



Research Article

Factors Impacting 30-Day Mortality in Emergency Laparotomy in an Australian Tertiary Centre

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Abstract

Backgrounds: With recent publication of the fourth annual National Emergency Laparotomy Audit (NELA), a certain level of international emergency laparotomy (EL) benchmarking has been set. This makes it more important than ever to critically review contemporary Australian EL outcomes, and identify factors contributing to 30-day mortality in our Australian population.

Methods: A retrospective review of EL performed by the General Surgery service at the Gold Coast University Hospital between March 2015 and July 2017 was performed. Data was collected on patient demographics, American Society of Anaesthesiologists Score (ASA), time to diagnosis, indication for surgery, timing of surgery in or out of normal working hours, consultant presence, ICU admission, and hospital length of stay (HLOS).

Results: Mean age of patients undergoing EL was 63+/-17 years, with a comparable gender distribution. The consultant surgeon was the primary operator in 74% of all EL. Among 30-day mortality patients, 76.9% had an ASA of IV/V, ischaemic bowel was the most common cause of death (38.5%), and 84.6% were admitted to ICU. Univariate analysis identified age ($p=0.01$), ASA IV/V ($p=0.001$), ICU admission ($p=0.042$), and ED-CT time ($p=0.089$) as potential predictors of 30-day mortality. When analysed as part of a multivariate analysis, only ASA IV/V ($p=0.036$; OR 9.44) and ED-CT time ($p=0.044$; OR 1.005) were found to be independent predictors of 30-day mortality.

Conclusion: Overall 30-day mortality in EL patients was 12.4%. Limitations included the moderate sample size and retrospective nature of the study. There was no formalised EL protocol in the authors' institution, however this may convey a more accurate picture of day-to-day EL outcomes in an Australian tertiary hospital. Future prospective blinded audits into these variables would be crucial in assessing progress and working towards improving 30-day mortality in EL.

Introduction

There has been a spotlight on Emergency Laparotomy (EL) mortality in recent years, with the National Emergency Laparotomy Audit (NELA) shining a light on multiple factors that contribute to mortality among this patient population. With

recent publication of their fourth report, NELA has presented an increase in pre-operative CT imaging to 87%, the presence of a surgical and anaesthetic consultant in 90% of cases that occurred within normal working hours and 66% of after-hours cases, a rate of 87% of patients admitted to critical care following surgery, and an improvement in hospital length of stay to 15.6 days. The

fourth NELA summarised an overall improvement in 30-day mortality from 11.8% to 9.5% [1]. With the emergence of these new published standards, it is important to compare Australian contemporary practice outcomes and understand the factors that are associated with perioperative mortality in EL patients in the Australian population.

Few Australian studies exist detailing local trends and outcomes from EL. Ho et al. reported a 9.7% 30-day mortality in their EL population in a 5-year review at Logan Hospital (a 360 bed public hospital), and found factors impacting on mortality to include patient age, P-POSSUM score, and admission source [2]. They found no statistically significant difference between patients that survived or died when comparing antibiotic administration, the use of a perioperative medical service, or frequency of intensive care admission. Limited other Australian studies reporting on EL mortality include a Victorian review (8.8% inpatient mortality) [3], a South Australian centre (3.8% 30-day mortality, 5.1% 90-day mortality) [4], and Western Australian reviews (5.2% in-hospital mortality [5], 5.4% 30-day mortality [6]). Gold Coast University Hospital is a 750-bed public teaching hospital. Between 2014 and 2017, the Acute Surgical Unit (ASU) was overseen by a daily alternating on call consultant. The authors review outcomes of EL at the Gold Coast University Hospital, and analyse factors that are associated with 30-day mortality in this patient population.

Methods

A retrospective review of all EL performed by the adult General Surgery service at the Gold Coast University Hospital between March 2015 and July 2017 was performed. All surgical admissions from the emergency department were reviewed, and patients who underwent an EL within 24 hours were included. Trauma laparotomies were excluded due to a potentially confounding high morbidity and mortality. Data was collected on patient demographics, American Society of Anesthesiologists (ASA) physical status classification system score, time to diagnosis,

indication for surgery, timing of surgery in or out of normal working hours, consultant surgeon presence, ICU admission, and Hospital Length of Stay (HLOS). ASA score was divided into two groups for analysis; ASA I/II/III, or ASA IV/V. Outcomes included ICU admission, Hospital Length of Stay (HLOS), and 30-day mortality.

