Cost of infection after surgery for intracapsular fracture of the femoral neck

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ABSTRACT

INTRODUCTION We investigated the financial and human costs of postoperative infection for intracapsular fracture of the femoral neck at a district general hospital in the UK.

METHODS Data on postoperative infections after surgical treatment for intracapsular fracture of the femoral neck were collected prospectively from June 2005 to April 2009. Infected patients were pairwise-matched (1:2 ratio) with a non-infected group of patients from a database on hip fractures. Costs of additional surgery, duration of hospital stay, and opportunity costs were calculated using Primary Care Trust (PCT) tariffs and PCT-specific data.

RESULTS A total of 525 patients were treated with total hip replacement (n=110) or hip hemiarthroplasty (n=415). Seventeen patients (3.2%) were identified as having a surgical-site infection. Eight (1.5%) deep infections and nine (1.7%) superficial infections were documented. Compared with the non-infected group, duration of hospital stay and the prevalence of mortality doubled. Repeat surgery and the costs associated with hospital admission were increased significantly in the infected group. Mean financial loss associated with an infected patient was £7,726, whereas an uninfected patient brought £153 of profit to the hospital. When opportunity costs were considered, an infected patient represented £24,397 of lost income.

CONCLUSIONS Postoperative infection after surgical treatment for intracapsular fracture of the femoral neck has a significant negative impact on duration of hospital stay and financial costs, and demonstrates a trend towards an increase in the prevalence of mortality.

KEYWORDS

Intracapsular fracture of the femoral neck – hip hemiarthroplasty – infection – duration of hospital stay – opportunity cost – mortality

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The UK population aged over 80 years is projected to double over the next 25 years, growing from 2.9 million in 2010 to 5.9 million by 2035.¹ As the population ages, the already high burden of hip fracture on healthcare systems is expected to continue to rise.² Hip fractures in the elderly are associated with impaired mobility, and are a major cause of morbidity and mortality.^{2,4} They also lead to dependency and, if the patient needs to sell his/her property to pay for residential care, the loss of home.⁴

Approximately 76,000 hip fractures are recorded each year in the UK, with costs to the National Health Service (NHS) amounting to >£2 billion.⁴ This figure is almost doubled if the social-care costs of dependency are considered.⁴

Surgical site infections (SSIs) are a significant complication after treatment of hip fractures.⁵ SSIs have been recognised in the latest report of the *Mandatory Surveillance of Surgical Site Infection in Orthopaedic Surgery in England*.⁶ The prevalence of infection after surgery for hip fractures is significantly higher than in elective hip arthroplasty for arthritis.

This higher prevalence is explained (at least in part) by risk factors in this group of patients such as older age, underlying medical conditions, and traumatic injury.^{6,12} Therefore, initiation and maintenance of the highest standards of infection prevention in the surgical care of such patients is crucial.¹² These vulnerable patients also tend to have a longer duration of stay in hospital (DoSH) after surgery, which increases the likelihood of SSIs being identified by surveillance.

Edwards *et al.*⁵ recently pointed out that, despite the high costs of hip fractures and the associated prevalence of SSIs, data on the added financial costs of SSIs after hip-fracture surgery are lacking. Their study in a large teaching hospital in the UK found a prevalence of deep infection of 1.2% and that of superficial infection of 1.1%. They estimated that the mean cost of treating a surgical patient with an infected hip fracture was £25,940, whereas it was only £8,978 for a surgical patient with an uninfected hip fracture.⁵ DoSH costs represented 82% of the total cost, surgical costs contributed 13%, and the costs of investigations

and antibiotics represented the remainder.⁵ Mean DoSH of patients with SSIs in that study was 76 days vs 22 days in uninfected patients. Furthermore, one-year mortality was 50% in patients who had developed SSIs compared with 30% in patients who had not.⁵

We investigated the financial and human costs of infection after surgery for intracapsular fracture of the femoral neck at a district general hospital (DGH) in the UK.

