians fear that giving excessive fluid will precipitate left ventricular failure.[14] This is reflected in our study by the significantly lower volumes of fluid given to the control patients.

Reducing patients' stay in hospital

Unless it is profound, hypovolaemia is difficult to diagnose on clinical grounds. It will contribute to perioperative hypoperfusion of tissues and lead to organ dysfunction after operation.[15] This may manifest itself in a clinical spectrum ranging from generalised malaise to multiple organ failure. This will adversely affect the patient's inclination or ability to mobilise during the postoperative phase, thereby prolonging hospital stay and worsening outcome. Our study showed this clearly. All patients were given preoperative resuscitation before they were randomised into control and protocol groups, which differed only by the additional volumes of colloid given to optimise circulatory status during the period of surgical stress. An advantage of colloid over crystalloid therapy is the lesser quantity needed to maintain intravascular volumes.[16] The success of this simple protocol in increasing haemodynamic performance confirms the suspicion of occult hypovolaemia. Maximal intravascular volume loading alone seemed sufficient to improve postoperative mobilisation, leading to a significant reduction in hospital stay.

Monitoring

The recently published 1993-4 report of the National Confidential Enquiry into Perioperative Deaths pinpointed mortality after hip fracture surgery as an area of particular concern.[17] In the 422 patients evaluated, the report highlighted the minimal use of invasive intraoperative monitoring (central venous pressure was monitored in eight patients, arterial pressure in five, pulmonary artery catheterisation in none) and of high dependency or intensive care after operation (with only 24 admissions). The wide variation in intravascular volume required during the intraoperative period reflects the importance of precise monitoring to enable adequate but not excessive fluid loading.

The fluid challenge principle is familiar to all anaesthetists, yet it is difficult to gauge benefit accurately in the absence of sufficient haemodynamic monitoring. The Doppler ultrasound haemodynamic monitoring used in this study enables precise fluid optimisation in the intraoperative period. It is simple to use and prolongs the time required to prepare the patient for surgery only minimally. As the technology is minimally invasive, the patient could be managed subsequently on a general orthopaedic ward. We found no complications attributable either to the technique or the fluid resuscitation regimen.

Postoperative recovery

Preventing perioperative tissue oxygen debt by adequate fluid resuscitation may thus contribute to a better postoperative recovery.[18] An equivalent effect using the same monitoring equipment and a similar fluid administration protocol has been shown in patients having elective cardiac surgery.[15] The timing of this volume loading and removal of any such tissue oxygen debt may be crucial. Delaying fluid replacement until the postoperative period may be partly responsible for patients not benefitting from aggressive haemodynamic management after they have been admitted to an intensive care unit.[19] [20] Use of this simple procedure could produce considerable cost benefit in terms of shorter hospital stays and improved patient outcome.

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Papers

Differences in mortality after fracture of hip: the East Anglian audit

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Abstract

Objective: To investigate differences between hospitals in clinical management of patients admitted with fractured hip and to relate these to mortality at 90 days.
Design: A prospective audit of process and outcome of care based on interviews with patients, abstraction from records with standard proforma, and follow up at three months. Data were analysed with 2 test and forward stepwise regression modelling of mortality.
Setting: All eight hospitals in East Anglia with trauma orthopaedic departments.
Patients: 580 consecutive patients admitted for fracture of neck of femur.
Main outcome measure: Mortality at 90 days.
Results: Patients admitted to each hospital were similar with respect to age, sex, pre-existing illnesses, and activities of daily living before fracture. In all, 560 (97%) were treated surgically, by a range of grades of surgeon. Two hundred and sixty one patients (45%; range between hospitals 10-91%) received pharmaceutical thromboembolic prophylaxis, 502 (93%; 81-99%) perioperative antibiotic prophylaxis. The incidence of fatal pulmonary emboli differed between patients who received and those who did not receive prophylaxis against deep vein thrombosis (P=0.001). Mortality at 90 days was 18%, differing significantly between hospitals (5-24%). One hospital had significantly better survival than the others (odds ratio 0.14; 95% confidence interval 0.04-0.48; P-0.0016).
Conclusions: No single factor or aspect of practice accounted for this protective effect. Lower mortality may be associated with the cumulative effects of several aspects of the organisation of treatment and the management of fracture of the hip, including thromboembolic pharmaceutical prophylaxis, antibiotic prophylaxis, and early mobilisation.

