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Original Article

Incidence and estimated annual cost of emergency laparotomy in England: is there a major funding shortfall?*

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Summary

Significant recent interest has focussed on improving outcomes after emergency laparotomy. This retrospective database analysis estimated the annual incidence and associated inpatient costs of emergency laparotomy in England. Demographic, process and outcome data were collected for all patients undergoing emergency laparotomy in Brighton for two calendar years (2009–2010). Cost analysis assumed £16 per minute theatre time, and £282 per day ward bed and £1382 per day critical care bed costs. National incidence was confirmed from Hospital Episode Statistics and Office of National Statistics mid-year population data. In total, 768 patients underwent 850 emergency laparotomies. The incidence of emergency laparotomy was estimated as ∼1:1100 population. Thirty-six percent (276 patients) were admitted for a median (IQR [range]) of 5 (3–11 [1–76]) days of critical care. Postoperative median (IQR [range]) length of stay was 13 (8–24 [1–176]) days. Our estimated annual inpatient cost of emergency laparotomy for Brighton was ∼£5 million, equivalent to ∼£13 000 per patient, and for England, an annual estimated cost of ∼£650 million. However, 'Payment by Results' reimbursement amounted to a mean (SD) hospital income of just £6905 (2639) per patient, a net financial loss of ∼£6100 per patient, equivalent to a reimbursement shortfall nationally of ∼£300 million. We also found that patients > 70 years (46%) had significantly higher 30-day postoperative mortality (18% vs 6%, $p < 0.0001$), significantly prolonged median (IQR [range]) length of stay (15 (10–26 [1–123]) days vs 12 (7–22 [1–176]) days, $p < 0.001$) and incurred higher costs (median (IQR [range]) £9667 (6620–15 732 [1920–103 624]) vs £7467 (4975–14 251 [1178–118 060]), $p < 0.001$). Emergency laparotomy is a common procedure associated with considerable cost, particularly among elderly patients. A National Emergency Laparotomy Database will help provide an evidence base on which to improve clinical outcome and cost efficiency.

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There has been significant recent interest in trying to improve surgical outcomes after emergency surgery [1], particularly among sick, elderly patients for whom both the quality of care and measured outcomes are often poor [2, 3] and likely to worsen as the population ages [4, 5]. Although there has been considerable political and professional attention focussed on the management of hip fracture (which is a similarly costly and life-changing episode for predominantly elderly patients), there has been relatively little interest specifically aimed

at improving the management of patients undergoing emergency laparotomy, although recent developments such as the formation of an Age Anaesthesia Association-sponsored NHS Emergency Laparotomy Network [6] hope to address this deficiency. There are still remarkably few published data, therefore, on which to develop management guidance, to the extent that it remains uncertain how many emergency laparotomies are performed in England each year and what the financial implications of treatment are. Moreover, in the current climate of financial austerity, information about the costs of treatment are likely to act as potential drivers for future research funding from governmental agencies.

The main aim of this prospective database audit was to estimate the annual incidence of emergency laparotomy in England. The secondary aims were to estimate the national annual financial inpatient costs of emergency laparotomy and calculate whether hospital income matches hospital expenditure on these cases. Other aims included an analysis of age-related mortality, and determination of mortality and cost differences between younger and older (> 70 years) patients undergoing this procedure.

Methods

As part of a coordinated strategy to improve clinical outcomes for patients undergoing emergency laparotomy at the Royal Sussex County Hospital (RSCH), the Brighton Hip Fracture Database [7] was modified to record prospectively standardised details of all adult patients (> 18 years of age) undergoing emergency laparotomy since 1 January 2009. Ethical approval was not necessary as these data were collected anonymously primarily for analysis of service provision (and this was confirmed by the Trust's Caldicott Guardian). Cases were initially identified from daily analysis of emergency theatre logbooks, with operation (but not personal) details confirmed by centrally stored hospital Office of Population Censuses and Surveys (OPCS) codes and health resource group (HRG) codes. Duration of intensive care admission was ascertained from intensive care unit (ICU) logbooks. Data were stored on a computerised, double password protected, hospital-located Microsoft Access (Microsoft Corporation, Redmond, WA, USA) audit database.

All patients who underwent emergency midline laparotomy for a general surgical procedure were included. Patients undergoing repeated, secondary or emergency thoraco-abdominal procedures were included, but patients undergoing emergency appendicectomy and vascular, endoscopic and gynaecological procedures were excluded, unless these were performed as coincidental surgery.

For the purposes of this study, anonymised demographic and operative time data and postoperative mortality and length of stay data (retrieved from the hospital Patient Administration Service (PAS) database) were analysed, and the latter were compared between elderly (> 70) and younger patients using a two-tailed Fisher's exact test. Non-continuous data were compared using a Wilcoxon Mann–Whitney U-test. Significance was denoted by $p < 0.05$.

