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Original Research

Mortality after emergency abdominal surgery in a non-metropolitan Australian centre

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Abstract

Objective: *Emergency abdominal surgery has poorer outcomes and higher mortality rates, compared with elective surgery. Serious morbidity or mortality occurs in up to 40% of patients. No information is available with regard to the outcome of patients undergoing emergency abdominal surgery in rural Australia.*

Methods: *Patients undergoing emergency abdominal surgery in a 110-bed rural surgical centre in South Australia over a 5 year period (January 2010–December 2014) were included in the study. Patient data were retrieved using the hospital database and review of patient records.*

Results: *A total of 4396 general surgical emergency admissions was recorded. Emergency admissions without intervention, endoscopic intervention only, appendectomy, cholecystectomy or urological or gynaecological diagnoses were excluded from mortality analysis. The remaining 237 patients underwent major abdominal emergency surgery for bowel obstruction (benign and malignant:* n = *143, 60%), injury/inflammation/perforation/peritonitis (*n = *85, 36%) or haemorrhage/ischaemia (*n = *9, 3.8%). Thirty- (*n = *9) and 90- (*n = *12) day mortality rates were 3.8% and 5.1%, respectively.*

Conclusion: *Emergency abdominal surgery can be safely provided in non-metropolitan Australian centres, with a low 30-day mortality rate of 3.8% and a 90-day mortality rate of 5.1%. This compares well with results published by other national and international investigators.*

KEY WORDS: *abdominal surgery, emergency surgery, laparoscopy, laparotomy, outcomes, rural surgery.*

Introduction

Patients who undergo emergency gastrointestinal surgery suffer from a fivefold higher 30-day mortality rate[1] compared to other emergency surgery. Furthermore, complication rates have been reported to exceed 50%.[2] Thirty-day mortality rates of 11–15% are commonly reported[3–6] and these are known to far exceed the low mortality rates of elective major general surgical procedures.

In Australia, there is currently no national audit on general surgical outcomes, let alone one that looks at outcomes of rural surgery. In the UK, the National Emergency Laparotomy Audit (NELA) was established to investigate the outcome of patients undergoing emergency bowel surgery in England and Wales.[3]

It has been proposed by one study to centralise high-risk emergency surgery in more densely populated countries, allowing optimised use of resources.[7] Centralisation of emergency general surgery services is not an option for large countries like Australia with a low population density in rural areas. Large distances and rough weather can make patient retrieval by road or air time-consuming and unpredictable. For example, the 'golden hour' for time to theatre in emergency trauma laparotomy has been proposed by in 1973. With South

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***What is already known on this subject*:**
- *Emergency abdominal surgery carries with it a high mortality rate, of up to 40%.*
- *Rural hospitals must provide safe and comprehensive care with sometimes limited resources.*
- *The outcomes of emergency abdominal surgery in rural general surgical units are not well documented.*

***What this study adds*:**
- *Provision of emergency abdominal surgery can be safely provided in a rural setting, with a 30-day mortality rate of 3.8%.*
- *The 30-day mortality rate in rural general surgical units can match those of metropolitan centres.*
- *The safe provision of emergency general surgical care in rural settings requires the support of a metropolitan centre for up-transfer when required.*

Australia spanning over 984 000 Km^2 and centralisation of trauma services in its capital, Adelaide, achieving this golden hour would be impossible for patients in most non-metropolitan areas of the state.

However, the outcomes of rural emergency general surgery must be audited and should meet the results published by other groups.[3–5,8,9] To date, there has been little focus on the results of rural general surgical emergency procedures.

This article investigates the outcomes of abdominal emergency surgery in a rural Australian centre and compares the results to those reported from metropolitan centres.

Methods

Setting

Mount Gambier General Hospital is a 110-bed hospital, which serves the lower south-eastern part of South Australia. This includes the city of Mount Gambier, which has a population of 28 000, and surrounding small towns and farming districts. General surgical services are provided by four consultants and one accredited registrar and include oncology, trauma and elective services.