Key messages

* Key messages
* Being older, having a poorer level of activities of daily living, being male, and having a history of cardiovascular disease were important determinants of death
* One of the hospitals had a much higher survival rate. This seemed to be due to an aggregate effect of the total package of care
* Routine thromboembolic prophylaxis is indicated for patients with fractured hip
* Written policies that include prophylaxis should be developed and implemented for this vulnerable group of patients if mortality is to be improved

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BMJ, October 19, 2002; 325(7369): 868 - 869.
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C J Todd, C. Palmer, C Camilleri-Ferrante, C J Freeman, C E Laxton, M J Parker, B V Payne, and N Rushton
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Overall survival rate is most important measure
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Related letters in BMJ:

Differences in mortality after fracture of hip
J Calder and E C Ashby
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Casemix factors may not have been considered sufficiently
C J Packham
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Patients' nutritional status is not recorded
Alison Avenell
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Overall survival rate is most important measure
David Warwick and Michael Freeman
BMJ 1995 311: 572. [Letter]

Antithrombotic prophylaxis had little effect on overall mortality
K C Kong

BMJ 1995 311: 572. [Letter]

MORTALITY AND MORBIDITY AFTER HIP-FRACTURES

KEENE, GS;PARKER, MJ;PRYOR, GA

BRITISH MEDICAL JOURNAL
307: (6914) 1248-1250 NOV 13 1993
Document type: Article **Language:** English

Abstract:
Objective-To study the mortality and morbidity associated with proximal femoral fractures with reference to fracture type (intracapsular and extracapsular).

Design-Consecutive prospective study with 12 month follow ups.

Setting-Two British trauma receiving centres.

Patients-1000 consecutive acute proximal femoral fractures (fractured necks of femur) in 972 patients.

Results-Significantly higher mortality at one year was seen in patients with extracapsular fractures (188/490; 38%) than in those with intracapsular fractures (147/510; 29%; $p < 0.01$). Greater morbidity was experienced during the study period by patients with extracapsular fractures, who were less mobile and less independent at the time of their injury.

Conclusions-The rise in average age of presentation with proximal femoral fracture is associated with a persistently high mortality (33%) and morbidity, greater in patients with an extracapsular

fracture. Comparison with other studies, principally from outside Britain, is difficult, but despite advancing standards of care the mortality and morbidity of femoral neck fractures remains high, placing an ever increasing burden on the health service.

Mortality rates after hip fracture in persons aged 65 years and over 27 November 2002

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Peter Oster

Send response to journal:
Re: Mortality rates after hip fracture in persons aged 65 years and over

Email Norbert Specht-Leible, et al.

Mortality rates after hip fracture in persons aged 65 years and over

Editor – In their paper concerning excess mortality following fractured neck of femur, Goldacre et al. reported that the fracture is often not reported on death certificates even when death occurs soon after fracture.1 That may be due to legalistic policies.

In Germany, certifying death caused by fractured hip results in police investigations of the circumstances of the fall. However, doctors here might be persuaded to certify the death as independent of the fracture in order to prevent the family from any additional suffering, resulting in an underestimation of case fatality rates from official death statistics alone. Thus, substantial international differences may occur due to different national legal policies.

In addition, the authors raise the question whether mortality rates after hip fracture indicate sequelae of the fracture or the individual´s pre- fracture frailty. Only the former might be reduced by interventions improving case management. We studied functional outcomes in patients aged 65 and over with hip fracture in Heidelberg, Germany. A total of 331 patients (81% female; mean age 81.5 years) presenting at three surgical departments within 12 months were included. There were no significant differences in case management; 82% of the survivors were transferred to the Geriatric Centre for in-hospital rehabilitation. We had substantial inter-hospital differences concerning patients` pre-fracture health (e. g. number of nursing home residents 5%, 23%, and 30%; ADL-dependent patients 18%, 31%, and 36%), and, accordingly, mortality at 6 months (13.3%, 14.0%, and 26.0%). The hospital treating the highest number of patients with pre- fracture poor health had the highest mortality rates. Data suggest that pre-fracture frailty affected patient selection and primary placement, so that frailty rather than in-hospital care correlates with inter-hospital differences in mortality rates.

Thus, the emergency physician, the paramedic, the GP or the chief of the local health service authority, by determining appropriate location, determines inter-hospital differences in hip fracture mortality rates.

1 Goldacre MJ, Roberts SE, Yeates D. Mortality after admission to hospital with fractured neck of femur: a database study. BMJ 2002; 325: 868-9.