

Original Research Article

Frailty associated with poor outcomes after emergency laparotomy

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ABSTRACT

Background: Emergency laparotomy is a morbid and mortal operation that is often performed as a lifesaving treatment in the acutely unwell surgical patient. This study assessed morbidity and mortality in patients undergoing emergency abdominal surgery in an Australian metropolitan hospital to improve our understanding of factors that are associated with perioperative outcome.

Methods: Patients were identified from a high-volume institution between 01 March 2018 and 01 February 2022. Baseline, operative and postoperative parameters were collected and analysed for associations with significant complications, defined as Clavien-Dindo (CD) scores of 3 or greater, using a binary logistic regression.

Results: Independent predictors of $\geq$ CD 3 complications were female sex ($p=0.02$, OR: 2.36 (95% CI 1.10, 5.05)) and frailty ($p=0.03$, OR: 2.30 (95% CI 1.03, 5.13)). Mortality rate in our cohort was 3.5%. Twelve of 13 deceased patients were female, all were frail and were of advanced age (mean 83.1 years).

Conclusions: An improved recognition of frailty and the assessment of frailty in the acutely unwell surgical patient requiring an emergency laparotomy is required to aid perioperative assessment and decision making.

Keywords: Emergency surgery, Laparotomy, Frailty, Mortality, Morbidity

INTRODUCTION

Emergency laparotomy is a common surgical procedure and carries with it high rates of morbidity and mortality.^{1,2} As a result of this, many risk stratification systems have been developed to improve patient outcomes in those who undergo an emergency laparotomy.³ The most successful of these is the National Emergency Laparotomy Audit (NELA) in the United Kingdom (UK), which was first launched in 2015 by the Royal College of Anaesthetists. It was designed to provide data that aimed to enhance quality improvement standards for all emergency laparotomy patients by assessing hospital compliance with established standards of care.³

Since its inception, 30-day mortality, unplanned return to theatre and unplanned ICU admission rates have all steadily fallen with each subsequent annual audit.⁴

Given its success, the Australian and New Zealand Emergency Laparotomy Audit (ANZELA) was formed in 2016. Whilst it has also yielded invaluable information, its dissemination across Australian hospitals has not been as successful as its UK counterpart.⁵ An ANZELA pilot study that looked at 2755 emergency laparotomy patients over two years, between 2018-2020, across 24 hospitals in Australia, found overall in-hospital mortality was 7.1%, compared to a literature mortality of between 7-9% in Australia, for patients undergoing emergency laparotomy.⁵ It did not, however, provide an in-depth analysis of patient characteristics and outcomes. Compliances it found lacking included routine postoperative ICU admissions for high-risk patients and involvement of a geriatric service for elderly patients undergoing an emergency laparotomy.

Thus far, the data suggests that patient factors associated with poorer outcomes in emergency laparotomy patients include increasing age and American Society of

Anaesthesiologists (ASA) grade of three or above. Non-patient factors include consultant surgeon input to decision making and operating, increased surgeon to patient ratios and access to higher level care.^{4,6,7} This retrospective study, at a high-volume institution, seeks to examine the perioperative and postoperative characteristics and outcomes of patients undergoing emergency laparotomy, using NELA as a framework. With these data, we aimed to evaluate morbidity and mortality outcomes and their contributing factors.

METHODS

Patient selection

Ethics approval was attained from the Metro South Health Human Research Ethics Committee (LNR/2020/QMS/62457). Patients aged 18-year-old or older, who underwent emergency abdominal operations at Queen Elizabeth II Jubilee Hospital (QEII) in Brisbane, Queensland, Australia between 01 March 2018 and 01 February 2022 were identified and included in this retrospective study. All patients undergoing an emergency operation during the study period were first identified. Exclusion criteria was based on that used by NELA and excluded any patients who underwent an operation in which the primary surgery did not involve the abdomen or involved the appendix, pancreas, spleen, oesophagus or gallbladder.⁸ Patients who underwent emergency hernia repair were also excluded unless they underwent a concurrent bowel resection or adhesiolysis. All diagnostic laparotomies/laparoscopies without a subsequent procedure (unless the reason for not proceeding was inoperable pathology), vascular, obstetric, gynaecological and organ transplantation procedures were also excluded. All duplicates or subsequent procedures for a given patient were excluded.

