Mortality associated with delay in operation after hip fracture: observational study

Alex Bottle, Paul Aylin

Abstract

Objective To estimate the number of deaths and readmissions associated with delay in operation after femoral fracture.
Design Analysis of inpatient hospital episode statistics.
Setting NHS hospital trusts in England with at least 100 admissions for fractured neck of femur during the study period.
Patients People aged ≥ 65 admitted from home with fractured neck of femur and discharged between April 2001 and March 2004.
Main outcome measures In hospital mortality and emergency readmission within 28 days.
Results There were 129 522 admissions for fractured neck of femur in 151 trusts with 18 508 deaths in hospital (14.3%). Delay in operation was associated with an increased risk of death in hospital, which was reduced but persisted after adjustment for comorbidity. For all deaths in hospital, the odds ratio for more than one day's delay relative to one day or less was 1.27 (95% confidence interval 1.23 to 1.32) after adjustment for comorbidity. The proportion with more than two days' delay ranged from 1.1% to 62.4% between trusts. If death rates in patients with at most one day's delay had been repeated throughout all 151 trusts in this study, there would have been an average of 581 (478 to 683) fewer total deaths per year (9.4% of the total). There was little evidence of an association between delay and emergency readmission.
Conclusions Delay in operation is associated with an increased risk of death but not readmission after a fractured neck of femur, even with adjustment for comorbidity, and there is wide variation between trusts.

Introduction

Each year, about 60 000 hip fractures occur in the United Kingdom, with mortality 10-20% above that expected on the basis of age and sex.[1] The importance of delay in operation (the time between admission to hospital and corrective operation) is inconclusive.[2–5] In older patients, a valid reason for delay is the need to stabilise any concurrent medical conditions. We estimated the association between delay in patients admitted from home with a fractured hip and death in hospital and emergency readmission rates within 28 days of discharge using routine hospital data.

Methods

We examined data from the hospital episode statistics for the period April 2001 to March 2004 for all NHS hospitals in England and extracted records of patients aged ≥ 65 with a primary diagnosis of fractured hip admitted from their home (see bmj.com for details). Patients were allocated to one of four categories of treatment according to the first recorded orthopaedic procedure: fixation, prosthetic replacement of head of femur, any other procedure (including non-orthopaedic ones if no fixation or replacement procedure was recorded anywhere in the admission), and no procedure recorded ("medical management"). We included all hospital trusts with >100 admission for fractured hip over three years.

We used two definitions of delay: more than one day (if the date of the operation was two or more days later than the admission date) and more than two days (if the gap was three or more days). For each patient, we used three outcome measures: any death in hospital during the initial admission for the fracture, death in hospital within 30 days of the initial admission, and emergency readmission within 28 days of discharge at the end of the initial admission.

We used logistic regression with and without random effects to estimate the number of outcome events associated with operative delay for each trust (see bmj.com).

Results

Numbers of admissions and procedures

There were 151 trusts with at least 100 admissions for hip fracture, yielding 129 522 admissions in patients aged ≥ 65 during the three years. A total of 18 508 died in hospital (a rate of 14.3%), of whom 2068 (11.2%) died in another NHS hospital after transfer. Another 7428 admissions were excluded because of invalid data (mainly duplicate records and invalid dates of admission or discharge). The mean number of fixation and replacement procedures was 761 per trust (range 80-1854). The proportion waiting more than one day or more than two days varied more than twofold between trusts.

Comorbidity was more common in surgical patients with delay compared with those with at most one day's delay and those managed medically (table 1). The differences in proportions across the delay groups in table 1 were highly significant for each variable ($P<0.001$, except $P=0.081$ for hypertension, Cochran-Armitage tests for trend).

