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"Comparison of major abdominal emergency surgery outcomes across organisational models of emergency surgical care: analysis of the UK NELA national database"

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A propensity matched study comparing traditional general surgery on call models versus newer emergency surgeon on call.

No difference in mortality detected. Longer length of stay and intensive care length of stay.

#emergency surgery #laparotomy #NELA

Abstract

Background

Emergency General Surgery (EGS) admissions account for a large proportion of surgical care and represent the majority of surgical patients who suffer in-hospital mortality. Healthcare systems continue to experience growing demand for emergency services: one way in which this is being increasingly addressed is dedicated subspecialty teams for emergency surgical admissions, most commonly termed 'Emergency General Surgery'(EGS) in the UK. This study aims to understand the impact of the emergency general surgery model of care on outcomes from emergency laparotomies.

Methods

Data was obtained from the National Emergency Laparotomy Audit (NELA) database. Patients were dichotomised into EGS hospital or non EGS Hospital. EGS hospital is defined as a hospital where >50 % of in-hours emergency laparotomy operating is performed by an emergency general surgeon. The primary outcome was in – hospital mortality. Secondary outcomes were Intensive Therapy Unit (ITU) length of stay and duration of hospital stay. A propensity score weighting approach was used to reduce confounding and selection bias.

Results

115,509 patients from 175 hospitals were included in the final analysis. The EGS hospital care group included 5,789 patients vs 109,720 patients in the non EGS group. Following propensity score weighting, mean standardised mean difference reduced from 0.055 to <0.001. In-hospital mortality was similar (10.8% vs 11.1%, p=0.094), with mean length of stay (16.7 vs 16.1 days, p<0.001) and ITU stay (2.8 vs 2.6 days, p<0.001) persistently longer in patients treated in EGS systems.

Conclusion

No significant association between the emergency surgery hospital model of care and in – hospital mortality in emergency laparotomy patients was seen. There is a significant association between the emergency surgery hospital model of care and an increased length of ITU stay and overall hospital stay. Further studies are required to examine the impact of changing models of EGS delivery in the UK.

Study Type

Original Research (Clinical Research)

Level of Evidence

Level III, Epidemiological Study

Keywords:

NELA, Laparotomy, Emergency General Surgery, Acute Care Surgery

Introduction

Approximately 50,000 emergency laparotomies are performed in the UK alone each year(1), with a 30-day mortality rate of 8.7% and an average length of stay of 15 days(2). Emergency General Surgery (EGS) admissions are among the highest risk hospital inpatients and account for 14000 intensive care admissions costing over £88 million per year(3). It is estimated the between 80 and 90% of deaths in general surgery are accounted for by patients admitted through an emergency or unplanned admission pathway(3).

Healthcare systems continue to experience growing demand for emergency services, driven by an ageing population and limited resources. One way in which this is being increasingly addressed is the care of emergency admissions by a dedicated subspecialty or clinical team for emergency surgical admissions, most commonly termed 'Emergency General Surgery'(EGS) in the UK, or 'Acute Care Surgery' (ACS) in North America(4–6) , in contrast to the traditional general surgeon on-call (GSOC) model of care in which acute admissions are managed by a general surgical specialist wherein a rotating block of "on call" shifts supplants normal elective activity.

Meta-analyses have suggested that the adoption of the well-established ACS model in the US has been associated with a significant reduction in morbidity and mortality, particularly for high volume cases such as appendicectomy and cholecystectomy(7). Retrospective studies have also shown that high performing acute care hospitals in the US performing large numbers of procedures have better outcomes with less variability than smaller volume centres(8). A number of studies across institutions in North America and Australia have shown that hospitals with dedicated ACS units have better access to theatres(9) and diagnostic and interventional resources(10).

