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# Clinical and economic burden of surgical site infection (SSI) and predicted financial consequences of elimination of SSI from an English hospital

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SUMMARY

***Background:*** Although surgical site infections (SSIs) are known to be associated with increased length of stay (LOS) and additional cost, their impact on the profitability of surgical procedures is unknown.

***Aim:*** To determine the clinical and economic burden of SSI over a two-year period and to predict the financial consequences of their elimination.

***Methods:*** SSI surveillance and Patient Level Information and Costing System (PLICS) datasets for patients who underwent major surgical procedures at Plymouth Hospitals NHS Trust between April 2010 and March 2012 were consolidated. The main outcome measures were the attributable postoperative length of stay (LOS), cost, and impact on the margin differential (profitability) of SSI. A secondary outcome was the predicted financial consequence of eliminating all SSIs.

***Findings:*** The median additional LOS attributable to SSI was 10 days [95% confidence interval (CI): 7–13 days] and a total of 4694 bed-days were lost over the two-year period. The median additional cost attributable to SSI was £5,239 (95% CI: 4,622–6,719) and the aggregate extra cost over the study period was £2,491,424. After calculating the opportunity cost of eliminating all SSIs that had occurred in the two-year period, the combined overall predicted financial benefit of doing so would have been only £694,007. For seven surgical categories, the hospital would have been financially worse off if it had successfully eliminated all SSIs.

***Conclusion:*** SSI causes significant clinical and economic burden. Nevertheless the current system of reimbursement provided a financial disincentive to their reduction.



## Introduction

In the most recent point prevalence survey of inpatients in England, surgical site infection (SSI) was again the third most frequently occurring healthcare-associated infection (HCAI), causing 15.7% of reported infections.[1] As well as resulting in substantial morbidity and mortality to patients who have undergone surgical procedures, SSI contributes to the burden

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on providers of healthcare services by prolonging the duration of hospital stay and increasing costs.[2–8] Comprehensive, evidence-based guidelines exist for the prevention of SSI and many carefully conducted studies have successfully reduced rates of wound sepsis by a combination of effective intervention and feedback of data on infection rates to surgical teams.[7,9–13] Despite the success in some areas of HCAI prevention in England, most notably the fall in incidence of MRSA bacteraemia and *Clostridium difficile*, a similar reduction in SSI rates has not occurred.[1,14] Few hospitals in England have the resources to perform comprehensive surveillance of surgical procedures and recent studies have confirmed that SSIs are significantly underestimated in the national surveillance programme facilitated by Public Health England (formerly the English Health Protection Agency).[7,15,16] In 2009, concerns that there was inadequate information for English hospitals on the adverse effects of SSI in defined categories of surgical procedures were raised by the Public Accounts Committee who, having reviewed the national SSI surveillance system, concluded that the true scale of SSIs in England was not understood because of a 'lack of decent data'.[17]

A critical step in convincing organizations to allocate scarce resources to infection control programmes is to demonstrate that these interventions will not only reduce the rate of infection, but will also result in savings that exceed the cost of preventive strategies.[18,19] A better understanding of the financial burden of SSI would help justify decisions on the economic benefit of greater investment in evidence-based interventions to prevent them. An effective SSI prevention programme should also be able to demonstrate a valuable return on investment through ongoing delivery of quantifiable health benefits by releasing hospital resources for alternative use and beds for new admissions.[18–20] The additional cost associated with SSI has not been fully elucidated due to inconsistencies in study design and variation in methods of cost calculation.[18,19,21] In general, previous studies have allocated hospital costs using the additional length of stay (LOS) associated with SSI, a method that may introduce bias and therefore be inaccurate.[5–8,19–22] Despite these problems, a recent review comparing studies of magnitude of costs due to SSI estimated that the healthcare cost for a patient with SSI is likely to be approximately twice that of one without.[23] This contrasts with the latest total attributable hospital cost due to SSI estimated by the National Institute for Health and Clinical Excellence (NICE) of £469 per infection.[9]

