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Management and cost of surgical site infection in patients undergoing surgery for spinal metastasis

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SUMMARY

Background: Surgical site infection (SSI) is a serious potential complication of spinal surgery. SSI may impact significantly on inpatient hospitalization and the costs associated with extra care.
Aim: To investigate the management of patients experiencing SSI following surgery for spinal metastatic tumours, and to estimate the costs associated with SSI in this context.
Methods: Patients experiencing SSI following spinal tumour surgery at a large spinal surgery centre between January 2009 and December 2012 were identified. Existing case notes were reviewed and patient and procedural data, details of the infection, and treatment interventions were recorded. A bottom-up approach to calculating costs associated with infection was used for patients experiencing SSI and compared with a quasi-random sample of similar patients without SSI.
Findings: The mean cost of treating patients with SSI was significantly greater than costs associated with those without SSI ($P = 0.019$). Mean cost of inpatient hospital stay was 60% higher in patients with SSI compared to those without SSI ($P = 0.004$). Inpatient hospital stay alone accounted for 59% of total costs. Return to theatre was the second most costly intervention overall, accounting for 38% of costs, and was the most expensive single intervention involved in the treatment of SSI.
Conclusion: SSI significantly increases healthcare costs for patients undergoing surgery for spinal metastasis, with prolonged inpatient hospitalization and return to theatre for wound management being major contributors. The actual total cost to society derived from SSI in this patient group is likely to be far beyond just the direct costs to healthcare providers.

Introduction

Surgical site infection (SSI) is a frequent complication of surgery, accounting for about 16% of all healthcare-acquired infections in England.[1] SSI occurs in about 10–20% of patients who undergo surgery for secondary (metastatic) spinal

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tumours, which is considerably higher than the average of 4% for all surgical procedures.[2–7] Aside from the significant morbidity associated with SSI and a substantive effect on patient survival, the impact on patients' quality of life and the challenge to the care team, there is an undoubtedly negative impact on the health service through elevated costs due to this complication.[8–10] Recently there has been one comprehensive review of the economic burden of SSI to healthcare organizations, which included spinal surgery as a surgical category. However, there are no published reports that estimate the costs of SSI in spinal tumour patients specifically.[10]

Given the increased success of treatments in prolonging the life of many patients with cancer, the number of individuals affected by spinal metastasis is likely to grow, leading to a corresponding rise in surgical cases. This not only puts services under greater pressure to provide the initial surgical and medical care to this increased number of patients, but potentiates a significant problem with respect to complications such as SSI.

The aim of this study was to describe the current management of patients with SSI who have undergone surgery for spinal metastases at a large tertiary referral centre, in order to estimate the economic costs associated with this complication in this patient group.

Methods

This was a sub-study of an ethically approved case note review of adult patients (aged ≥18 years) who had undergone surgical treatment for spinal metastatic tumours at Salford Royal NHS Foundation Trust between January 1st, 2009 and December 31st, 2012.[6] Patients experiencing SSI during this four-year period were identified and patient and procedural data, details of the infection, and treatment interventions were recorded. A comparator group consisting of a quasi-random sample of 23 metastatic spinal tumour patients without SSI (operated on within the same time period) was included. This comparator group consisted of every fifth patient (when ordered by date of operation).

Definition of SSI

The presence or absence of SSI (superficial or deep) was defined using the criteria set out by Public Health England, which is largely based on the definitions published by the US Centers for Disease Control and Prevention (CDC) and the work of Horan *et al.*[11,12] SSIs were classified by the SSI surveillance nurse for the neurosurgery department, as per standard routine for the reporting of SSIs through the hospital SSI Surveillance Service.

Data collection

Data were collected from existing patient case notes and associated medical records (e.g. medical images) and were anonymized prior to analysis; no contact with patients or relatives was required for additional data collection. It was assumed that all patients who experienced SSI were treated for the infection at the tertiary referral centre where they underwent their operation, though in practice this may not be the case if some were treated in primary care or other healthcare settings. In addition to demographic data, American Society of Anesthesiologists (ASA) grade was obtained as a measure of health status and Revised Tokuhashi Score (RTS) as a measure of prognosis.[8]

Determination of costs

A bottom-up approach to calculating costs associated with infection was used for patients experiencing SSI and compared with a quasi-random sample of similar surgical metastatic spinal tumour patients without SSI, on a patient-by-patient basis. The bottom-up approach was used due to the low number of SSI cases in the data set, meaning that the data could be interrogated at a closer level to provide a more detailed perspective than a top-down method. The bottom-up approach provides a greater level of granularity and versatility, and is a more robust method of estimating benefits to those commissioning services where savings need to be made.[13]

Costs were provided independently by the finance department of the hospital. Costs for inpatient hospital stay were calculated for all patients, based on the current rate (as of 2014) of one night's stay for each ward (e.g. intensive care unit; high dependency unit; spinal unit) on which a patient was resident. Additionally, for patients with SSI, costs associated with assessments or interventions directly related to SSI were calculated on an individual basis, in order to accurately reflect the treatment of each inpatient. These included referral of samples to clinical microbiology department, antibiotic treatment, return to theatre, additional wound care interventions (e.g. negative pressure wound therapy, NPWT), and other wound-specific assessments (e.g. wound ultrasound scan). Thus, the cost of each of these additional components was assumed to be zero for patients without SSI. Costs associated with wound dressings, outpatient clinic visits and community care (e.g. general practitioner consultations and community nurse visits) were not included in the analysis.

Statistical analysis

Patients with and without an SSI were compared at baseline in terms of key demographic and health variables to verify that groups were reasonably matched at baseline. Total costs and stay costs for both groups were summarized descriptively. Independent sample *t*-tests were used to assess the significance of the difference of total costs and stay costs between groups in unadjusted models. Factorial analysis of variance (ANOVA) was conducted on corresponding adjusted models correcting for controlling factors and covariates shown to be imbalanced at baseline. In both cases a Bonferroni correction was applied to the significance level to reflect the multiple comparison testing being undertaken. Models with and without controlling variables were compared using the adjusted R^2 statistic.

Results

Seventeen patients (seven females and 10 males) experienced SSI (14 superficial and three deep) out of a total of 152 patients undergoing surgery for spinal metastasis over the four-year study period, representing a rate of 11.2%. Mean age at operation of those with SSI was 63.5 years [(standard deviation (SD): 11.0 years]. All except two SSIs were identified as