Factors associated with mortality and emergency readmission

Table 2 gives odds ratios for mortality in hospital and emergency readmission for each factor considered. Age, sex, and fifth of deprivation were highly significant ($P<0.001$, Wald tests) for all outcomes, and comorbidity factors were usually significant. The most common single cause (primary diagnosis) of emergency readmission within 28 days was hip fracture

Dr Foster Unit at Imperial College London, Department of Primary Care and Social Medicine, Imperial College London, London W6 8RP
Alex Bottle *research associate*
Paul Aylin *clinical senior lecturer in epidemiology and public health*
Correspondence to: A Bottle robert.bottle@imperial.ac.uk

BMJ 2006;332:947–50

ELPS *This is the abridged version of an article that was posted on bmj.com on 22 March 2006: http://bmj.com/cgi/doi/10.1136/bmj.38790.468519.55*

Table 1 Frequency of comorbidity variables with respect to presence and timing of surgery. Figures are numbers (percentages) of patients

Comorbidity	≤1 day delay*	2 day delay*	>2 day delay*	No procedure
Heart failure	2705 (3.9)	974 (4.6)	1979 (8.1)	960 (10.4)
Chronic IHD	5949 (8.7)	2091 (9.8)	2962 (12.1)	1299 (14.1)
Renal failure	1105 (1.6)	441 (2.1)	743 (3.1)	441 (4.8)
Dementia	8169 (11.9)	2773 (13.0)	3142 (12.9)	1201 (13.1)
Diabetes	4675 (6.8)	1591 (7.5)	1910 (7.8)	692 (7.5)
Lower RTI	4719 (6.9)	1652 (7.8)	2358 (9.7)	1006 (10.9)
Malignancy	1524 (2.2)	551 (2.6)	751 (3.1)	379 (4.1)
Hypertension	11 923 (17.3)	3928 (18.5)	4599 (18.9)	1322 (14.4)
Other comorbidity	19 156 (27.9)	6009 (28.2)	7105 (29.1)	2602 (28.3)
≥3 comorbidities	1863 (2.7)	700 (3.9)	1161 (4.8)	522 (5.7)
No comorbidity recorded	20 104 (29.2)	5245 (24.7)	4793 (19.7)	1839 (20.0)
All patients†	68 771	21 275	24 389	9206

IHD=ischaemic heart disease; RTI=respiratory tract infection.
*For those with replacement or fixation procedures and valid dates of operation only.
†Sum to more than total because patients can have more than one comorbidity.

(11.9% for all patients and 10.2% for those having either a fixation or replacement), followed by "complications of internal prosthetic devices, implants and grafts" and unspecified pneumonia. The data do not allow us to distinguish between new and existing fractures.

Effect of type of surgery and operative delay

Fixation and replacement procedures had similar mortality and readmission rates; patients with some other operation had almost twice the death rate and those with no operation had the highest rate of all. For patients having either a fixation or replacement, 11.0% of readmissions were for "complications of surgical and medical care not elsewhere classified." These were more common after a replacement (14.5% *v* 8.1%, $P<0.001$, χ^2 test).

Overall, 39.9% of procedures were performed more than one day after admission (range between trusts 1.1%-82.7%) and 21.3% were delayed more than two days (1.1%-62.4%). Delay rates were similar for the two main procedure types but slightly more common in the oldest patients (35.9% in the 65-69 age range had more than one day's delay compared with 40.3% in those aged ≥95).

Older age, female, the four most deprived fifths, replacement procedure, and each comorbidity variable were associated with higher rates of delay (table 3). For patients having only either a fixation or a replacement procedure and death or death at 30 days as the outcome, age, sex, fifth of deprivation, and operative delay were highly significant (both categories) and the comorbidity variables ($P<0.001$). There was little evidence of an effect of delay on readmissions.

Adjustment for comorbidity reduced the estimated effect of delay in operation (see bmj.com). After adjustment for all measured factors, the death rate increased with delay, as shown by the adjusted odds ratios relative to at most one day's delay (see fig 1 on bmj.com).