A dedicated team at Plymouth Hospitals NHS Trust has conducted surveillance of SSI, including for infections developing after discharge from hospital, with feedback to surgeons for all major surgical procedures since January 2009. In April 2010, the hospital introduced a Patient Level Information and Costing System (PLICS) that combines data from a range of administrative, clinical and financial systems to allocate cost to individual patient episodes, and allowing linkage of financial and clinical outcomes. In the present study, we sought to quantify the clinical and economic burden of SSI through analysis of PLICS data for patients who underwent surgical site surveillance at our hospital between April 2010 and March 2012. We aimed to obtain a measure of the attributable cost of SSI and also the margin (profitability) differential between patients with and without SSI for different surgical categories. In addition, we sought to predict the financial consequences of the elimination of all SSIs that occurred over the study period.

**Table I**

Surgical site infection (SSI) and return of post-discharge questionnaires (PDQs) by surgical category

| Surgical category | No. of procedures | No. (%) of PDQs returned | No. (%) of SSIs during admission | No. (%) of SSIs on readmission | No. (%) of SSIs post discharge | Total SSIs (overall SSI rate) |
|---|---|---|---|---|---|---|
| Cardiac | 1672 | 970 (58) | 25 (1.5) | 18 (1.1) | 137 (8.2) | 180 (10.8) |
| Vascular | 401 | 176 (44) | 5 (1.2) | 7 (1.8) | 16 (4.0) | 28 (7.0) |
| Limb amputation | 291 | 102 (35) | 3 (1.0) | 4 (1.4) | 6 (2.1) | 13 (4.5) |
| Hip replacement | 980 | 588 (60) | 6 (0.6) | 5 (0.5) | 5 (0.5) | 16 (1.6) |
| Knee replacement | 970 | 543 (56) | 0 | 6 (0.6) | 25 (2.6) | 31 (3.2) |
| Reduction long bone fracture | 1503 | 631 (42) | 6 (0.4) | 13 (0.9) | 12 (0.8) | 31 (2.1) |
| Repair neck of femur | 598 | 305 (51) | 1 (0.2) | 6 (1.0) | 7 (1.2) | 14 (2.3) |
| Cranial | 896 | 278 (31) | 2 (0.2) | 7 (0.8) | 0 | 9 (1.0) |
| Spinal | 1827 | 713 (39) | 2 (0.1) | 9 (0.5) | 7 (0.4) | 18 (1.0) |
| Abdominal hysterectomy | 402 | 273 (68) | 3 (0.7) | 2 (0.5) | 9 (2.2) | 14 (3.5) |
| Caesarean section | 1837 | 1745 (95) | 16 (0.9) | 9 (0.5) | 114 (6.2) | 139 (7.6) |
| Breast | 1016 | 569 (56) | 3 (0.3) | 11 (1.1) | 35 (3.4) | 49 (4.8) |
| Bile duct, liver, pancreatic | 222 | 124 (56) | 9 (4.1) | 1 (0.5) | 11 (5.0) | 21 (9.5) |
| Cholecystectomy | 46 | 23 (50) | 1 (2.2) | 2 (4.4) | 3 (6.5) | 6 (13.0) |
| Gastric | 228 | 121 (53) | 4 (1.8) | 2 (0.9) | 3 (1.3) | 9 (4.0) |
| Large bowel | 673 | 337 (50) | 41 (6.1) | 12 (1.8) | 33 (4.9) | 86 (12.8) |
| Small bowel | 259 | 117 (45) | 15 (5.8) | 1 (0.4) | 8 (3.1) | 24 (9.3) |
| Multiple intra-abdominal | 385 | 193 (50) | 17 (4.4) | 3 (0.8) | 18 (4.7) | 38 (9.9) |
| Multiple other procedures | 94 | 47 (50) | 3 (3.2) | 2 (2.1) | 2 (2.1) | 7 (7.4) |
| All procedures | 14,300 | 7854 (55) | 162 (1.1) | 120 (0.8) | 451 (3.2) | 733 (5.1) |