Frailty is associated with increased waiting time for relevant process of care measures; findings from the Emergency Laparoscopic & Laparotomy Scottish Audit (ELLSA)

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Introduction

Emergency Laparotomy (EmLAP) is one of the commonest surgical procedures in the UK, encompassing a wide range of acute abdominal conditions with significantly high post-operative morbidity and mortality[1,2]. Most patients undergoing EmLap are older adults (65 years and above) and have, until recently, been under-served by clinical research[3]. The ELF Study (Emergency Laparotomy and Frailty) found frailty to be present in 20% of older adults undergoing EmLap with increasing frailty associated with higher morbidity, mortality, and reduced independence at discharge[4,5]. As a result, both NELA (National Emergency Laparotomy Audit) and ELLSA (Emergency Laparoscopic & Laparotomy Scottish Audit) integrated frailty scoring into their national datasets to improve perioperative pathways for this vulnerable population[6].

Temporal processes of care are measurements of timing and efficiency within aspects of the patient pathway, that have been applied successfully in conditions such as stroke[7]. Although reported in the ELLSA and NELA datasets, the influence of these process of care measurements remain unexplored in the EmLap setting.

We aim to describe the temporal processes of care within the EmLap peri-operative pathway and the impact of frailty on such processes.

Methods

All patient information was taken from the ELLSA Database[6]. ELLSA is a Scottish Government initiative supported by the Modernising Patient Pathways Programme that collects data on all patients aged 18 and over who underwent an emergency general surgical procedure within 17 participating Scottish centres. Using data from November 2017 to October 2018, we report on patient demographics, process and outcome measures. Permission was granted on behalf of ELLSA to use patient data for this work.

Patient demographic information included: age (categorised into <65, 65-74 and ≥75), sex, Hospital type, American Society of Anaesthesiologists Physical Status Classification (ASA graded as: ASA I-II, ASA III and ASA IV-V)[8], NELA Score[9], Clinical Frailty Scale (CFS categorised as 1-3 - not frail, CFS 4 - pre-frail, CFS 5 - mildly frail and CFS 6-7 - moderate and severely frail)[10], operation type, post-operative Length of Stay (LOS), provision of sepsis antibiotics and discharge destination.

Temporal information was collected for eight process of care variables. These were: Time from admission until (in hours): CT scan (requested); CT scan performed; care of Anaesthetics; start of surgery; pre-operative time in care of Anaesthetics.
Time from CT request to (in hours): CT performed; care of Anaesthetics; and start of surgery. Variables were 99% windsorized to reduce the effect of positive skew.

The primary clinical outcomes were temporal process of care measures. Co-primary outcome was 30-day mortality

Statistical Analysis

A one-way Analysis of Variance was used to determine the association between frailty categorised and patient characteristics. To compare the prognostic characteristics of frailty and ASA separately two additional analyses were carried out with these covariates. An area under the curve (AUC) was calculated for all three models to compare the operating characteristics.

The co-primary outcomes analysis associated day-30 mortality with frailty, using a multivariable logistic regression adjusted by sex and age as a base model, fitting 95% Confidence interval (95% CI) and p-values. Anonymised patient data were analysed using SPSS (SPSS Version 26; IBM Corp., Armonk, NY).

Results

A total of 2245 patients underwent EmLap over the 12-month study period with 1 exclusion. Median age was 65 (range 18-96, IQR 24), and 1098 (48.9%) were males (Table 1). All cause 30-day mortality was 9.1% (n=205). Median age of those who died was 74.5 compared to 63.0 years in those who remained alive after 30-days (p<0.0001). Operation types performed and individual mortality rates are described in Supplementary Table 1. Of the 1432 patients who underwent frailty assessment, 152 had a CFS >4 (10.6%, n=1432).

TABLE 1 HERE

Primary Outcome: Association between CFS, Age, ASA, and process measures

Frailty was associated with time from admission to: CT request (p=0.002); CT performed (p=0.001); care of Anaesthetics (p<0.0001); Surgery start (p<0.0001); and Time in care of Anaesthetics (p=0.012) (Table 2). Compared to CFS 1-3, CFS 6-7 patients had longer process measure timings across all measures of temporal processes of care.