Difference between observed and expected deaths

We estimated differences between the observed number of deaths and the number expected with at most one day's delay for each trust. For a delay of more than one day, the sum of the difference for all deaths in hospital was 1742 in three years (1435 to 2049), or 9.4% of the 18 508 total deaths during that time. Half

Table 2 Odds ratios (95% confidence intervals) for death and readmission for age, sex, deprivation fifth, and comorbidity

Factor and category	No (%)	Outcome: Death in hospital	Death in hospital within 30 days of admission	Emergency readmission within 28 days
Sex:				
Male	26 430 (20.6)	1.89 (1.82 to 1.97)	1.85 (1.78 to 1.92)	1.33 (1.26 to 1.39)
Female	101 860 (79.4)	1	1	1
Age:				
≥95	6008 (4.7)	9.52 (8.33 to 10.9)	8.49 (7.27 to 9.91)	1.63 (1.42 to 1.87)
90-94	19 319 (15.1)	6.44 (5.69 to 7.30)	5.36 (4.63 to 6.20)	1.56 (1.40 to 1.75)
85-89	30 612 (23.9)	4.26 (3.77 to 4.82)	3.61 (3.13 to 4.17)	1.47 (1.32 to 1.63)
80-84	31 810 (24.8)	3.00 (2.65 to 3.39)	2.62 (2.27 to 3.03)	1.32 (1.19 to 1.47)
75-79	22 120 (17.2)	2.10 (1.84 to 2.38)	1.88 (1.62 to 2.19)	1.27 (1.14 to 1.42)
70-74	12 107 (9.4)	1.50 (1.30 to 1.72)	1.38 (1.18 to 1.63)	1.12 (1.00 to 1.26)
65-69	6314 (4.9)	1	1	1
Fifth of deprivation*:				
1 (most deprived)	24 716 (19.3)	1.19 (1.12 to 1.25)	1.18 (1.11 to 1.25)	1.32 (1.23 to 1.41)
2	25 718 (20.1)	1.10 (1.04 to 1.16)	1.10 (1.03 to 1.17)	1.20 (1.13 to 1.29)
3	26 723 (20.8)	1.00 (0.95 to 1.06)	1.03 (0.96 to 1.09)	1.13 (1.06 to 1.21)
4	26 084 (20.3)	0.95 (0.90 to 1.00)	0.98 (0.92 to 1.04)	1.07 (1.00 to 1.15)
5 (least deprived)	25 049 (19.5)	1	1	1
Comorbidity				
Presence of (compared with absence):				
Dementia	15 575 (12.1)	1.34 (1.28 to 1.41)	1.23 (1.16 to 1.30)	1.41 (1.33 to 1.50)
Lower RTI	10 112 (7.9)	1.85 (1.75 to 1.96)	1.95 (1.83 to 2.07)	1.26 (1.17 to 1.36)
Chronic IHD	12 739 (9.9)	1.89 (1.80 to 1.98)	2.12 (2.01 to 2.23)	1.26 (1.17 to 1.35)
Heart failure	6939 (5.4)	3.79 (3.59 to 4.00)	3.90 (3.68 to 4.13)	1.15 (1.04 to 1.27)
Diabetes mellitus	9185 (7.2)	1.14 (1.07 to 1.21)	1.06 (0.98 to 1.14)	1.24 (1.15 to 1.34)
Renal failure	2927 (2.3)	5.55 (5.12 to 6.03)	4.95 (4.56 to 5.39)	1.28 (1.09 to 1.51)
Malignancy	3402 (2.7)	3.02 (2.79 to 3.27)	2.81 (2.57 to 3.07)	1.14 (0.99 to 1.30)
Hypertension	22 526 (17.6)	0.88 (0.84 to 0.92)	0.87 (0.82 to 0.91)	0.93 (0.88 to 0.99)

RTI=respiratory tract infection; IHD=ischaemic heart disease.
*950 patients excluded because of unknown fifth (missing or invalid postcode).

of the difference occurred in those aged ≥85, with 24% in the 80-84 age group. Differences a year at trust level ranged from 17 fewer to 38 more deaths. Forty of the 151 trusts had fewer observed deaths than expected. For more than two days' delay, the total difference between the observed and expected deaths in three years was 1307 deaths (1202 to 1412), 7.1% of the 18 508 total.