Mean expected hospital income was calculated according to the formula below [8, 9]:

'Superspell' defines the total ward or ICU stay, including pre-operative and postoperative care. Adjustments were made to this figure to avoid double-accounting, by subtracting theatre expenditure accruing as a result of multiple/repeated surgical procedures, and readmissions to ICU. Mean actual hospital income was calculated by cross referencing patients' details with centrally allocated Payment by Results (PbR) HRG codes.

The incidence of emergency laparotomy was calculated by dividing the mean number of emergency laparotomies per year by the hospital catchment population. To support the validity of our cost projections at a national level, confirmation of this incidence was performed by analysing HES three-character main procedure and intervention data from 2006/7 to 2009/10 (emergency procedure numbers listed for codes G01-07, 09, 23, 27–29, 31–36, 38, 48–53, 57–61, 63, 67, 69–76, 78, 82;

$$\begin{aligned}&(\text{Theatre time (min)} \times 16.\text{min}^{-1}) + (\text{Superspell general surgical inpatient stay (days)} \times 282.\text{day}^{-1}) \\ &\quad + (\text{Superspell ICU stay (days)} \times 1382.\text{day}^{-1})\end{aligned}$$

H03-17, 19, 29–30, 33–34, 46, 62, 66; J55–61, 63, 65, 68–70, 72; M02–05, 34–35, 37, 39, 41, 61; T15–16, 20–28, 30, 33–34, 36–39, 41, 46, 48, 51) [10] and mid-year English population estimates [11] for the same time periods. These codes were selected as a representation of procedures included in our hospital database.

Results

In the two years 2009 and 2010, 768 patients underwent 850 emergency laparotomy operations at the RSCH (n = 407 and 443 annually, respectively), a mean incidence of one emergency laparotomy per 1082 patients per year. This figure was closely confirmed using Hospital Episode Statistics (HES) and Office of National Statistics (ONS) data (Table 1).

Sixty-one of the 768 patients (∼8%) underwent between one and three additional emergency laparotomies. The median (IQR [range]) age of patients was 68 (51–79 [16–102]) years, and 52% were female. Small bowel resection was the most commonly recorded procedure (n = 110/841 records, 13%), followed by Hartmann's procedure (n = 96, 11%) and right hemicolectomy (n = 82, 10%). A total of 171 operations (21%) were performed on the same day as hospital admission. The median (IQR [range]) length of pre-operative patient stay was 2 (1–5 [0–77]) days. A total of 329 patients (39%) underwent 'out-of-hours' operations between 17.00 and 08.00 h. Ninety-seven patients (∼11%) were anaesthetised directly in theatre, rather than in an anaesthetic room. The primary operator was a consultant surgeon or senior trainee in 840 operations (99%); the primary anaesthetist was a consultant or senior trainee in 796 operations (94%). The median (IQR [range]) operation time (entry into anaesthetic room/theatre to leaving theatre) was 180 (138–240 [35–670]) min. A total of 276 patients (36%) were admitted to the critical care unit, for a median (IQR [range]) of 5 (3–11 [1–76]) days. Postoperatively, patients stayed in hospital for a median (IQR [range]) of 13 (8–24 [1–176]) days, with a superspell inpatient stay of 15 (9–28 [1–179]) days.

The total inpatient cost of emergency laparotomy was estimated to be ∼£5 million per annum (£4 992 572), equivalent to £13 000 per patient (Table 2). Applied nationally, we estimate that the annual inpatient cost of emergency laparotomy to the National Health Service in England is ∼£650 million.

Three hundred and fifty (46%) of patients were aged > 70 years, and of these 141 (40%) patients were admitted to the ICU. Overall inpatient and 30-day postoperative mortalities were ∼14% and ∼11%, respectively, but significantly higher among patients over 70 compared with younger patients (inpatient mortality ∼21% vs 7%, $p < 0.0001$; 30 day mortality 18% vs ∼6%, $p < 0.0001$). The > 70 year age group had a significantly longer median (IQR [range]) inpatient stay than younger patients (15 (10–26 [1–123]) days vs 12 (7–22 [1–176]) days, $p < 0.001$), and incurred higher inpatient total costs (£9667 (6620–15 732 [1920–103 624]) vs £7467 (4975–14 251 [1178–118 060], $p < 0.001$).

A total of 742 (97%) patients had had their inpatient stays coded for PbR purposes, generating a mean actual income of £6905 (SD 2639) per patient, a loss of ∼£6100

Table 1 Annual incidence of emergency laparotomy in England from 2006 to 2010. Values are number.

	2006/7	2007/8	2008/9	2009/10	Mean
HES 'emergency laparotomies'	47 142	47 373	48 399	50 483	48 349
ONS England population	50 763 900	51 106 200	51 464 600	51 809 700	51 286 100
Incidence by year	1:1077	1:1079	1:1063	1:1026	1:1061

HES, Hospital Episode Statistics; ONS, Office of National Statistics.

Table 2 Costs per patient for 768 patients undergoing emergency laparotomy at Royal Sussex County Hospital. Values are median (IQR [range]).