Data collection

Patient data were collected from the hospital's electronic medical records and entered into Microsoft Excel. Demographic variables collected were age, sex and preadmission location. Preoperative variables included time of triage, time of admission, time of decision to operate, time to first dose of intravenous (IV) antibiotics, whether sepsis was suspected on arrival and at time of surgery, time of cross-sectional imaging, whether the patient was trialled on conservative management, patient clinical frailty score (CFS) (if not formally documented, this was inferred by a single observer based on assessment of patient's functional status in their clinical notes), consultant surgeon involvement in patient assessment and ASA score. Baseline bloods, vitals, cardiorespiratory history and emergency surgery category (category A represents patients who require surgery within an hour, B within four hours, C within 24 hours and D within ten days) were also recorded. Mortality and morbidity risks were calculated using the P-POSSUM tool, a commonly used perioperative risk calculator that has been verified for

Australian emergency laparotomy patients.^{1,9} NELA do not make their risk calculator publicly available, so the perioperative risks were not able to be calculated using the NELA modelling.

Intraoperative data included most senior operator present at time of surgery, procedure performed, indication of surgery, stoma formation, surgical approach (laparoscopic, converted to open or open) and peritoneal contamination. Postoperative data included postoperative destination (ward versus ICU/HDU), length of stay in ICU, return to theatre, complications (including Clavien-Dindo (CD) classification), length of stay (LOS), discharge location and time to next follow up.¹⁰

For analysis, diagnoses were grouped into five categories: viscus perforation, intestinal obstruction, intestinal ischaemia, intrabdominal abscess/peritonitis and other. Intestinal obstruction included gastric and caecal volvulus, as well as intussusception. Surgeries were divided into six categories: small bowel resection, large bowel resection, repair of intestinal perforation, adhesiolysis, abscess drainage and other. Procedures classed as 'other' primarily included reduction of volvulus, para-oesophageal hernia repair and removal of foreign body.

Statistical analysis

Statistical analysis was performing using the statistical package for the social sciences (SPSS) statistics programs for Windows version 8 (IBM Corporation, NY, USA). Categorical data were expressed as frequency and percentage, whereas continuous data were expressed as mean and standard deviation (SD). χ^2 tests were used for univariate analysis. Univariate analysis was used to identify predictors of severe complications, defined as CD grade III-V. Variables with a $p < 0.10$ were then analysed using multivariate binomial logistic regression. All tests were two-sided with a $p < 0.05$ considered significant. Several non-dichotomous categorical and continuous variables were grouped dichotomously for simplicity of presentation and biological plausibility, including age, which was grouped according to being greater or less than the median.

RESULTS

Patient demographics

During the study period from 01 March 2018 to 01 February 2022, 371 patients met the inclusion criteria. The study population comprised of 182 males (49.1%) and 189 females (50.9%) with a mean age of 64.0 years and median age of 66 years (SD=17.2). Three hundred and fifty-three patients (95.1%) presented from home. Eighty-nine patients (24.0%) had their operation more than twenty-four hours after their admission. Two-hundred and seventeen patients (58.5%) had an ASA score of III-IV and 102 (27.5%) patients were anaemic preoperatively.

Table 1: Patient characteristics.

Characteristic	N (%)
Total patients	371
Male	182 (49.1)
Age (mean (SD))	64.0 (17.2)
More than 4 hours to CT scan	120 (32.3)
Pre-admission location	
Home	353 (95.1)
Independent living unit	6 (1.6)
Nursing home	9 (2.7)
Other	1 (0.3)
Admit out of hours	127 (34.2)
Time to surgery >24 hours	89 (24.0)
Sepsis pre-op	35 (9.4)
ASA>2	217 (58.5)
Frail (CFS>3)	114 (30.7)
Pre-op anaemia	102 (27.5)
Haemoglobin (mean (g/l) (SD))	131.9 (25.7)
WCC>11	180 (48.5)
Cardiac disease	148 (39.9)
Respiratory disease	89 (24.0)
P-POSSUM mortality >20%	55 (14.8)
P-POSSUM morbidity >50%	244 (65.8)
Surgery indication	
Perforation	97 (26.1)
Obstruction	217 (58.5)
Ischaemia	13 (3.5)
Intra-abdominal infection/abscess	32 (8.6)
Other	12 (3.2)
Surgery type	
SB resection	73 (19.7)
LB resection	123 (33.2)
Repair of intestinal perforation	25 (6.7)
Adhesiolysis	119 (32.1)
Abscess drainage	3 (0.8)
Other	28 (7.5)
Approach	
Laparoscopic	167 (45)
Open	204 (55)
Converted to open	73 (35.7)
Soiled abdomen	110 (29.6)
Stoma	81 (21.8)
Emergency category	
A	6 (1.6)
B	230 (62)
C	134 (36.1)
D	1 (0.3)
Transferred from other facility	16 (4.3)
Trial of conservative management	141 (38)