Shapiro-Wilk test for normality was used to determine which continuous variables showed a normal parametric distribution. All continuous data showed a non-parametric distribution and was thus presented as median (interquartile range, IQR). To identify predictors of 30-day mortality, a univariate logistic regression was initially used with a significance level of $\alpha=0.1$. All variables which showed significance (p -value <0.1) were then analysed together as covariates in a multivariate analysis with a significance level of $\alpha=0.05$. To identify predictors of HLOS, a univariate log rank analysis was first used for categorical values whilst a univariate cox regression was used for continuous values with a significance level of $\alpha=0.1$ applied. All variables which showed significance (p -value <0.1) in both univariate analyses were then analysed together as covariates in a multivariate analysis with a significance level of $\alpha=0.05$. All data analyses were performed using SPSS 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp).

Results

30-day mortality

Demographics: 105 patients underwent EL in the 2.33 year study period. 49.5% ($n=52$) were male, and mean age of patients was 63 ± 17 years (range 14-94 years; Table 1). Univariate analysis identified a statistically significant ($p=0.010$) higher mortality in older patients (mean age 75 ± 10 years) when compared to younger patients (61 ± 17 years), however this was not statistically significant on multivariate analysis ($p=0.084$). There was a higher mortality rate in males undergoing EL (53.8% vs 48.9%), however, again this was not statistically significant ($p=0.739$) (Table 2, Table 3).

		Total [†]	mortality [†]	
		(n = 105)	Yes (n = 13)	No (n = 92)
Age (years)		63 (51-78)	78 (64-83)	62 (49-77)
Gender	Female	53 (50.5)	6 (46.2)	47 (51.1)
	Male	52 (49.5)	7 (53.8)	45 (48.9)
ASA	I/II/III	71 (67.6)	3 (23.1)	68 (73.9)
	IV/V	34 (32.4)	10 (76.9)	24 (26.1)

Procedure				
	Negative Laparotomy	3 (2.9)	1 (7.7)	2 (2.2)
	Perforated viscous	41 (39)	3 (23.1)	38 (41.3)
	SBO	18 (17.1)	1 (7.7)	17 (18.5)
	LBO	10 (9.5)	1 (7.7)	9 (9.8)
	Incarcerated Hernia	14 (13.3)	1 (7.7)	13 (8.7)
	Ischaemic Bowel	10 (9.5)	5 (38.5)	5 (5.4)
	Other	9 (8.6)	1 (7.7)	2 (2.2)
Working Hours[‡]				
	In-Hours	32 (30.5)	4 (30.8)	28 (30.4)
	After-Hours	40 (38.1)	4 (30.8)	36 (39.1)
	Weekends	33 (31.4)	5 (38.5)	28 (30.4)
	ICU admission	59 (56.2)	11 (84.6)	48 (52.2)
	ICU LOS (days)	1 (0-4)	2 (2-12)	1 (0-3)
	Consultant operator	74 (70.5)	9 (69.2)	65 (70.7)
	ED-CT time (min)	179 (110-248)	179 (83-565)	180 (111-246)
	CT-OT time (min)	282 (176-404)	439 (158-560)	275 (177-374)
	CT reporting time (min)	164 (102-352)	244 (173-511)	156 (91-292)
	OT duration (min)	171 (128-205)	161 (136-182)	171 (127-206)
	ED-OT time (min)	459 (326-599)	480 (270-1030)	459 (333-574)

ASA: American Society of Anaesthesiologists Score; SBO: Small Bowel Obstruction; LBO: Large Bowel Obstruction; ICU: Intensive Care Unit; LOS: Length of Stay; ED: emergency department; CT: Computed Tomography; OT: Operating Theatre; † Categorical values expressed as counts (percentage) whilst continuous values expressed as median (interquartile range); ‡ In-hours: weekdays from 0800 to 1600; After-hours: weekdays from 1601 to 0759 following day; Weekends: 24hours on Saturday and Sunday

Table 1: Overall population demographics and mortality.