The hospital provides 100% consultant on-call availability for general surgery, anaesthesia, general medicine and radiology. There is 24 h access to operating theatres and radiology. Perioperative care is provided in either a surgical ward or in a high dependency unit (HDU) with availability of invasive ventilation and one-on-one nursing. There is a close working relationship with The Queen Elizabeth Hospital in Adelaide (340 beds) for cases requiring intensive care unit (ICU) care.

Data collection

Patient information involving any emergency general surgery during the 5-year time period between January 2010 and December 2014 was retrieved from the hospital database (Country Data Mart, Country Health SA, Adelaide, South Australia) and retrospectively analysed (Microsoft Excel; Microsoft Corporation, Redmond, WA, USA and SigmaStat 3.5; Systat Software, San Jose, CA, USA). Cases included admissions via the Emergency Department, transfers from other units within the hospital and direct admissions from other hospitals. Cases were compared with operator logbooks and records to avoid missing cases incorrectly coded.

A total of 4396 emergency general surgical admissions were identified during the 5 year study period (1/1/2010 to 31/12/2014). This represented 46% of all general surgical admissions during this time period (excluding elective day surgery admissions). Emergency admissions without intervention, endoscopic intervention only or appendectomy and cholecystectomy were excluded from mortality analysis. Cases were excluded where there was hernia repair without bowel resection or where a diagnostic laparoscopy or laparotomy was performed with no subsequent procedure. This was in keeping with the National Emergency Laparotomy Audit (UK), which included all surgery that was urgent, emergency or expedited, and on the gastrointestinal tract. Both laparoscopic and open abdominal surgical cases were included, which encompasses procedures, such as bowel resection and repair.

Data analysis

Data were analysed with respect to demographics, principal diagnosis, management and outcome. Statistical analysis was performed using single-group, as well as log-rank testing. Group comparison was carried out by using χ^2-test, *t*-test and rank-sum test. Results were presented as median (where appropriate for non-normally distributed data), mean and standard error of the mean. A *P*-value of <0.05 was considered statistically significant. A 90-day mortality rate was chosen as an additional endpoint since it has been reported to better reflect the true mortality rate after abdominal surgery.[10,11]