In the UK, increasing subspecialisation with the intention of improving outcomes for patients undergoing elective operations, has together with an increase in demand for service left gaps in the provision of consultant led emergency surgery care(3,11);the need for dedicated emergency general surgeons is increasing to meet this service requirement(5,11). The EGS model of care has been gradually introduced in the UK over the last 2 decades to address the increased demand for emergency surgery. Its implementation has been variable and ranges from a single emergency general surgeon participating in an on-call rota to an entire emergency surgery team with 7 days per week care delivery by a dedicated team. However, the current healthcare model lacks the provision of many of the favourable contextual factors which are likely to have helped promote emergency surgical care as a desirable subspecialty in the US, such as dedicated training schemes, fellowships and fee-for-service-based remuneration; a current lack of similar focus on provision of emergency care in the UK means that in some units EGS posts are seen as undesirable and can struggle to recruit to. In the UK, training for acute or emergency care is incorporated into standard training (residency) for general surgical trainees (upper gastrointestinal/foregut, colorectal, or hepatobiliary subspecialty training tracks). The UK training system currently lacks a dedicated acute/emergency surgical training or fellowship pathway. Trainees gain exposure through regular on call shifts, with experience and ability formally assessed through summative and formative assessments. Minimum case numbers, with assessments of competency completed, of all common emergency operations are mandated for completion of training.

Emergency general surgeons have several potential advantages according to a survey of 242 general surgeons caried out by Symons et al(5). These include providing service, improving the delivery of an EGS service, and increasing time available for subspecialists to perform their elective practice. However, the same survey also raised concerns about the quality of surgery, insufficient specialist care and compromise in the training of juniors. The lack of job structure, high attrition rate and insufficient quality of applicants were further concerns raised that suggest EGS posts need to be tailored to encourage development and retention of surgeons.

Evidence increasingly supports the idea that surgeon-level variability is an important factor in patient outcomes. A previous analysis of over 2,000 surgeons and 500,000 patients from the Florida State Inpatient Database suggested that the greatest proportion of variation in mortality risk of patient undergoing emergency surgery could be attributed to individual surgeon variation[12]. Analyses of the UK National Emergency Laparotomy Audit (NELA) database have reported increased mortality rates when emergency abdominal procedures are performed by non-specialised surgeons, or surgeons not specialised in the most relevant area for a given procedure (*i.e.* non-colorectal surgeons performing emergency colectomy)(12,13). Given the evolving structure of EGS care in the UK, it is important to understand what impact restructuring emergency models of care may have on patient outcomes at hospital level.

This aim of this study is to analyse cases entered into the NELA database to understand the impact of the EGS model of care on outcomes from emergency laparotomies.

Methods

Data was obtained from the prospectively maintained NELA database of all major emergency abdominal surgery performed in England and Wales. The full inclusion criteria and data have been described in the latest NELA project report(2); data analysis is permitted under the NHS

Act 2006(14). Significant exclusions from the database are all vascular, gynaecological, and trauma-related pathology, as well as cholecystitis, appendicitis, and uncomplicated hernia repair(15).

Anonymised demographic, clinical and outcome data for all patients entered into the NELA database between 2013 and 2019 were considered for inclusion(14). The NELA database was started in 2013 and is an ongoing audit in the UK. Data is openly available for request via the Healthcare Quality Improvement Partnership, data for this study was received 2022 with latest dataset available for analysis at time of receipt comprising the time period presented here (2013-2019). Patients were dichotomised into 2 groups based on whether they received care in a hospital employing an EGS model of care (EGS hospital) or not (non-EGS hospital). An EGS hospital was defined as a hospital in which the majority (>50%) of in-hours (between 0800 and 1700) emergency laparotomies were performed or supervised by an emergency general surgeon. The threshold of 50% of in – hours operating was used to more closely represent the current status of emergency surgery delivery in the UK, whereby daytime emergency care is often delivered by emergency general surgeons but out of hours care is covered by a wider pool of speciality surgeons. The NELA dataset codes the subspecialty of responsible surgical consultant as colorectal, oesophagogastric, emergency, hepatobiliary, general, vascular, breast and endocrine. For the purposes of our analysis, we excluded all patients operated on by 'general' surgeons because of the ambiguity over their subspeciality and potential confounding impact on our results. A further sensitivity analysis was performed where a lower threshold for proportion of in-hours laparotomies performed by emergency general surgeons was used, to capture hospitals which employed a less than full-time EGS service; a >5% minimum threshold was selected to control for potential data entry error.