		Coefficient (B)	P-value	OR/exp (B)	95% CI for exp (B)	
					Lower	upper
Age (years)		0.064	0.010**	1.066	1.015	1.119
Gender	Female	ref	-	-	-	-
	Male	0.198	0.739	1.219	0.38	3.905
ASA	I/II/III	ref	-	-	-	-
	IV/V	2.245	0.001***	9.444	2.396	37.225

Procedure	Negative Laparotomy	ref	-	-	-	-
	Perforated viscous	-1.846	0.176	0.158	0.011	2.286
	SBO	-2.14	0.181	0.118	0.005	2.705
	LBO	-1.504	0.352	0.222	0.009	5.275
	Incarcerated Hernia	-1.872	0.244	0.154	0.007	3.577
	Ischaemic Bowel	0.693	0.615	2	0.134	29.808
	Other	-1.386	0.392	0.25	0.01	5.985
Working hours†	In-Hours	ref	-	-	-	-
	After-Hours	-0.251	0.738	0.778	0.179	3.387
	Weekends	0.223	0.757	1.25	0.304	5.147
ICU admission		1.618	0.042**	5.042	1.058	24.021
ICU LOS (days)		0.053	0.155	1.055	0.98	1.136
Consultant operator		-0.068	0.916	0.935	0.265	3.296
ED-CT time (min)		0.003	0.089*	1	1	1.007
CT-OT time (min)		0.002	0.138	1.002	0.999	1.004
CT reporting time (min)		0.001	0.423	1.001	0.999	1.003
OT duration (min)		-0.005	0.399	0.995	0.983	1.007
ED-OT time (min)		0.002	0.117	1.002	1	1.003
ASA: American Society of Anaesthesiologists Score; SBO: Small Bowel Obstruction; LBO: Large Bowel Obstruction; ICU: Intensive Care Unit; LOS: Length Of Stay; ED: Emergency Department; CT : Computed Tomography; OT : Operating Theatre; Ref: Reference; OR/Exp (B):Odds Ratio Or Exponential Coefficient; CI : Confidence Interval; † In-hours : weekdays from 0800 to 1600; After-hours : weekdays from 1601 to 0759 following day; Weekends : 24hours on Saturday and Sunday; * P-value <0.1; ** P-value <0.05; *** P-value <0.01						

Table 2: Univariate analysis for 30-day mortality.

		Coefficient (B)	P-value	OR/exp (B)	95% CI for exp (B)	
					Lower	upper
Age (years)		0.05	0.084	1.052	0.993	1.113
ASA	I/II/III	ref	-	-	-	-
	IV/V	1.999	0.036*	7.378	1.14	47.755
ICU admission		0.612	0.587	1.845	0.203	16.777
ED-CT time		0.005	0.044*	1.005	1	1.009
ASA : American Society Of Anaesthesiologists Score; ICU : Intensive Care Unit; Ref: Reference; ED : Emergency Department; CT : Computed Tomography; OR/Exp (B) : Odds Ratio Or Exponential Coefficient; CI : Confidence Interval; * P-Value <0.05						

Table 3: Multivariate analysis for 30-day mortality.

American Society of Anesthesiologists (ASA) physical status classification system score: Of patients undergoing EL, 67.6% (n=71) were classed ASA I-III and 32.4% (n=34) were classified an ASA of IV or V (Table 1). There was a higher 30-day mortality rate in patients in the ASA IV/V group (76.9% vs 26.1%), and this was statistically significant on univariate (p=0.001) and multivariate analysis (p=0.036).

Indications for emergency laparotomy: The etiology of each patient's acute abdomen was recorded as the pathology diagnosed intra-operatively. The most common indication for EL in our study population was perforated viscus (39%, n=41), followed by small bowel obstruction (17.7%, n=18), large bowel obstruction (9.1%, n=10), incarcerated hernia (13.3%, n=14), and ischaemic bowel (9.5%, n=10) (Table 1). Other indications included peptic ulcer disease, post-operative complications (eg. anastomotic leak), caecal mass, and sepsis in enterocutaneous fistula disease 2.9% (n=3) of patients underwent a negative EL, and indications included haemodynamic instability and sepsis concerning for ischaemic bowel, and pneumoperitoneum or peritonitis concerning for perforation. EL performed in patients with ischaemic bowel had the highest mortality (38.5%, n=5; Table 2), and were secondary to superior mesenteric artery occlusion, global small bowel ischaemia secondary to a necrotic mass, and embolic infarcts. The next highest mortality was EL performed for perforated viscus (23.1%, n=3), and these included esophageal perforation, perforated diverticular disease, and perforated stercoral colitis.