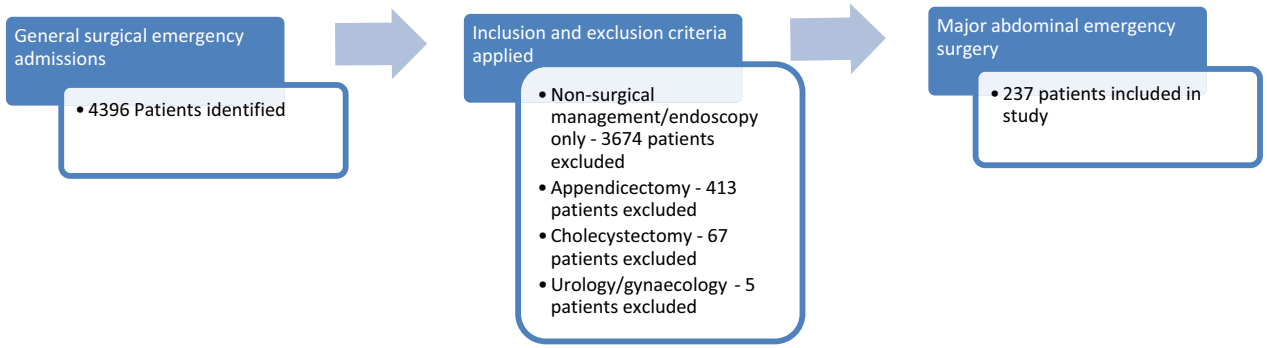

FIGURE 1: *Patient selection process.*

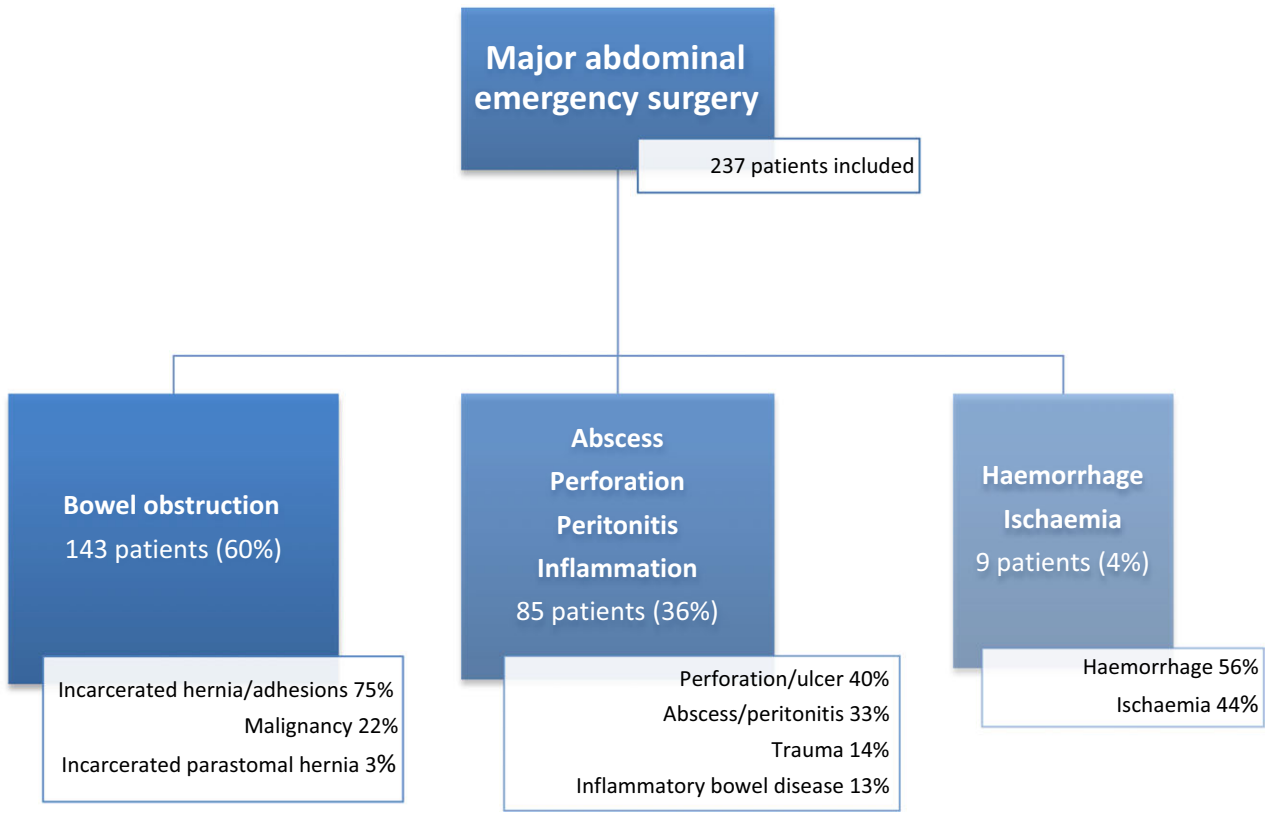

FIGURE 2: *Overview of diagnoses and management.*

Ethical approval

This research was granted exemption from the ethical review process by the Flinders University Institutional Review Board as it was viewed to be of negligible risk (Application Number 425.15).

Results

Patient selection

There was a total of 4396 emergency general surgical admissions during the 5-year study period (01/01/2010 to 31/12/2014; Figs 1, 2). This amounted to 46% of the total 9556 general surgical admissions (day surgery not included). As described in the Methods section, NELA inclusion and exclusion criteria were used as a guide to choosing cases for analysis in this article.

The majority of general surgical emergency admissions (n = 3674, 83.6%) did not require major emergency surgery and were excluded from mortality analysis. A total of 413 patients (9.4% of all emergency admissions) underwent appendectomy and 67 patients (1.5%) underwent emergency cholecystectomy. Five patients underwent emergency surgery for urological or

TABLE 1: *Overview of patients included in study*

Characteristic	Mean	Standard error of the mean	Median
Age (years)	58.3	1.3	62
Length of admission (days)	8.4	0.6	6
Follow-up (months)	35.9	1.2	34

gynaecological indications. No mortality was observed in any of these groups and they were excluded.