Patients in whom discharge status (i.e. dead or alive), time of surgery (in-hours or out-of-hours), or subspecialty of consultant surgeon were unknown were excluded. Details of exclusions to yield the final sample size of 115,509 are detailed in Figure 1.

The primary outcome of our study was in-hospital mortality. Secondary outcomes were intensive therapy unit (ITU) length of stay and overall postoperative length of stay.

In order to reduce confounding and selection bias, a propensity score weighting approach was used(14,16–20).Briefly, in the context of this study, the propensity score for each case is equivalent to the probability yielded from a multivariable logistic regression where treatment in an emergency general surgery model is the dependent variable and variables on which to adjust are independent variables. The inverse of the propensity score is then used to weight each case in subsequent analyses, reducing systematic differences between the treatment groups. In this study we adjusted for 13 potentially confounding variables as listed in Table 1. Social deprivation was quantified using the English index of multiple deprivation (IMD) (which measures deprivation at post-code level) split into deciles. Covariate balance before and after weighting was quantified using the standardised mean difference (SMD), with >0.1 considered to indicate significant imbalance(20).

Missing data was present in 15,492 cases (13.4%). IMD was missing in 13,020 cases (11.3%), all other variables were missing in <1% of cases. Missing data was handled using multiple imputation by chained equations (MICE) with 10 iterations of 10 imputed datasets. Propensity score weights were combined by mean aggregation to yield a single final dataset(21).

To assess for generalisability of demonstrated effects in the primary analysis, planned subgroup analyses were conducted with propensity scores recalculated each time(19). Firstly, outcomes were compared when defining the emergency surgery model as >5% of in-hours operating performed by emergency general surgeons to establish whether units functioning with a partial emergency general surgery service, in which EGS surgeons were employed but delivered less than 50% (i.e. the previously defined threshold for the original analysis) of emergency laparotomies, demonstrated similar outcomes. Then the outcomes among patients undergoing colorectal and upper gastrointestinal procedures were analysed separately to assess if the division of emergency general surgery affected outcomes of subspecialist procedures, as EGS care models commonly pair on call EGS surgeons with subspecialists who are available to deliver subspecialist care, for example in case of obstructing cancers, such that an EGS model might potentially result in greater levels of subspecialist care for some procedures. Colorectal procedures were defined as stoma formation, left colectomy, right colectomy, subtotal colectomy, and Hartmann's procedure. UGI procedures were defined as peptic ulcer repair and gastric surgery – other. Analysis was conducted in R 4.1.0 with weighted statistical tests and logistic regression used as appropriate. Findings are reported in line with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (Supplemental Digital Content, http://links.lww.com/TA/D151).(22)

Results

A total of 115,509 patients was included in the final analysis. Summary descriptive statistics are presented in Table 2. Patients suffered an unadjusted in-hospital mortality of 11.0%. The mean pre-operative P-POSSUM mortality prediction was 16.5%. The EGS hospital care group included 5,789 patients vs 109,720 patients in the non EGS group. 40% of hospitals

(75/175 hospitals in this study) had at least one emergency general surgeon in post as recorded on the NELA database, with >50% of in hours emergency laparotomies performed by emergency surgeons in 10 hospitals (5.7%).

Following dichotomisation according to hospital care model (EGS vs non-EGS), characteristics were generally similar between groups, with pre-weighting SMD highest for IMD decile at 0.159. Propensity score weighting further reduced this, with the mean SMD reducing from 0.055 to 0.011. No characteristics had an SMD of >0.1 after weighting. The most commonly recorded speciality of surgeon was colorectal, and the least commonly recorded was endocrine. Emergency General Surgeons accounted for the 3rd highest number of patients (Table 3).

Prior to propensity score weighting, in hospital mortality was equivalent between patients treated in EGS systems (10.6% vs 11.1% p=0.260), with similar postoperative length of stay (16.2 vs 16.0 days, p=0.367) and ITU stay (2.5 vs 2.7 days, p=0.087) observed in patients treated in EGS systems. Following weighting, in hospital mortality was similar (10.8% vs 11.1%, p=0.094), however mean length of stay (16.7 vs 16.1 days, p<0.001) and ITU stay (2.8 vs 2.6 days, p<0.001) were significantly longer in patients treated in EGS systems (Table 4).