	Theatre	Ward superspell	Critical care	Total
Cost; €	2880 (2200–3840 [560–10 720])	3948 (2256–7050 [0–47 094])	6910 (4146–15 202 [1382–105 032])	8434 (5700–15 103 [842–118 060])

per patient compared with the calculated cost of treatment, which, translated nationally, is equivalent to a reimbursement shortfall of ~£300 million.

Discussion

Our main finding is that of a major funding shortfall for emergency laparotomy. We estimate that emergency laparotomy costs the NHS in England ~£650 million annually. It should be noted, however, that this figure is only an estimate of inpatient single superspell costs. During data collection, we noted that patients frequently attended for follow-up outpatient appointments and secondary inpatient episodes following their emergency laparotomy (these would attract further income per episode). In addition, our study did not attempt to estimate ongoing social costs to either the NHS or the economy as a whole, relating to lost days of work, sickness benefits, mortality (with associated loss of productivity and ongoing financial implications for other family members) etc. – costs that in the case of hip fracture have been estimated to double the cost of inpatient care [12]. We have estimated that ward costs account for ~46% of inpatient costs (theatre costs ~24%, ICU ~30%), and are therefore the primary starting point for analysing where care improvements and cost savings might be made. Of note is the prolonged pre-operative median stay of 5 days, experienced by those patients not taken to theatre on the day of hospital admission, which contrasts unfavourably with the 36-h target suggested for hip fracture patients [13]. This may be explained by the fact that the decision to undertake a laparotomy can be a more complicated treatment decision than that of hip fracture, but equally this reinforces the need for early senior surgical involvement in the management of these patients. Nevertheless, the cost savings that might be made by reducing pre-operative ward stay from 5 days to 2 days (equivalent to ~£850) represent only a small fraction (~14%) of the enormous funding shortfall between PbR income and hospital expenditure, a shortfall that is likely to hamper improvements in quality and outcome, and that exists despite a relatively predictable and measurable workload.

Our data are of considerable use in planning and budgeting for inpatient services. However, we accept that national incidence and financial estimates are subject to potential error. The annual incidence of emergency laparotomy in England is approximately 1:1100 population. Hospital episode statistics suggest that the incidence has been decreasing over the last four years (Table 1), which may not be statistically significant, as the 95% confidence limits of a Poisson distribution would include an incidence of as low as ~1:3300 [14], or, it may suggest that improvements in medical care have reduced the necessity for emergency operation. It may also reflect the fact that we focussed on open laparotomy, and changes in surgical technique (i.e. laparoscopic emergency intra-abdominal surgery) may be responsible. However, the hospital and HES/ONS data appear to agree. In calculating costs, we used a mid-range value for the total cost of theatre time (which includes personnel and consumable costs and overheads) of £16 per minute, but could have used any value between £12 and £20 per minute [8]. Similarly, the estimates used for ward and ICU costs (which together comprise ~76% of total inpatient cost) are dependent on the cost per day value used. In calculating the shortfall, evidence has shown that PbR remuneration tends to underestimate the expense of a hospital superspell [8], but the calculated value may be more or less depending on whether operations have been coded wrongly or significant co-morbidities or additional procedures unaccounted for.

In line with other studies, this analysis has shown significant inpatient (~14%) and 30-day (~11%) post-operative mortality [15–17]. Outcome data were significantly worse for older patients, with a fifth of patients failing to leave hospital alive, although it should be noted that ~82% of 79 'extremely old' patients (> 85 years of age) survived to hospital discharge. Unsurprisingly, given the physiological decline and co-morbid pathology associated with age, recovery from surgery appeared to be slower in older patients, resulting in longer inpatient stay (similar to findings of previous studies [18, 19]) and financial cost.

We believe ours is the largest database currently being continuously compiled in the UK with regard to emergency laparotomy, which is disappointing given the volume of cases nationally and the poverty of associated outcomes. By comparison, the National Hip Fracture Database (NHFD) has collected data on > 130 000 cases of hip fracture over the last four years,

and is proving an immensely powerful audit tool for highlighting clinical and organisational quality variations, with the aim of identifying and learning from hospitals that perform well, and helping hospitals that perform less well [20]. Although the European Surgical Outcomes Study (EuSOS) is likely to provide important risk-adjusted outcome comparisons for emergency intra-abdominal surgery in large numbers of patients, the exact procedures undertaken will not have been recorded. Therefore, we strongly advocate the formation of a National Emergency Laparotomy Database similar in nature and funding to the NHFD, and in the interim would encourage anaesthetists to collect and analyse data from their own hospitals and contribute to the Emergency Laparotomy Network [6].

Competing interests

SW is a Council member of the Age Anaesthesia Association, whom he represents at the National Hip Fracture Database, and hospital representative to the NHS Emergency Laparotomy and Hip Fracture Networks. SW is an Editor of *Anaesthesia*, and this paper has undergone an additional external review as a result.

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