Time to diagnosis: Data was collected for time from patient presentation to CT study (ED-CT), and time from initiation of the imaging study to the EL start time recorded in the operating theatre (CT-OT). The time from patient presentation to EL start time was also recorded (ED-OT). Note was made of the time taken for radiology reporting of an imaging study to be completed. The median time from ED-CT was 179 (110-248) minutes with an additional 282 (176-404) minutes between CT-OT, and the median duration for all operations was 171 (128-205) minutes. There was a similar median ED-CT time between the 30-day mortality and non-30-day mortality groups, although a wider distribution was

noted (179mins, IQR 83-565 vs 180mins, IQR 111-246). This was statistically significant on both univariate (p=0.089) and multivariate analyses (p=0.044). Patients in the 30-day mortality group were found to have longer CT-OT, CT reporting, and total ED-OT times, however these were not statistically significant on univariate analysis. Patients in the 30-day mortality group were also noted to have a shorter OT duration (161mins, IQR 136-182 vs 171mins, IQR 127-206), however this was again not statistically significant on univariate analysis.

Timing of emergency laparotomy - Normal working hours vs. After-hours: Normal working hours were defined as weekdays between 0800 to 1800 hours, and after-hours defined as between 1801 to 0759 hours on weekdays, and 0000 to 2359 hours on weekends. There was no statistically significant difference in mortality in patients undergoing EL during normal working hours in comparison to EL performed after-hours (Table 1), which has also been found in other studies critically assessing emergency surgery [7,8].

Presence of surgical consultant: NELA data reported on consultant presence in patients with high mortality risk >5% based on P-POSSUM scores. On review of all patients in our study period who underwent EL, the authors found a similar proportion of consultant presence between the 30-day mortality (69.2%) and non-30-day mortality (70.7%) groups.

Hospital length of stay (HLOS) and ICU admission: Median HLOS was 10 days (range 6-19 days) and 59% of all patients were admitted to ICU with a median LOS of 1 day (range 0-4). 59 total patients were admitted to ICU post operatively, 64.4% of those were in weekdays compared to weekends. Among 30-day mortality patients, 84.6% were admitted to ICU with a median LOS of 2 days (range 2-12). Univariate analyses identified age (p=0.067), ASA (p<0.001), ICU admission (p<0.001), ICU LOS (p<0.001), and operation duration (p=0.007) as potential predictors of HLOS (Table 4, Table 5). When analysed as part of a multivariate analysis, only age (p=0.048, OR 0.986) and ICU LOS (p<0.001; OR 0.853) were found to be independent predictors of HLOS (Table 6).

		Median HLOS (days)	Interquartile range	P-value
Gender	Female	10	(7-20)	0.599
	Male	11	(7-22)	
ASA	I/II/III	9	(5-14)	<0.001***
	IV/V	20	(12-34)	
Procedure	Negative Laparotomy	8	(8-17)	0.326
	Perforated viscous	12	(7-21)	
	SBO	10	(7-14)	
	LBO	9	(6-11)	
	Incarcerated Hernia	6	(4-20)	
	Ischaemic bowel	13	(6-13)	
	Other	13	(11-28)	
Working hours†	In-Hours	10	(7-26)	0.934
	After-Hours	11	(6-20)	
	Weekends	10	(6-19)	
ICU admission	no	8	(4-10)	<0.001***
	yes	19	(9-28)	
Consultant operator	No	10	(6-20)	0.831
	Yes	11	(7-21)	

ASA : American Society of Anaesthesiologists Score; SBO : Small Bowel Obstruction; LBO : Large Bowel Obstruction; ICU : Intensive Care Unit; HLOS : Hospital Length Of Stay; † In-Hours : Weekdays From 0800 To 1600; After-Hours : Weekdays From 1601 To 0759 Following Day; Weekends : 24hours On Saturday And Sunday; * P-value <0.1; ** P-value <0.05; *** P-value <0.01

Table 4: Univariate log rank analysis for HLOS (categorical variables only).