Specialist colorectal and upper GI procedures were more likely to be performed by a dedicated specialist in non EGS systems compared to EGS systems (Table 5). Mortality rates were similar among patients treated in EGS systems vs non EGS systems when undergoing colorectal (10.8% vs 11.1%, p=0.444) and upper GI (11.1% vs 12.8%, p=0.054) procedures. Similarly, a longer length of stay was also seen in patients treated in EGS systems for both colorectal (17.8 vs 17.0 days p=0.001) and UGI procedures (16.2 vs 15.1 days p=0.046). ITU stay was longer in EGS systems for colorectal (3.1 vs 2.8 days p<0.001) but not UGI (3.3 vs 3.1 days p=0.046).

Subgroup analysis, where an EGS hospital was defined as ≥ 5% operations being performed by an emergency general surgeon revealed similar trends with 43/175 (24.5%) of hospitals meeting this criterion. In hospital mortality was similar (10.8% vs 11.1%, p=0.09), whilst mean length of stay (16.7 vs 16.1 days, p<0.001) and ITU stay (2.8 vs 2.6 days, p<0.001) remained significantly longer.

Discussion

This retrospective population-level analysis considers the association between the increasingly prevalent EGS model of care and its impact on outcomes on emergency laparotomies in the UK. Findings from this analysis suggest that the provision of emergency laparotomy care via an EGS model in the UK has not significantly impacted mortality outcomes, in contrast to the improvements in care reported in North American based studies. While there were statistically significant (p<0.001) associations between the EGS hospital model and increased lengths of both ITU stay and length of hospital stay, these differences were small and of questionable clinical significance.

Around 50% of general surgical beds in UK hospitals are estimated to be occupied by patients admitted via an emergency care pathway at any one time(3). Improving emergency care delivery is critical to the future delivery of surgical care and Western health systems in general. Data for outcomes after emergency laparotomy indicate that mortality rates have improved significantly from the 15 – 20% first reported when NELA first started recording data 7 years ago(2,23–26) these patients still represent a vast number of patients and accounts for a disproportionate amount of general surgical deaths. Efforts to improve laparotomy care have taken the form of care bundles such as the quality improvement (QI) programme described in the EPOCH trial group of high-risk patients and the ELPQuiC bundle, with variable results. Implementation of the ELPQuiC bundle which focussed on early warning scores, early antibiotics, goal-directed fluid therapy, early operative intervention and post operative intensive care resulted in a significant reduction in the risk of death(23). However, the much larger EPOCH randomised controlled trial showed no significant difference in survival, suggesting that future QI programmes require significant investment in time and resources to improve patient care(24).

The paradigm shift represented by the EGS model of care has in part been driven by the increasing complexity and subspecialisation of elective surgery and increasing burden of emergency patient care (in part due to an aging and more comorbid population. However, the nature of EGS service delivery can be highly variable, from a single emergency surgeon providing occasional daytime care to much larger centres that have acute surgical units run exclusively by dedicated emergency surgeons. It is clear, however, that demand for emergency surgery services is increasing and this is associated with an increase in advertisements for specific EGS consultant jobs(5,11,27). Indeed, many subspecialists are in favour of broadening the base of emergency surgeons with 78% respondents from a recent survey of UK surgeons reporting a perceived improvement in the delivery of emergency care with an EGS service(5). However, no study to date has looked at the impact of an emergency surgery service on laparotomy outcomes.

Evidence from emergency surgery services or acute care surgery model in North America has suggested a significant improvement in mortality (31% reduction) across all emergency surgery procedures including appendicectomies, cholecystectomies and major intestinal resections(28). Hospitals that run dedicated acute surgery services have also been shown to have improved access to operating theatres which can have a significant impact on patient outcomes(29). Trauma centres that have implemented acute care surgery services in the US have improved outcomes in emergency surgery procedures(30). Estimates from the US state that implementation of an ACS service ranges between 18.2% (29)to 27% of hospitals(28) with variations in models of service delivery. The heterogeneity in services offered therefore make it difficult to directly compare healthcare services and models of emergency surgery care. The strength of association of some of these studies does, however, suggest, that further work into optimising acute or emergency surgery delivery can have a significant impact on patient outcomes.