The remaining 237 patients underwent major abdominal emergency surgery and the mortality analysis was based on these patients only. Emergency surgery was performed for the treatment of bowel obstruction (benign and malignant: $n = 143$, 60%), injury/inflammation/perforation/peritonitis ($n = 85$, 36%) or haemorrhage/ischaemia ($n = 9$, 4%).

Patient demographics

The mean patient age was 58.3 years (±1.3) with a range from 9 to 94 years (Table 1). After excluding patients with an appendicectomy, there was no patient who was aged 17 years or younger. One-hundred-and-twenty patients were women (51%). Median postoperative length of stay was 6 days. Length of follow-up after surgery was 34.0 (median) months (mean: 35.9 ± 1.2).

American Society of Anaesthesiologists classification

The American Society of Anaesthesiologists (ASA) has classified patients based on their medical fitness, to allow stratification of peri-operative risk (Table 2; Appendix I). More than 60% of all patients were classified as ASA 3 (49.2%) and ASA 4 (12.3%). Less critically ill patients, as defined by ASA 1 or 2, were operated on in 38.5% of cases (ASA 1: 7.8%, ASA 2: 30.7%). The 30- and 90-day mortality rates between ASA 1/2 and ASA 3/4 patients did not differ significantly ($P = 0.072$).

TABLE 2: *American Society of Anaesthesiologists-type of patients included in study*

Patient type	*n* (%)	30-day mortality *n* (%)	90-day mortality *n* (%)
All patients	237	9 (3.8)	12 (5.1)
ASA 1	18 (7.8)	0 (0)	0 (0)
ASA 2	73 (30.7)	1 (1.4)	1 (1.4)
ASA 3	117 (49.2)	7 (6.0)	10 (8.5)
ASA 4	29 (12.3)	1 (3.4)	1 (3.4)

$P = 0.072$ – ASA1/2 versus ASA 3/4.

Procedures performed

The three most common procedures performed were 'division of adhesions' (27%), 'bowel resection with anastomosis' (23%) and 'reduction of incarcerated hernia' (18%; Table 3). The mortality rates of these procedures ranged between 0 and 7.4%.

Thirty and 90-day mortality rates

The overall 30- and 90-day mortality rates observed in the study population were 3.8% ($n = 9$) and 5.1% ($n = 12$), respectively (Tables 3,4). Nineteen patients were transferred to a metropolitan centre after emergency surgery for ICU treatment or further surgery. Three of these patients died in the metropolitan centre and have been included in this analysis.

Factors influencing postoperative survival

Age

Seventy-eight patients (32.9%) were aged 70 years or older (Tables 2, 3 and 4). These patients were

TABLE 3: *Patient demographics*

Characteristic	*n* (%)	30-day mortality *n* (%)	90-day mortality *n* (%)	*P*-value
All patients	237	9 (3.8)	12 (5.1)	
Women	120 (50.6)	6 (5.0)	8 (6.7)	0.431
Men	117 (49.4)	5 (2.6)	4 (3.4)	
No patient transfer	218 (92.0)	7 (3.2)	9 (4.1)	0.133
Patient up-transfer	19 (8.0)	2 (10.5)	3 (15.8)	
Open surgery	204 (86.1)	9 (4.4)	12 (5.9)	0.341
Laparoscopic surgery	29 (12.3)	0 (0)	0 (0)	
Age				
≥70 years	78 (32.9)	8 (10.3)	11 (14.1)	**0.001**
<70 years	159 (67.1)	1 (0.6)	1 (0.6)	
Bowel obstruction	143 (60.3)	6 (4.2)	9 (6.3)	0.538
Abscess	85 (35.9)	3 (3.5)	3 (3.5)	
Perforation				
Peritonitis				
Haemorrhage	9 (3.8)	0 (0)	0 (0)	
Ischaemia				

Significant *P*-value in bold.