	Coefficient (B)	P-value	OR/exp (B)	95% CI for exp (B)	
				Lower	upper
Age	-0.012	0.067*	0.988	0.976	1.001
ICU LOS	-0.186	<0.001***	0.83	0.773	0.892
ED-CT time	0	0.896	1	0.998	1.001
CT-OT time	0	0.869	1	0.999	1.001
CT reporting time	0	0.767	1	0.999	1.001
OT duration	-0.006	0.007***	0.994	0.99	0.998
ED-OT time	0	0.846	1	0.999	1.001

ICU : Intensive Care Unit; LOS : Length of Stay; ED : Emergency Department; CT : Computed Tomography; OT : Operating Theatre; OR/Exp (B) : Odds Ratio Or Exponential Coefficient; CI : Confidence Interval; * P-Value <0.1; ** P-Value <0.05; *** P-Value <0.01

Table 5: Univariate Cox regression analysis for HLOS (continuous variables).

	Coefficient (B)	P-value	OR/ exp (B)	95% CI for exp (B)	
				Lower	upper
Age	-0.014	0.048*	0.986	0.973	1
ASA	-0.182	0.545	0.834	0.462	1.503
ICU admission	-0.102	0.762	0.903	0.468	1.743
ICU LOS	-0.159	<0.001**	0.853	0.781	0.932
OT duration	-0.003	0.203	0.997	0.992	1.002

ASA : American Society Of Anaesthesiologists Score; ICU : Intensive Care Unit; LOS : Length Of Stay; OT : Operating Theatre; OR/Exp (B) : Odds Ratio Or Exponential Coefficient; CI : Confidence Interval; * P-Value <0.05; ** P-Value <0.01

Table 6: Multivariate Cox regression analysis for HLOS.

A higher proportion of patients in the 30-day mortality group were admitted to ICU (84.6% vs 52.2%). This was significant on univariate analysis (p=0.042) but not on statistically significant on multivariate analysis (p=0.587). Patients in the 30-day mortality group were also found to have a longer median ICU LOS (2 days, IQR 2-12 vs 1days, IQR 0-3), however this was not statistically significant on univariate analysis.

Discussion

There is currently a huge focus worldwide on factors affecting 30-day mortality in EL patients with multiple studies in the literature reviewing their own variables and evaluating outcomes [2-6,9], largely spurred by the publication of annual NELA reports.

Overall mortality in the authors' study population was 12.4%. The authors identified age (p=0.01), ASA IV/V (p=0.001), ICU admission (p=0.042), and ED-CT time (p=0.089) as potential predictors of 30-day mortality on univariate analysis. ICU admission was not routinely sort, and dependent on clinical concern and clinical parameters, therefore patients with higher morbidity may have confounded the ICU admission group. When analysed as part of a multivariate analysis, only ASA IV/V (p=0.036; OR 9.44) and ED-CT time (p=0.044; OR 1.005) were found to be independent predictors of 30-day mortality. Limitations included the moderate sample size, which only included patients who underwent EL within 24 hours of admission from the emergency department and excluded trauma patients, in order to reduce confounding factors.

Although it is noted that some studies have reviewed the use of EL protocols at their institution [10], there was no formalised EL care pathway or protocol established in the authors' institution, which is not uncommon between institutions. With the limitations of a retrospective study in mind, independently reviewing patient variables and outcomes in this study population may derive a better understanding of the true day-to-day outcomes in a tertiary

Australian hospital, in comparison to a well publicised prospective study's potential procedural or interviewer bias.

Further prospective blinded studies assessing these variables over a longer study period would be crucial in auditing and reviewing long term progress in reducing 30-day mortality in EL patients. ASA scores can at times be rudimentary and biased by the scoring physician, and implementation of other risk stratifying tools in co-morbid EL patients such as analysis based on P-POSSUM scores [11,12] used in other studies [2,7,10,11,13] would add depth to these findings.

As a result of these findings the Gold Coast University Hospital has now implemented a consultant led ASU with a permanent consultant during normal working hours. Further prospective data collection is currently being undertaken to allow for comparison of the different care models, as published literature worldwide has suggested better outcomes with a consultant lead ASU [14,15], including studies with supportive findings in Australia [13,16,17].

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