Recent studies based on the NELA database have shown that emergency laparotomy for gastric or colonic pathology, when performed by an appropriate subspecialist surgeon, is associated with a reduced risk of death at 30 days(13). Subspecialists are also associated with higher rates of laparoscopy when performing emergency cases which overlap with their area of elective practice(12). Emergency management of diverticulitis by subspecialist colorectal surgeons is associated with low overall and operative mortality with higher rates of primary anastomosis and reduced permanent stoma rates(31). Data presented here, however, suggest that in the UK EGS model, patients are far less likely to be referred for upper GI or colorectal subspecialist care. This calls into question the common model of a "second-on call" upper GI or colorectal subspecialist, and whether patients indeed are appropriately referred. While EGS specialists will commonly have completed subspecialist upper GI or colorectal training (in the absence of a dedicated EGS training pathway), the aim of subspecialist care is that patients are operated on by high-volume surgeons whose routine (elective) practice covers the pathology in question.

Our study is limited by the retrospective nature of our analysis, making it susceptible to confounders, which we have attempted to account for through multivariate regression models and propensity score weighting. National case ascertainment is thought to be between 65 – 82.9%(2). Our database was generally well completed, but the absence of certain data points and uncertainty over the definition of a 'General Surgeon' (16480 patients) has required us to exclude 50,372 patients from our dataset. Coding of surgeon type is subject to local data entry errors, which we have attempted to account for by defining minimum thresholds and assessing a subgroup analysis in our definition of EGS centres. Furthermore, the number of EGS centres was consistent with the approximate number of expected centres and in agreement with the trend reported in a recent survey(5). We were unable to model or account for changing models of service delivery over time as date of operation was unavailable within our dataset to preserve anonymity. We have, however, accounted for the small number of other missing datapoints using the recognised statistical technique of multiple imputation by chained equations(21).

A major difficulty we encountered in our database analysis was precisely how to define an emergency surgery hospital. As there is no registry to inform us as to which hospitals run a dedicated acute surgery service run by emergency surgeons, we opted to define an emergency surgery hospital as one where over 50% of the in hours operating was performed by emergency surgeons. Adjusting the percentage from 50% to 5% did not affect the overall results of our regression analysis. There is clearly a huge variation in how emergency surgery is delivered across the UK and the world, and therefore we acknowledge the limitations in grouping all hospitals that have anything from one emergency surgeon to a full roster of EGS surgeons. Given the lack of published data on EGS models in the UK, outcomes from our study are related to presumed organisational models of care rather than established or published practice.

Interpretation of our analysis is limited by the NELA database which only includes outcomes from patients undergoing emergency laparotomies, and excludes high-volume cases such as appendicectomies, cholecystectomies and hernias. However, we elected to utilise the NELA database specifically as it captures only the highest morbidity and mortality-risk patients, and those where structural or process changes to care are most likely to affect the greatest impact.

An EGS care model is but one of many innovations which is changing the paradigm of emergency surgical care. There is significant evidence pointing towards other modifiable factors such as laparoscopy(14,16), particularly in the elderly(32), that can result in improved outcomes in this high-risk cohort of emergency patients. Evidence from the US points towards improved outcomes in hospitals that have dedicated acute surgery units, with important factors cited such as improved access to emergency theatres and interventional services such as radiology(6,7,10,30). A move towards centralising emergency care is another area that has been discussed for decades but has not progressed significantly(8).

In this analysis of UK data, there was no significant association between the emergency surgery hospital model of care and in-hospital mortality in emergency laparotomy patients. The increase in numbers of emergency general surgical posts over the last few years to meet increasing demand for services suggests that investment in this part of the workforce is essential for the delivery of a service that is under ever-increasing strain with an ageing population and scarce resources. In contrast to published evidence from other health systems, however, this analysis has not demonstrated any improvements in care outcomes with the EGS model. In order to depict organisational models of care more accurately, we would recommend further studies that may require the submission of questionnaires to all participating 175 hospitals that comprise the NELA dataset. This would aim to specifically address deficiencies in our dataset and obtain key hospital level variables such as trauma centre vs non trauma centre, emergency surgery fellowships, or dedicated EGS unit vs the traditional General surgeon on call model.