Methods

Data on infections after hip hemiarthroplasty or total hip replacement (THR) for an intracapsular fracture of the femoral neck were collected prospectively at the West Suffolk Hospital from June 2005 to April 2009. The Surgical Site Surveillance Programme comprises wound inspection at least thrice before hospital discharge, and monitoring of microbiological wound swab results for 30 days from the date of surgery. Extracapsular fractures and sub-trochanteric fractures were excluded from the present study. All hospital episodes until the study date (April 2010) were analysed.

Cases of infection were identified and matched pairwise with a non-infected control group of patients at a ratio of 1:2. Patients were matched for age, sex and American Society of Anaesthesiologists (ASA) score.

Surgery was undertaken in dedicated orthopaedic theatres. Locally agreed protocols for antibiotics (2 g flucloxacillin and 160 mg gentamicin) were administered preoperatively. If the patient had an allergy to penicillin, 1 g vancomycin or 400 mg teicoplanin was used. Gentamicin-impregnated cement was used in all patients who had cemented implants.

Between June 2005 and July 2007, a Thompson hemiarthroplasty prosthesis was used (Stryker, Newbury, UK). Use of cement was encouraged but was at the discretion of the surgeon. Due to a change in departmental policy, from July 2007 until the end of the study period, the Exeter Trauma Stem (Stryker) was used for cemented hemiarthroplasty and the Austin–Moore hemiarthroplasty (DePuy Orthopaedics, New Brunswick, NJ, USA) used if cement use was contraindicated. Patients who were medically fitter received a THR at the discretion of the surgeon (this trend increased towards the end of the study period). In all cases of THR the implants used were the Exeter Femoral Stem (Stryker) and the Ogee (DePuy Orthopaedics) or Contemporary (Stryker) acetabular cup.

Data collected included: age; sex; date of hospital admission; date of surgery; delay to surgery; date of hospital discharge and/or death; DoSH; ASA score; co-morbidities; infecting organism; time to the diagnosis of infection; number of times the patient returned to the operating theatre.

Information regarding DoSH and implant type was obtained from the medical notes and operating-theatre records. The cost of one minute of operating-theatre time was calculated to be £22.11. The cost of inpatient stay was calculated to be £300 per day. These figures were provided by the hospital's finance department and were correct for 2010.

Opportunity costs were calculated as the amount 'lost' per day by not filling the bed with a new patient. This was

calculated to be £650 per day using Primary Care Trust (PCT) tariffs and PCT-specific data. The tariff for a patient with a hip fracture is sufficient to provide for a mean DoSH of 17 days. If the patient stays longer (eg 26 days) and a new patient cannot take his/her bed, then the 'lost' opportunity cost to generate income from that bed is calculated to be £650 × 9 days = £5850.

'Superficial infection' was defined as a positive swab in the presence of an erythematous and discharging wound. If the discharge failed to settle, surgical debridement and washout was advocated. If the infection was found to be deep to the fascia at the time of surgery, the infection was considered to be 'deep'.

Infection and control groups were compared using the two-tailed Mann–Whitney U-test. Data were coded, stored and analysed using SPSS v18 (IBM, Armonk, NY, USA) and Windows XP (Microsoft, Redmond, WA, USA).

Results

Between 1 June 2005 and 30 April 2009, 525 patients (mean age, 83 years) with an intracapsular fracture of the femoral neck were treated with THR (n=110) or hip hemiarthroplasty (n=415). Of these, 17 patients (3.2%; 11 females and 6 males (mean age, 81 years) were identified as having developed an SSI. There were ten cemented hemiarthroplasties, five uncemented hemiarthroplasties, and two THRs in the infected group. Eight (1.5%) infections were deep and 9 (1.7%) were superficial.

There were no significant differences in demographic characteristics between infected and control groups (Table 1).