For deaths within 30 days of admission, the sum of the differences in the three years was 1155 (944 to 1366) for more than one day's delay and 825 (752 to 898) for more than two days' delay. Differences a year at trust level ranged from 10 fewer to 23 more deaths for more than one day's delay. At trust level, there were no significant relations overall between delay rates and (in turn) the proportion of patients managed medically (P = 0.493), mortality (P = 0.207), and the readmission rate (P = 0.127). The 37 out of 151 trusts with more than half of their patients waiting more than one day for a fixation or replacement procedure, however, had significantly greater mean observed minus expected deaths than the other 114 (10.3, 0.8 to 19.8).The trust with the largest difference (either raw or volume adjusted) had the second highest mortality and the 19th highest rate of delay.

Discussion

Analysis of hospital episode statistics shows that a delay in operating was associated with a higher risk of mortality after hip fracture, even after we adjusted for available covariates. Although patients with a delayed procedure were on average only slightly older than those with no such delay, they were much more likely to have each of the comorbidity variables. The differences in the odds of death and the frequency of comorbidity also existed between patients managed surgically and those with no procedure. These findings suggest that comorbidity does indeed affect management, including the timing of operation, and that deleterious effect of delay remains after adjustment. If death rates in patients with at most one day's delay had been repeated throughout all 151 trusts in this study, there would have been an average of 581 fewer total deaths (9.4% of the total) or 385 total deaths at 30 days a year.

The estimation of the numbers of deaths associated with delayed operation requires the identification of all important factors that are related to both the risk of death and the timing of surgery. The reasons for delay can be divided into clinical and organisational: the expected deaths are assumed to take into account the first category for the purposes of the calculation. It would be wrong to conclude, however, that delaying surgery by more than 24 hours costs 581 lives per year in England. Some of these deaths will be due to pre-existing disease, which might itself have caused the fall or the fracture, or both. This may be partly mitigated by considering deaths within 30 days of admission (a performance indicator used by the Department of Health[6]), which gave a total difference between observed and expected a year of 385 deaths. Some of these will be attributable to incomplete comorbidity coding and other unmeasured medical reasons for the delay.

Table 3 Odds ratios (95% confidence interval) for death and readmission by intervention, adjusted for age, sex, deprivation fifth, and comorbidity

	Outcome		
	Death in hospital	Death in hospital within 30 days of admission	Emergency readmission within 28 days
Intervention:			
No procedure	3.33 (3.15 to 3.51)	4.50 (4.25 to 4.77)	1.35 (1.24 to 1.46)
Other procedure	1.96 (1.81 to 2.12)	2.28 (2.09 to 2.49)	1.05 (0.94 to 1.17)
Replacement	1.02 (0.98 to 1.06)	0.99 (0.95 to 1.04)	1.02 (0.97 to 1.06)
Fixation	1	1	1
Delay in operation*:			
>1 day *v* ≤1 day	1.27 (1.23 to 1.32)	1.25 (1.19 to 1.31)	1.04 (0.99 to 1.08)
>2 days *v* ≤2 days	1.43 (1.37 to 1.49)	1.36 (1.29 to 1.43)	1.04 (0.99 to 1.10)

*Replacement or fixation only.

Study limitations

Data from the hospital episode statistics need careful interpretation.[7] The statistics do not capture deaths out of hospital, which will reduce reported in hospital mortality in trusts that discharge early. We captured most transfers to other NHS hospitals so this will mainly affect discharges home or to residential homes. The timing of discharge is related to factors such as availability of rehabilitation beds, preoperative delay, and postoperative complications.[8] The time between fracture and admission was also unknown and might be important. Deaths out of hospital are less important when we consider deaths within 30 days of admission, though this loss actually leads to an underestimate of the effect of operative delay.