Further studies are required to examine the impact of changing models of emergency surgery delivery more closely in the UK and consider the best ways of improving outcomes for the critically ill surgical patient.

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FIGURE LEGEND

Figure 1. Study Flow Diagram

Supplemental Digital Content

SDC 1. STROBE Checklist

ACCEPTED

Figure 1: Study Flow Diagram

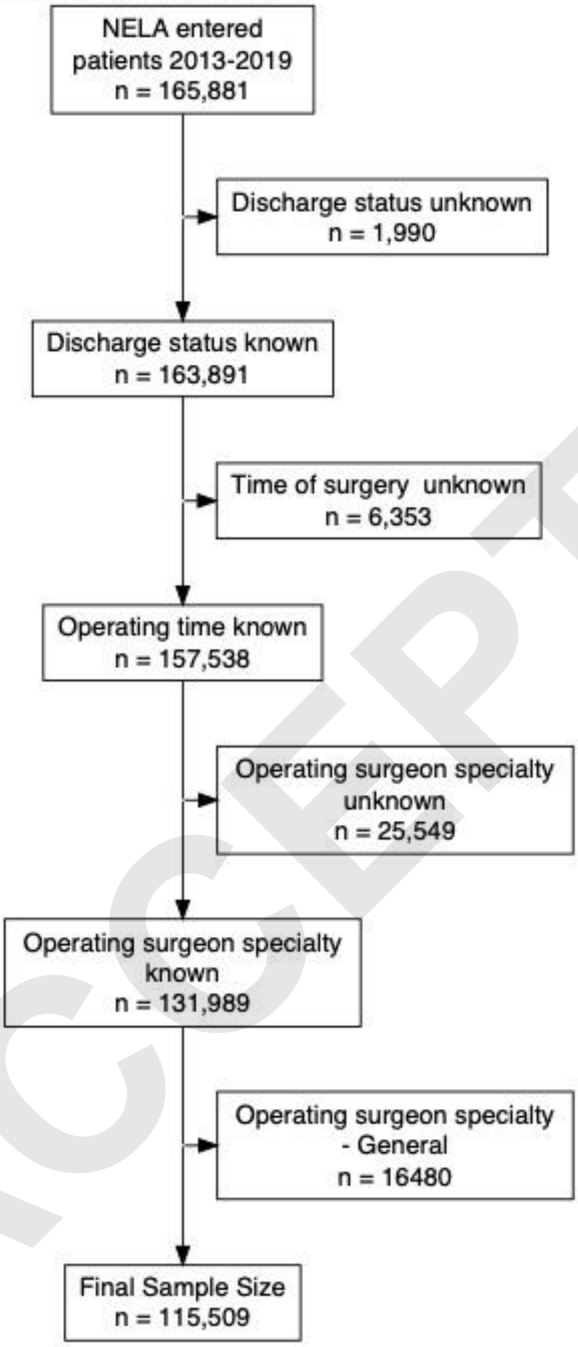


Table 1 Weighting characteristics

Patient and Treatment Details	Disease Characteristics
Patient age	Actual blood boss
	Degree of peritoneal soiling
Gender	Presence of malignancy
	P-POSSUM predicted mortality
Procedure	
Operator Grade	
Anaesthetist Grade	
Preoperative CT performed	
Time of surgery	
Social deprivation (IMD decile)	
Surgical Approach	