TABLE 4: *Causes of 90-day mortality rate*

No.	Age (years)	Sex	Diagnosis	Procedure	American Society of Anaesthesiologists	Cause of Death	Day	Comment
1	71	M	Bleeding gastric cancer	Distal gastrectomy	3E	MI, palliation	32	Death after transfer for vascular intervention; Stage 4 gastric cancer
2	65	F	Ulcer perforation	Distal gastrectomy	3E	Abdominal sepsis	9	Death after transfer for ICU care
3	72	M	Diverticulitis perforation	Hartmann procedure	3E	CVA	13	
4	70	M	Obstructive large bowel cancer	Right hemicolectomy	2E	Progressive disease	10	Patient refused further active treatment
5	73	F	Obstructive large bowel cancer	Bypass	3E	Progressive disease	9	Patient refused further active treatment
6	77	F	Metastatic pancreatic cancer	Bypass, small bowel resection	3E	Progressive disease	13	Patient/family refused further active treatment
7	88	F	Ulcer perforation	Suture repair	3E	MI	3	Rapid AF postoperative-caused MI
8	76	F	Obstructive large bowel cancer	Right hemicolectomy	3E	Progressive disease	44	Death after transfer to palliative care; Stage 4 mucinous cancer
9	79	M	Incarcerated hernia	Hernia repair	4E	MI	2	
10	80	F	Small bowel perforation	Small bowel resection	3E	MODS	23	Pneumonia resulted in MODS; patient refused ventilation
11	74	F	Small bowel obstruction	Small bowel resection	3E	Sepsis	5	Patient refused 2nd-look operation and/or transfer
12	84	F	Obstructive large bowel cancer	Hartmann procedure	3E	Progressive disease	42	Death after transfer to palliative care; Stage 4 cancer
M ± SE	75.8 ± 1.9	F:M = 8:4					19 ± 5	

AF, atrial fibrillation; CVA, cerebrovascular accident; F, female; ICU, intensive care unit; M, male; M ± SE, mean ± standard error of the mean; MI, myocardial infarction; MODS, multi-organ dysfunction syndrome.

significantly more likely to die after emergency surgery ($P < 0.001$).

Sex

One-hundred-and-twenty patients were women (50.6%). Patient sex did not influence postoperative survival significantly ($P = 0.431$).

American Society of Anaesthesiologists

The ASA classification 3/4 did not result in significantly worse survival, when compared to patients classified as ASA 1/2 ($P = 0.072$).

Diagnosis

A total of 143 patients underwent surgery for bowel obstruction (60.3%), 85 patients were treated for trauma/perforation/sepsis (35.9%) and nine patients for haemorrhage or ischaemia (3.8%). The diagnosis did not significantly influence postoperative survival ($P = 0.538$). When comparing the different procedures performed, only 'partial gastrectomy' carried a significantly increased risk of mortality ($P = 0.005$).

No transfer/up-transfer

Nineteen patients were transferred for ICU treatment after emergency surgery. up-transfer did not influence postoperative survival significantly ($P = 0.133$).

Laparoscopic or open surgery

Laparoscopic surgery was performed on 33 of the study patients (13.9%). The choice of surgical approach did not significantly influence postoperative survival ($P = 0.341$).

Discussion

To date, this is the first study focusing on outcomes of major abdominal emergency surgery in a rural setting. In the rural general surgical unit studied, patients who required major abdominal emergency surgery had favourable outcomes, with a low 30-day mortality rate of 3.8% and a 90-day mortality rate of 5.1%. These figures are not influenced by minor operations, such as appendectomy and cholecystectomy, which were excluded from the study. This is the first Australian study focusing on the results of major abdominal emergency surgery performed in a rural referral centre.

