

CLINICAL PRACTICE

Mortality of emergency general surgical patients and associations with hospital structures and processes

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Abstract

Background: Variations in patient outcomes between providers have been described for emergency admissions, including general surgery. The aim of this study was to investigate whether differences in modifiable hospital structures and processes were associated with variance in mortality, amongst patients admitted for emergency colorectal laparotomy, peptic ulcer surgery, appendicectomy, hernia repair and pancreatitis.

Methods: Adult emergency admissions in the English NHS were extracted from the Hospital Episode Statistics between April 2005 and March 2010. The association between mortality and structure and process measures including medical and nursing staffing levels, critical care and operating theatre availability, radiology utilization, teaching hospital status and weekend admissions were investigated.

Results: There were 294 602 emergency admissions to 156 NHS Trusts (hospital systems) with a 30-day mortality of 4.2%. Trust-level mortality rates for this cohort ranged from 1.6 to 8.0%. The lowest mortality rates were observed in Trusts with higher levels of medical and nursing staffing, and a greater number of operating theatres and critical care beds relative to provider size. Higher mortality rates were seen in patients admitted to hospital at weekends [OR 1.11 (95% CI 1.06–1.17) $P < 0.0001$], in Trusts with fewer general surgical doctors [1.07 (1.01–1.13) $P = 0.019$] and with lower nursing staff ratios [1.07 (1.01–1.13) $P = 0.024$].

Conclusions: Significant differences between Trusts were identified in staffing and other infrastructure resources for patients admitted with an emergency general surgical diagnosis. Associations between these factors and mortality rates suggest that potentially modifiable factors exist that relate to patient outcomes, and warrant further investigation.

Key words: healthcare delivery; health resources; health services research; outcome

Patients undergoing emergency general surgery, especially those undergoing intra-abdominal operations, are at high-risk of poor postoperative outcomes.^{1,2} The variability in the quality of care delivered and the outcomes from emergency admissions and operations is of growing concern.^{3,4} The Royal College of Surgeons of

England (RCS) has highlighted this variability and proposed a care bundle which addresses many of the perceived deficiencies, but also highlights the paucity of high quality data on the care of the higher risk general surgical patient.⁵ The Enhanced Peri-Operative Care for High-risk patients (EPOCH) study, currently

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Editor's key points

- Levels of clinician seniority and staffing, and other resources, are likely to impact on outcomes of care, particularly in the emergency setting.
- This study has identified variation in risk-adjusted mortality of emergency general surgical patients associated with modifiable structures and process.
- Evidence-based structured pathways and appropriate resources are needed to improve perioperative surgical care.

underway in the UK, aims to assess the impact of implementation of a modification of this perioperative care pathway, for patients undergoing emergency laparotomy.

There are also national efforts underway in England and Wales to audit general surgical emergency practice and link outcomes to structures and processes of care. Conducted by the National Institute of Academic Anaesthesia's Health Services Research Centre, the National Emergency Laparotomy Audit (NELA) organizational audit, identified inter-institutional variation in structure and process measures including critical care bed provision, availability of imaging and interventional radiology, emergency theatre provision, and patterns of staffing. An individual patient audit of all adults undergoing emergency laparotomy in NHS Hospitals in England and Wales commenced in December 2013 and the first report will be published in the second half of 2015.

Variation in healthcare resource availability and utilization is well established in the UK.⁶ In the USA, a number of structure and process factors have been shown to affect patient outcomes, across disparate specialities in individual hospitals.⁷ Although our understanding remains incomplete, this observation does suggest that structural and process factors may be relevant at a provider level,^{8–10} including 'failure-to-rescue' (FTR).¹¹ The National Confidential Enquiry into Patient Outcome and Death (NCEPOD) and the RCS have highlighted staff numbers and seniority as particularly important in reducing variations in outcome.

The primary aim of this study was to identify whether modifiable structures and processes within NHS Trusts (hospital systems) in England were associated with mortality in patients undergoing emergency general surgery or admitted with pancreatitis.

Methods

The reporting of this study conforms to the STROBE statement. Ethical approval for studies using Hospital Episode Statistics (HES) database extracts by our unit has previously been sought and we have confirmation that it was not required (Wandsworth Research Ethics Committee).

Emergency general surgery cohort

Patient and outcome data were obtained from the HES database from 1st April 2005 to 31st March 2010. The HES data warehouse is an administrative database that records the details of every patient admission in England and holds patient-level data on patient characteristics, comorbidities, and social deprivation indices.

We extracted relevant data for all emergency admissions to each Trust categorized into a number of predefined clinical groups. These patient groups covered a spectrum of emergency general surgical procedures (appendicectomy, hernia repair, colorectal laparotomy, peptic ulcer surgery) and acute pancreatitis. The outcomes of this cohort have been previously published along with

details of patient selection.¹⁰ The groups were analysed as an amalgamated emergency general surgical dataset. Patient selection was based on the primary procedural code (Office of Population, Census and Surveys-Version 4, OPCS-4), with the exception of pancreatitis, where selection was based on primary diagnostic code (International classification of diseases-Tenth Revision, ICD-10) as this condition is the most frequently managed non-operative surgical condition (Supplementary data Appendix 1).

Outcomes: death

The primary outcome measure was 30-day mortality; 90-day mortality was a secondary outcome measure; both were determined from the Office of National Statistics (ONS) Registry linkage to HES records.

The confounding effect of inter-hospital transfer on mortality rates was accounted for as patients can be tracked between providers within HES. Concurrent admissions were linked and the ultimate outcome was assigned to the index hospital (super-spells), which provides the most accurate reflection of death rate. The outcome was attributed to the index hospital Trust, defined as the Trust in which the operation was undertaken for patients who had surgery, with the exception of pancreatitis where the initial hospital of admission was used.

Outcomes: complications and failure to rescue

To aid understanding of the underlying mechanisms by which death rates vary across institutions a *post hoc* analysis of 30-day complication and FTR rates was performed comparing trust mortality categories. Complications were considered binary outcomes. Both surgical complications and medical complications were included using respectively OPCS-4 and ICD-10 codes (Supplementary data Appendix 2). Further details of the methodology used have been published previously.¹² FTR was defined as the number of deaths after a complication divided by the number of patients with a complication.

Structure and process factors

Structure and process data were collated from the Department of Health, Health and Social Care Information Centre (HSCIC) and NHS England databases.^{13–15} The variables selected for inclusion in the analysis encompassed aspects of staffing, critical care and operating theatre availability, radiology utilization, and teaching status, including those in the NHS Trust Development Authority accountability framework for NHS Trust boards and the World Health Organization standardized surgical metrics.^{16,17} The variables included in the analysis consisted of total doctors, total doctors in general surgery, consultant doctors in general surgery, senior house officers in general surgery, house officers in general surgery, total nurse staffing, total critical care beds, operating theatres, MRI usage, CT usage, total ultrasound, total fluoroscopies, total senior house officers and total house officers, teaching status and weekend vs weekday admission.

Where appropriate, numerical factors were scaled as either per hospital bed or annual emergency general surgical admission caseload (general surgical staffing variables), in order that relative differences between Trusts could be ascertained. Numerical variables were further categorized into tertiles for ease of interpretation. Hospitals were classified as teaching hospitals if they had a direct and specific link with a member of the Medical School Council in England. Analysis was performed at NHS

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