Table 2 Clinicopathological characteristics before and after weighting

	Overall	Non EGS Hospital	EGS Hospital	Pre-weighting SMD	Post-weighting SMD
n	115509	109720	5789		
Female Gender	59798 (51.8)	56839 (51.8)	2959 (51.1)	0.014	0.007
Age (years)				0.047	0.002
18-29	5987 (5.2)	5671 (5.2)	316 (5.5)		
30-39	6777 (5.9)	6415 (5.8)	362 (6.3)		
40-49	11028 (9.5)	10462 (9.5)	566 (9.8)		
50-59	16792 (14.5)	15933 (14.5)	859 (14.8)		
60-69	23402 (20.3)	22197 (20.2)	1205 (20.8)		
70-79	29143 (25.2)	27788 (25.3)	1355 (23.4)		
≥80	22380 (19.4)	21254 (19.4)	1126 (19.5)		
Operation performed 0800-1700	71699 (62.1)	68092 (62.1)	3607 (62.3)	0.005	<0.001
Preoperative CT scan	99062 (86.6)	94020 (86.5)	5042 (87.8)	0.040	<0.001
Preoperative P-POSSUM predicted mortality	6.60 [2.50, 20.10]	6.60 [2.50, 20.10]	6.00 [2.50, 19.80]	0.015	<0.001
Consultant surgeon present	102486 (88.7)	97533 (88.9)	4953 (85.6)	0.100	0.004
Consultant anaesthetist present	95109 (82.3)	90530 (82.5)	4579 (79.1)	0.087	0.007
Surgical Approach				0.074	0.005
Open	95987 (83.1)	91197 (83.1)	4790 (82.7)		
Laparoscopic	9881 (8.6)	9459 (8.6)	422 (7.3)		
Laparoscopic Converted	9641 (8.3)	9064 (8.3)	577 (10.0)		
Procedure				0.070	0.009
Small bowel resection	20036 (17.3)	19003 (17.3)	1033 (17.8)		
Adhesiolysis	19573 (16.9)	18592 (16.9)	981 (16.9)		
Other	19252 (16.7)	18285 (16.7)	967 (16.7)		
Right colectomy	15338 (13.3)	14559 (13.3)	779 (13.5)		
Hartmann’s procedure	14338 (12.4)	13655 (12.4)	683 (11.8)		
Peptic Ulcer Repair	6915 (6.0)	6512 (5.9)	403 (7.0)		
Subtotal colectomy	6316 (5.5)	6028 (5.5)	288 (5.0)		
Stoma formation	5171 (4.5)	4944 (4.5)	227 (3.9)		
Left colectomy	4011 (3.5)	3786 (3.5)	225 (3.9)		
Washout only	2680 (2.3)	2553 (2.3)	127 (2.2)		
Gastric surgery -other	1879 (1.6)	1803 (1.6)	76 (1.3)		
Estimated blood loss (mL)				0.052	0.004
<100	61434 (53.5)	58226 (53.4)	3208 (55.9)		
101-500	46500 (40.5)	44285 (40.6)	2215 (38.6)		
501-999	4477 (3.9)	4264 (3.9)	213 (3.7)		
≥1000	2367 (2.1)	2264 (2.1)	103 (1.8)		
Peritoneal Soiling				0.056	0.005
No peritoneal soiling	43262 (37.6)	41205 (37.7)	2057 (35.7)		
Serous	31129 (27.0)	29444 (26.9)	1685 (29.3)		
Pus	11978 (10.4)	11401 (10.4)	577 (10.0)		
Free pus/faeces	28767 (25.0)	27330 (25.0)	1437 (25.0)		

Presence of malignancy				0.021	0.005
None	89229 (77.5)	84743 (77.5)	4486 (78.0)		
Localised	12990 (11.3)	12375 (11.3)	615 (10.7)		
Nodal	4879 (4.2)	4629 (4.2)	250 (4.3)		
Distant	8049 (7.0)	7652 (7.0)	397 (6.9)		
Index of Multiple deprivation decile	5.00 [3.00, 8.00]	5.00 [3.00, 8.00]	5.00 [2.00, 8.00]	0.159	0.099

Data presented as absolute count (%) and median (IQR) SMD – Standardised mean difference, <0.1 indicating covariate balance.