One-hundred and fourteen (30.7%) patients had a CFS of four or greater (classified as 'frail' in the analysis) and 89 (24.0%) patients had documented cardiac and respiratory comorbidities respectively. Ninety-seven (26.1%) patients underwent surgery for a viscus perforation, 217 (58.5%)

for obstructive pathology, 13 (3.5%) for enteric ischaemia, 32 (8.6%) for intrabdominal abscess formation or peritonitis and 12 (3.2%) presented with another pathology. Table 1 further outlines patient characteristics.

Operative characteristics

The most common operation was adhesiolysis – 119 (32.1%) patients underwent this procedure. One hundred and forty-one (38%) patients were initially trialled with conservative management, the vast majority with adhesional small bowel obstructions who ultimately underwent an adhesiolysis ± small bowel resection.

In terms of urgency of operations, the vast majority of patients were either category B or C, 62% and 36.1% of patients respectively. Six (1.6%) patients were classed as category A. All category A patients presented in septic shock from bowel perforation.

Two hundred and forty (64.9%) patients initially underwent laparoscopic surgery, 73 (30%) were subsequently converted to open. Two-hundred and four (55%) patients underwent open procedures. All baseline patient data are outline in Table 1.

Postoperative outcomes

The mean LOS was 10.4 days (SD=8.7). Complications were observed in 115 (31.0%) patients, with 42 (11.3%) patients suffering a Clavien-Dindo III or greater complication. Twenty-four patients (6.5%) had to return to theatre for postoperative complications. Thirty-two (8.6%) were discharged to a residential aged care facility who weren't previously residing in one. The mortality rate amongst our patient population was 3.5% (n=13). The mean age of our mortalities was 83.1 (SD=6.5) and the mean number of days post-operatively that death occurred was 19.6 (SD=28.9). This includes one patient who died 110 days post operatively, after a prolonged stay and slow decline following a laparotomy and small bowel resection for a perforated segment of ischaemic ileum. Excluding this patient, the mean postoperative days to death was 12.1 (SD=10.16). The most common cause of death was multiorgan failure after a bowel resection. All patients had an ASA of 3 or greater and only 1 patient was not classified as frail (7.7%). Table 3 outlines the mortalities, and all postoperative complications are outlined in Table 2.

Univariate analysis was performed for predictors of severe complications (Clavien-Dindo of III or greater). On univariate analysis, female sex (p=0.005), frailty (p<0.001), anaemia (p=0.045), cardiac disease (p=0.02) and respiratory disease (p=0.02) were significant. Multivariate binomial logistic regression revealed female sex and frailty as independent factors associated with severe postoperative complications (p=0.03, OR=2.36, 95% CI: 1.10, 5.05 and p=0.04, OR=2.30, 95% CI: 1.03, 5.13 respectively). Table 4 outlines the complete statistical analysis.

Table 2: Post-operative outcomes.

Outcome	n (%)
ICU postop	152 (41)
Complications	
Total	115 (31)
Clavien-Dindo 3 or more	42 (36.5)
Complication type	
Leak	2 (1.7)
Collection	11 (9.6)
Perforation	1 (0.9)
Obstruction	8 (7.0)
Ileus	18 (15.7)
Wound complication	22 (19.1)
Pneumonia	7 (6.1)
Sepsis	4 (3.5)
Multiorgan failure	9 (7.8)
Stoma complication	2 (1.7)
Other	31 (27.0)
Death	13 (3.5)
Return to theatre	24 (6.5)
Length of stay (days (mean) (SD))	10.4 (8.7)
Discharge destination different to preadmission	32 (8.6)

Table 3: Mortalities summary.