After emergency laparotomy, perioperative mortality can be as high as 44% and severe morbidity can be observed in up to 50%, depending on patient age and perioperative conditions.[3–5,8,9] A recent US study reported that emergency operations account for 15% of all general surgical procedures and for almost 54% of all postoperative deaths.[12] In emergency general surgery, very few pathologies or procedures can be considered anything other than high-risk.[13,14] Compared to emergency surgery, the risk of death associated with major elective surgery is relatively low and has been reported to range between 1.5% and 10%.[15] The outcome difference between elective and emergency general surgery has resulted in a number of studies and audits focusing on quality improvement.[3]

Rural non-metropolitan surgeons deliver surgery in areas with limited medical infrastructure and reduced availability of support personnel when compared to their metropolitan peers. This results in significant challenges and can potentially influence the outcome of patients who are at higher risk of postoperative morbidity and mortality. It is important to evaluate outcomes of rural emergency surgery to identify potential areas of underperformance and to allow for system changes and subsequent improvement of patient care.[16]

This study's results show that approximately 6% of all emergency admissions under general surgeons in a rural referral hospital require major abdominal emergency surgery. The mortality rates reported here compare well with the results published by a number of other groups.[3–5,8,9] The positive results appear not to be related to the physical fitness of the emergency patients, with >60% scoring as ASA3 or ASA 4.

There is no comparable Australian rural study with which to compare data. Emergency laparotomy in the UK has been reported to carry a mortality rate as high as 14.9% for all patients.[17] On the other hand, another study recently reported a significantly lower overall 30-day mortality rate of 4.2% when reviewing the results of 156 NHS Trusts.[18] In this study, mortality rates varied from 1.6% to 8% between different hospitals.

Recommendations to improve outcomes of emergency surgical patients include identification of the appropriate level of care through risk stratification, perioperative resuscitation and optimisation of pathophysiology, early surgery, consultant involvement, prioritisation of emergency theatre cases and access to critical care.[3] One study reported a 15.6% 30-day mortality after high-risk emergency general surgery and identified availability of HDU beds and usage of computed tomography as independent predictors of reduced mortality.[19] Another study recently reported a 53% reduction of postoperative mortality (16.9% to 8%) in emergency general surgery following introduction of a consultant-led unit in a major Australian university hospital.[20]

There are some limitations to this study. These include sample size, data from a single centre and retrospective analysis. These factors could possibly limit reproducibility of the results and therefore larger multicentre prospective studies should be explored.

Low perioperative mortality after emergency abdominal surgery might be a reflection of consultant involvement (anaesthesia and general surgery) in the decision to operate, the timing of operation, as well as the emergency operation itself for all cases. Surgical delays are not common in this rural hospital, as there is less demand for emergency operating theatre time. This might also be a positive factor contributing to favourable patient outcomes. Furthermore, 24 h access to computerised tomography imaging with consultant reporting of all emergency scans might be another favourable contributor. Perioperative resuscitation is provided via Emergency Medicine and Anaesthesiology with access to a HDU providing critical care, including invasive ventilation and invasive monitoring. Patients requiring postoperative treatment in an ICU are transferred to metropolitan centres some 500 km away using a specialised airborne retrieval system (MedSTAR, SA Ambulance Service, Adelaide, South Australia, Australia). The length of the study period (5 years) excludes seasonal influences as a potential explanation for the observed low mortality rate. The distance to major metropolitan hospitals (500 km) and the time involved to organise these transfers also excludes preoperative bypassing of the institution in question by emergency services as an explanation for the results reported here.

Conclusion

Emergency abdominal surgery is associated with low 30- and 90-day mortality rates of 3.8% and 5.1%, respectively, in a rural Australian surgical centre. These results compare well with data reported from metropolitan centres in Australia[20] (8% mortality) and internationally[18] (4.2% mortality). Emergency abdominal surgery might therefore be safely provided in the non-metropolitan or rural setting if adequate skillsets and resources are available and if there is support from metropolitan centres should the need for uptransfer arise. It also appears that early involvement of consultant surgeons in treatment decisions, such as what occurred in all cases included in this study, might significantly reduce mortality associated with emergency abdominal surgery. In this study, emergency abdominal surgery was provided in a rural setting with favourable outcomes.

Appendix I

American Society of Anaesthesiologists classification of physical fitness

Class 1: fit patient; Class 2: mid-to-moderate systemic disease, no functional limitation; Class 3: severe systemic disease with some functional limitation; Class 4: severe systemic disease that is a constant threat to life; Class 5: moribund patient not expected to survive 24 h.

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Authors' contributions

All authors made a significant contribution to this research and its publication.

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