Table 3 Specialty of operating consultant

	Overall	Non EGS Hospital	EGS Hospital
	115509	109720	5789
Colorectal	71488 (61.9)	69959 (63.8)	1529 (26.4)
Oesophagogastric	25144 (21.8)	24517 (22.3)	627 (10.8)
Emergency general	8012 (6.9)	4653 (4.2)	3359 (58.0)
Hepatobiliary	4341 (3.8)	4183 (3.8)	158 (2.7)
Breast	3195 (2.8)	3106 (2.8)	89 (1.5)
Vascular	2247 (1.9)	2244 (2.0)	3 (0.1)
Endocrine	1082 (0.9)	1058 (1.0)	24 (0.4)

Data presented as absolute count (%)

Table 4 Outcomes

	Pre-Weighting			Post-Weighting		
	EGS Hospital	Non – EGS Hospital	p	EGS Hospital	Non-EGS Hospital	p
In-Hospital Mortality	10.60%	11.10%	0.26	10.80%	11.10%	0.094
ITU Length of Stay (days)	2.5	2.7	0.087	2.8	2.6	< 0.001
Length of Stay (days)	16.2	16.0	0.367	16.7	16.1	< 0.001

Table 5 Comparison of specialist Colorectal and Upper GI procedures performed

Colorectal Procedures	Non – EGS Hospital	EGS Hospital	p
n	38028	1975	
Performed by Colorectal Consultant	27280 (71.7)	606 (30.7)	<0.001
Responsible consultant Speciality			<0.001
Breast	941 (2.5)	22 (1.1)	
Colorectal	27280 (71.7)	606 (30.7)	
Emergency General	1521 (4.0)	1127 (57.1)	
Endocrine	281 (0.7)	5 (0.3)	
Hepatobiliary	933 (2.5)	36 (1.8)	
Oesophagogastric	6340 (16.7)	177 (9.0)	
Vascular	732 (1.9)	2 (0.1)	

Upper GI Procedures	Non – EGS Hospital	EGS Hospital	p
n	8315	479	
Performed by Upper GI Consultant	2912 (35.0)	72 (15.0)	<0.001
Responsible consultant Speciality			<0.001
Breast	286 (3.4)	14 (2.9)	
Colorectal	4076 (49.0)	77 (16.1)	
Emergency General	336 (4.0)	286 (59.7)	
Endocrine	87 (1.0)	2 (0.4)	
Hepatobiliary	426 (5.1)	28 (5.8)	
Oesophagogastric	2912 (35.0)	72 (15.0)	
Vascular	192 (2.3)	0 (0.0)	

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1 (Abstract)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1 (Abstract)
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1 -2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4-5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4
Bias	9	Describe any efforts to address potential sources of bias	5

Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5-6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	5
		(*e*) Describe any sensitivity analyses	6

Results

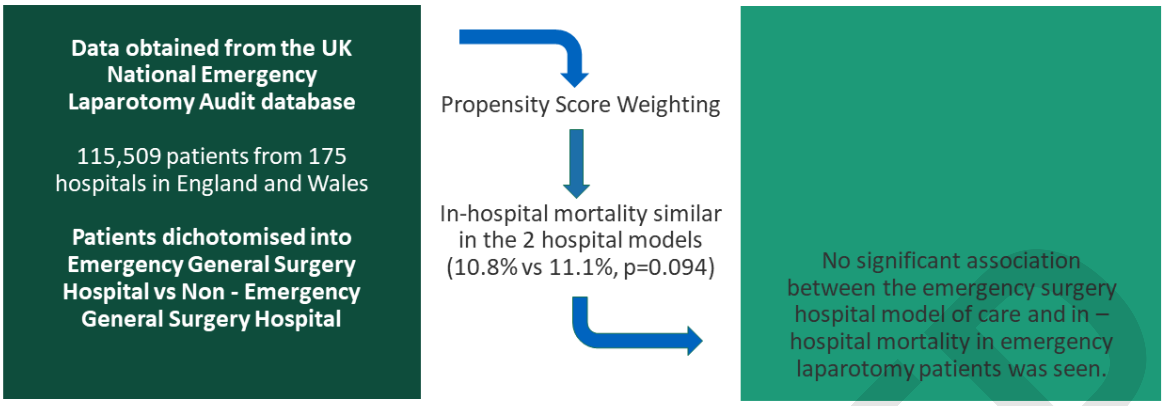
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	5
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	5-7
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	7
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	7
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders	7

		were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11-12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	N/A

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Comparison of major abdominal emergency surgery outcomes across organisational models of emergency surgical care: analysis of the UK NELA national database



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