Outcome	n (%)
Total	13
Age (mean (SD))	83.1 (6.5)
Female	12 (92.3)
Indication	
Perforation	2 (15.4)
Ischaemic gut	2 (15.4)
Obstruction	8 (61.5)
Intraabdominal infection/asbcess	1 (7.7)
Surgery	
SB resection	2 (15.4)
LB resection	6 (46.2)
Adhesiolysis	2 (15.4)
Other	3 (23.1)
Cause of death	
Ischaemic gut	2 (15.4)
Multiorgan failure	4 (30.8)
Disseminated colorectal malignancy	2 (15.4)
Cardiac event	2 (15.4)
Sepsis	1 (7.7)
Liver failure	1 (7.7)
Aspiration pneumonia	1 (7.7)
Days post-op (mean (SD))	19.6 (28.9)

Table 4: Analysis for Clavien-Dindo III or greater complication.

Characteristics	n (%)	Univariate p	Multivariate p	OR (CI)
Male	12 (6.6)			
Female	30 (15.9)	0.005	0.02	2.36 (1.10, 5.05)
Age >66 (median)	184 (49.6))	0.09	0.4	0.65 (0.27, 1.62)
ASA>2	16 (7.4)	0.4		
Admitted out of hours	11 (8.7)	0.2		
Frail	24 (21.1)	<0.001	0.03	2.30 (1.03, 5.13)
Time to surgery >24 hours	15 (16.9)	0.06	0.5	1.36 (0.63, 2.92)
Consultant scrubbed	24 (15.0)	0.05	0.05	2.00 (0.99, 4.02)
Laparoscopic approach	13 (7.8)	0.05	0.1	0.56 (0.26, 1.21)
WCC>11	23 (12.8)	0.4		
Anaemia	17 (16.7)	0.045	0.2	1.66 (0.80, 3.42)
Cardiac disease	24 (16.2)	0.02	0.4	1.32 (0.61, 2.88)
Respiratory disease	16 (18.0)	0.02	0.8	0.93 (0.40, 2.16)
Sepsis	5 (14.3)	0.6		
Stoma	12 (14.8)	0.3		
Transfer from another centre	1 (6.3)	0.5		
Trial of conservative management	18 (12.8)	0.4		

DISCUSSION

We conducted a comprehensive evaluation of emergency laparotomies at a high-volume institution. Our study identified that frail patients undergoing emergency laparotomy are significantly more likely to have poor outcomes. Understanding this enables surgeons to make

timely decisions and have timely discussions, with both patient and their families, around the surgical management of frail patients presenting with an acute abdomen. It also showed favourable mortality outcomes, demonstrating that judicious patient selection can aid in better outcomes and avoid a futile operation that result in more suffering to the elderly patient.

Frailty and female sex were both identified as significantly associated with CD III or greater complications (major complications) ($p=0.03$ and $p=0.02$ on multivariate analysis respectively). Frailty as an independent risk factor for poor outcomes in emergency laparotomies is well documented and the reasons for this are well understood. A retrospective review of 191 patients who were assessed using the CFS before emergency laparotomy in the UK between 2018-2021 revealed an odds ratio of 9.33 for 30-day all-cause mortality for patients scoring 4 or greater, and there are many other papers showing a significant association between frailty and poor outcomes.¹¹⁻¹³ Frail patients have decreased physiological reserve and function across multiple organ systems, independent of their comorbidities, and a resultant maladaptive response to stress. As such, a large insult, such as an emergency laparotomy, can cause an irreversible derangement in physiology that otherwise have been reversible for someone with greater reserve.¹¹

Interestingly, age, whilst trending to significant on the univariate analysis ($p=0.09$), was not significant when allowing for other factors ($p=0.4$). This supports the widely held notion that physiological frailty is more important when assessing a patient's ability to tolerate major surgery, rather than chronological age. This is supported by several geriatric studies, which have found multiple comorbidities and frailty to be interrelated and associated with poor outcomes across all presentation types.¹⁴⁻¹⁶ Whilst the CFS is a commonly used marker of frailty, a 2021 study examining multiple imaging modalities identified osteopenia as the best radiological perioperative risk marker for poor outcomes after emergency laparotomy.¹⁷ The development of objective frailty assessment tools remains an area of future development and will become increasingly relevant in an ageing population.