Mobility before the fracture influences survival.[9] We included only patients admitted from their own homes, who are likely to be healthier than patients living in nursing homes,[3] although this group also includes patients living in sheltered accommodation, who are likely to be more ill than patients living in their own homes. The completeness of recording of comorbidity has been known to vary between trusts.[10] Some trusts may systematically under-record secondary diagnoses, which will lead to overestimating the effect of operative delay and hence also the difference between the observed and expected deaths. There is evidence that the recording of secondary diagnoses is increasing. We inspected all emergency admissions in the hospital episode statistics and found that in 1996-7 only 29% had one or more secondary diagnosis recorded; this increased to 55% the next year; and rose further to 60% in 2003-4. We used a diagnosis of Alzheimer's disease or dementia as an estimate of cognitive impairment but appreciate that this is a relatively insensitive measure.[11] Also the statistics cannot distinguish between chronic but stable disease and acute exacerbations. Because the statistics may not record all comorbidities, residual confounding remains possible and indeed likely.

Readmissions

Patients managed conservatively had the highest risk of emergency readmission, presumably because of the underlying pathology that made them unfit for surgery. For those having fixation or replacement procedures, we found little evidence for higher emergency readmission rates associated with surgical delay and the effect was much smaller than for mortality.

What is already known on this topic

Over 60 000 hip fractures occur every year in the UK

There is conflicting evidence from fairly small studies for the association between delay in operation and mortality, though Royal College of Physicians' guidelines recommend that patients be operated on within 24 hours of admission

Operation may be delayed to stabilise concomitant medical conditions

What this study adds

In England, 40% of procedures were performed more than one day after admission

Proportions of patients waiting for more than one day or more than two days for their operation varies widely between trusts

Delay is associated with increased mortality: the association still exists but is reduced after adjustment for confounders

Contributors: See bmj.com.

Funding: AB is 100% and PA is 50% funded by Dr Foster Ltd through a research grant for the unit.

Competing interests: The unit is funded by a grant from Dr Foster Ltd (an independent health service research organisation).

Ethical approval: We have approval to hold patient identifiable data granted by Security and Confidentiality Advisory Group with Section 60 support from the Patient Information Advisory Group (PIAG). We also have approval from St Mary's local research ethics committee.

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(Accepted 15 February 2006)

doi 10.1136/bmj.38790.468519.55

DRUG POINTS

Atorvastatin may cause nightmares

Peter J H Smak Gregoor

Department of Internal Medicine, Albert Schweitzer Hospital, PO Box 444, 3300 AK Dordrecht, Netherlands

Peter J H Smak Gregoor
internist-nephrologist

p.smakgregoor@asz.nl

BMJ 2006;332:950

Atorvastatin (Lipitor; Pfizer, Walton-on-the-Hill) is a 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase inhibitor, prescribed for the treatment of hypercholesterolaemia in many patients worldwide. This case report relates atorvastatin to the occurrence of nightmares.

A 72 year old woman with a history of longstanding hypertension, treated hypothyroidism, heart failure, and chronic renal failure started taking 10 mg atorvastatin once a day because of hypercholesterolaemia. Concurrent drugs were 75 µg levothyroxine once a day, 5 mg amlodipine once a day, 100 mg atenolol once a day, and 50 mg losartan once a day. Five days after starting atorvastatin, she had extreme nightmares each night for two and a half weeks. Because of a presumed connection with her recently started statin, I discontinued this treatment for five days. No nightmares occurred. Although reluctant for a rechallenge, she agreed to take the atorvastatin again, which promptly resulted in nightmares; these dreams disappeared after discontinuation.

Several studies have looked at sleep disturbance or abnormal dreams related to HMG-CoA reductase inhibitors. The phenomena seem comparable within several groups of statins with different lipophilic properties and compared with placebo.[1] These studies found side effects only between groups of patients treated with different statins or placebo, without rechallenges to relate these events to the use of these drugs.

A possible relation between nightmares and statins has previously been reported with the use of simvastatin and metoprolol.[2] To my knowledge, no recounts of nightmares with the use of atorvastatin have been reported to Pfizer or have been published.

The nightmares could be a direct effect of atorvastatin on the central nervous system. But the mechanism may be pharmacokinetic (CYP3A4) or a pharmacodynamic interaction.

Although it seems that nightmares are an occasional adverse effect of statins, this is relevant for the patient and should be recognised by the treating doctor since it is easily corrected by stopping statins.

Funding: None.

Competing interests: None declared.

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