Superficial infections were diagnosed 5–29 (mean, 13) days after surgery. Deep infections were diagnosed 7–42 (mean, 19) days after surgery. There were no significant differences between the time to diagnosis for superficial and deep infections. All superficial infections were diagnosed before hospital discharge and treated with intravenous antibiotics. Two patients were diagnosed with an

Table 1 Patient demographics

	Infected	Uninfected
Male: female ratio	6:11	12:22
Mean age (SD)	80.53 (6.43)	80.56 (6.26)
Mean ASA (SD)	2.94 (0.75)	2.68 (0.77)
Number of uncemented hemiarthroplasties	5	10
Number of cemented hemiarthroplasties	10	18
Number of total hip replacements	2	6
Number of patients with diabetes mellitus	2	5
Number of patients with dementia	2	4

infection after hospital discharge. In both cases they were deep infections, and patients were taken to the operating theatre for washout and debridement of the prosthesis.

Mean duration for the primary surgical procedure was 64 min for the deep-infection group, 56 min for the superficial-infection group, and 64 min for the uninfected group. There were no significant differences between groups.

There was large variation between patients with regard to comorbidities. Two most common comorbidities were dementia and diabetes mellitus (DM). Prevalence of these comorbidities was similar in infected and non-infected groups.

Nine of the infection cases were caused by *Staphylococcus aureus* whereas, in three cases (16.7%), methicillin-resistant *Staphylococcus aureus* (MRSA) was found to be the causative organism. These two organisms accounted for most of the infections (Table 2) and were distributed approximately equally between deep and superficial infections.

Mean DoSH in the uninfected group was 16 days. Mean DoSH in deep infection and superficial infection groups was significantly longer (40 days and 38 days, respectively, $p < 0.001$, in both cases). There was no significant difference between deep and superficial infection groups.

Mean total cost of in-patient stay for an uninfected patient was £6,922 vs £15,576 for an infected patient, and this difference was significant ($p < 0.00005$). There was no significant difference between the mean total cost of superficial infection (£12,856) and deep infection (£18,636).

The deep-infection group had 14 additional visits to the operating theatre (mean, 0.75; range, 1–5) in addition to their index procedure. These comprised: nine washouts and debridements; two reductions of dislocated prosthesis; three implant removals. Costs of these extra procedures were included in calculation of the total cost of the in-patient stay of this group.

The PCT base tariff for treatment of a patient with a fractured hip is £7,076. This figure provides for a single surgical procedure and DoSH of 17 days. Mean financial loss associated with a deep infection was £10,807, whereas the mean surplus for an uninfected patient was £153. When opportunity costs were considered, a deep infection represented £23,847 of lost income

Mean follow-up was 29 (standard deviation, 14) months. The uninfected group had an inpatient and three-month mortality of 12%, whereas six-month and 12-month mortality was 15%. The infected group had the following corresponding mortality: 24%, 18%, 29% and 35%. Although increased, differences between groups were not significant due to the small sample size.

Discussion

Overall prevalence of infection after surgery for intracapsular fracture of the femoral neck in our DGH was 3.2% (1.5% for deep infections, 1.7% for superficial infections), which is comparable with other recent reports in the UK. Edwards *et al.*⁵ found a prevalence of infection of 2.3% (1.2% for deep infections, 1.1% for superficial infections) after surgery for hip fractures at a teaching hospital. Similarly, the latest report of the *Mandatory Surveillance of Surgical Site Infection in Orthopaedic Surgery* (which involved 154 NHS Trusts in England) identified a prevalence of SSIs of 1.7% in patients who underwent surgical procedures for fractures of the femoral neck.⁶ Almost half of these cases were deep infections or joint infections.⁶

We found that SSIs after hip-fracture surgery had substantial negative effects on DoSH, financial costs, return visits to the operating theatre, and survival. These findings are in agreement with previous research.