The reason for female sex being significantly associated with worse outcomes in our laparotomy patients is less clear. One possible explanation is that, given women are less likely to be comorbid at similar ages as men,¹⁸ they may be more likely to be offered surgery at more advanced ages. The difference in age between females and males, in our data, was significant (67.6 versus 60.35 years, $p<0.001$), which may explain the discrepancy. A retrospective analysis of 512 emergency general surgery admission in two Canadian Hospitals, done in 2019, found that women were more likely to be treated conservatively than men.¹⁹ This could suggest that women may present with more complicated surgical conditions, and thus be at greater risk of complications, if they are presenting after failed conservative management. Therefore, as women tend to live until an older age, their presentation with an acute abdomen requiring emergency laparotomy may result in poor physiological reserve and function to tolerate the surgical insult, hence this may explain its association with a poorer outcome.

Pre-operative anaemia and cardiorespiratory comorbidities were significant for major complications on univariate analysis but were all found to not be significant on the multivariate analysis. Other studies have found all these variables to be significantly associated with poor outcomes following emergency laparotomy. This re-emphasises the impact clinical frailty has on poor patient outcomes, given other major comorbidities don't appear to be as reliable risk factors for worse outcomes, and the importance of its consideration by surgeons when considering patients for emergency laparotomy.^{20, 21}

The presence of a consultant surgeon at the time of operation trended to significant on both univariate and multivariate analyses ($p=0.05$). Other studies have shown a lack of consultant presence at surgery to be significantly associated with worse laparotomy outcomes.^{4,6,7} Critically unwell patients require a high level of senior input, especially when being taken to theatre emergently. Often these patients can present haemodynamically unstable, presenting a high anaesthetic risk, as well as with challenging pathology. Having the most experienced operator present at the time of the operation can help ensure that operating time is not excessive, safe, appropriate decision are made intraoperatively and technical challenges are met with greater success. In our unit, emergency operations are primarily led by first year surgical fellows and consultant attendance often reflects an anticipated difficult case or intraoperative complications. Therefore, in our dataset, the presence of a consultant surgeon trended towards being potentially associated with poorer outcomes, indicating a more complex operation.

Open surgery also trended to significance on the univariate analysis ($p=0.05$) but was insignificant when accounting for other factors ($p=0.14$). Papers have shown patients undergoing laparoscopic vs open approach for adhesional SBO and perforated peptic ulcers have significantly better outcomes, with lower complication rates and mortality.^{22,23} An analysis of the NELA database in 2022 showed risk-adjusted mortality for emergency bowel surgery is lower for laparoscopy compared with open surgery, and that the P-POSSUM and NELA scores overpredict mortality for laparoscopic emergency abdominal operations.²⁴ Based on our results, as well as the current literature available, it is acceptable to conclude that laparoscopy is associated with improved perioperative outcome in the acute abdomen and it would be considered reasonable to attempt a minimally invasive approach, where clinically feasible, for emergency laparotomy patients.

Our patient dataset had a favourable mortality rate of 3.5%, compared to a literature mortality of 7-9%.⁵ With only 13 mortalities, it is too small a dataset to formally perform subgroup analyses. However, 12 of 13 patients had CFS of 4 or greater and all had an ASA of 3 or greater. They also had more serious surgical pathology, with most patients suffering ischaemic bowel or a large bowel obstruction secondary to cancer. This supports the trend in our data that frail patients suffered worst outcomes.

This study had several limitations, firstly that the data was retrospectively collected. This is why databases, such as NELA, have been so pivotal, given they are prospectively collected. Our data did not include operation time, which has been shown to be associated with worse outcomes for all surgical patients.²⁵ Our statistical analyses also did not consider the variety of pathologies and operations contained within the data, which may have impacted the outcomes of our patients.

CONCLUSION

This study demonstrates that frailty is the most reliable indicator of poor outcomes following emergency laparotomy and this is well supported by previous literature. Female sex was associated with poor outcomes. Our findings emphasise the importance of recognising frail patients presenting with an acute abdomen, to encourage early involvement of perioperative medical and geriatric services and to lower thresholds for having senior surgeon presence in the operating theatre. The development of a quick, robust, and objective frailty assessment tool will be increasingly useful in managing the risks of the elderly patient with an acute surgical pathology.

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