Total cost of care of patients with postoperative infected hip fractures in the present study was more than twofold that of uninfected patients (£15,576 vs £6,922). A threefold increase in the cost of treating an infected fracture was reported by Edwards *et al.*,⁵ though the costs at their centre (£25,940 vs £8,978 before considering opportunity costs) were considerably higher than those in our hospital. Similarly, Pollard *et al.*¹¹ found that the total cost of treating a deep infection in another teaching hospital in the UK was £24,410 vs £7,210 for an uninfected patient. The financial burden of SSIs is increased further by post-discharge costs such as longer outpatient follow-up, increased physiotherapy, rehabilitation, home help, or nursing-home care.⁵

An interesting aspect of our study that has not been investigated in this setting was the calculation of opportunity costs. If opportunity costs are also considered, an infected patient represented £24,396 of lost income. Addition of the lost opportunity cost income is a real loss to an organisation that has high bed occupancy, and reinforces the financial case for improving procedures for infection control.

Patients who developed SSIs were hospitalised for a significantly longer period of time, and the increased DoSH was a large proportion of the total cost. Mean DoSH for infected patients was 42 days (48 days for deep infections and 36 days for superficial infections). In comparison, mean DoSH for uninfected patients was 16 days. Studies have also reported greatly increased DoSH in hip-fracture patients who develop SSIs,^{5,7–9,11} with a mean DoSH of 100 days for deep-wound infections in the study by Edwards *et al.*⁵ DoSH is an approximate indicator of the

Table 2 Distribution of infecting organism between deep and superficial infections

	Total	Deep	Superficial
<i>Staphylococcus aureus</i>	9	5	4
MRSA	2	1	1
CoNS	3	1	2
<i>Escherichia coli</i>	1	1	0
Enterococcus	1	0	1
<i>Pseudomonas</i>	1	0	1
MRSA, methicillin-resistant <i>Staphylococcus aureus</i> ; CoNS, coagulase-negative staphylococci			

cost of SSIs after hip surgery but, for an accurate estimate, individual costs must be calculated using a linear regression model adjusted for all possible confounding factors.⁸

The present study has added to the already convincing evidence that infected patients are less likely to survive than uninfected patients.^{3,5,11,13} We found that the prevalence of mortality for infected patients was higher than that of uninfected patients at all the time points we assessed. They ranged from 18% to 35% in the infected group vs 12% to 15% in the uninfected group. Compared with uninfected patients, those who developed an SSI were twice as likely to die in hospital and more than twice as likely to die <12 months after surgery.

In accordance with previous reports,^{5,12} most infections (65%) in our study were caused by Gram-positive cocci, with the two most common pathogens being *S. aureus* and MRSA. Ridgeway *et al.*¹² found that the risk of acquiring an SSI caused by MRSA was particularly high after hip hemiarthroplasty, and Edwards *et al.*⁵ reported that DoSH, pre-hospital-discharge mortality, and costs were increased with MRSA-associated deep-wound infections vs non-MRSA infections. The small number of patients in our cohort prevented analyses of the effects of the causative organism on DoSH and mortality.

We could not identify any risk factors for infection. However, there is some evidence that corticosteroid use, DM, and renal disease may increase the likelihood of developing a SSI.⁵

In our study, dementia and DM were equally common in infected and uninfected groups but the prevalence of other comorbidities was too small to permit analyses. Similarly, mean duration of surgery was comparable in infected and uninfected groups (60 min and 64 min, respectively) and there were no correlations between duration of surgery and the prevalence of deep or superficial infections. Edwards *et al.*⁵ found a significant increase in SSI risk but only for surgery of extremely long duration. The small sample size of our study prevented further analyses into potential risk factors for infection, such as the professional grade of the surgeon and comorbidities other than those already discussed.

Limitations of our study included the problems associated with retrospective pairwise matching of patients. Efforts were made to ensure groups had similar demographics and comorbidities, but discrepancies were inevitable. Not all hip-fracture patients are followed up at our institution so some infections may have been missed, thereby skewing the results. The small cohort could also have led to misrepresentation of differences between

groups. However, these results are from a DGH (as opposed to a tertiary referral centre) and this factor would facilitate the generalisability of these findings to other healthcare settings.¹⁰

Conclusions

These findings from a DGH in the UK suggest that infection after surgery for intracapsular fracture of the femoral neck carries a significant negative impact on DoSH, financial costs, and, most importantly, survival. Therefore, optimal practice of infection control in orthopaedic surgery is strongly advocated.

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