Age was solely associated with the time from admission to care of Anaesthetics (p<0.0001) (Table 2). ASA Grade was significantly associated with the time from Admission to: CT request (p<0.0001), CT performed (p<0.0001), care of Anaesthetics (p<0.0001), Surgery start (p<0.0001) and Time in care of Anaesthetics (p<0.0001) (Table 2).

Co-primary Outcome: Association between Frailty and ASA Grade with Day 30 mortality

In the age and sex adjusted model, we found that age was associated with mortality: compared to <65, 65-75 OR=2.35 (95%CI 1.57-3.52, p<0.0001) and ≥75 OR=4.87 (95%CI 3.40-6.99, p<0.0001), and the AUC=0.68 (95%CI 0.64-0.72). In the model which additionally included frailty, frailty was significantly associated with mortality. Compared to CFS 1-3, CFS 4 OR=2.75 (95%CI 1.68-4.50, p<0.0001), CFS 5 OR=2.24 (95%CI 1.12-4.46, p=0.020) and CFS 6-7 OR=4.24 (95%CI 2.27-7.89, p<0.0001), the AUC=0.74 (95%CI 0.69-0.78). In the model with additional adjustment for ASA, ASA was significantly associated with mortality. Compared to ASA I-II, ASA III OR=4.24 (95%CI 2.24-8.03, p<0.0001) and ASA IV-V OR=18.8 (95%CI 10.1-34.9, p=0.02), and AUC=0.82 (95%CI 0.79-0.84).

TABLE 2 HERE

Discussion

This study has confirmed the negative influence of increasing frailty, age and ASA on 30-day mortality in patients undergoing emergency surgery. The key novel finding is that moderately and severely frail individuals wait longer at every temporal stage of the pre-operative pathway. In particular, the time from admission to start of surgery was twice as long with time to surgery widely accepted as a determinant of poorer outcome[2].

NELA is the world's largest prospective EmLap database and has consistently reported poorer outcomes after EmLap for older adults. They have stated an urgent clinical need to research and develop interventions to improve outcomes for this under-served, vulnerable population, focussing on early geriatrician engagement and consideration of a Comprehensive Geriatric Assessment (CGA). Integration of a frailty score by NELA and ELLSA was thought to be a progressive step to highlight the need for frail patients. However, only 63.8% of this ELLSA cohort had a frailty assessment reflecting more education is needed.

It is possible that the complexity of the older frail patient naturally embeds longer times for each step of the pathway and is not a reflection of suboptimal care. With a focus on shared decision-making, each pathway step should be discussed with the patient and could involve other specialties, including critical care[11]. There may also be a trial of unsuccessful conservative management. If geriatricians are involved, then a CGA could be part of the patient's active treatment plan whilst surgery is being considered. In the elective setting the CGA has been shown to improve outcomes[12]. However, with NELA reporting that only 36.9% of acute sites have such input, this viewpoint may be considered optimistic.

In conclusion, frailty is confirmed as a prognostic indicator for 30-day mortality for patients undergoing emergency laparotomy. Frail patients wait longer for investigations, specialty review and surgery across the EmLap pathway. Future research needs to explore reasons for these longer processes of care with a focus on defining geriatrician input.

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The authors declare no conflict of interest.

Table Legends:

Table 1. Patient demographics and perioperative characteristics.

Table 2. Data presented as Median (Interquartile range). Data in minutes. A one-way ANOVA was used to compare subgroups.

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Table 1: Patient demographic and perioperative characteristics

Variable	Day 30 Mortality (n=2244)		
	Alive	Dead	Total
	2039 (90.9%)	205 (9.1%)	2244
N = 2244			
Age, median (range)	63 (18-96)	75 (26-93)	138
Male (%)	997 (90.80%)	101 (9.20%)	1098
Location (n=2244)			
Large Teaching Hospital	1087 (92.83%)	84 (7.17%)	1171
Large General Hospital	886 (89.05%)	109 (10.95%)	995
General Hospital	66 (84.62%)	12 (15.38%)	78
Age (n=2243)			
< 65	1070 (95.6%)	49 (4.4%)	1119
65-74	499 (90.4%)	53 (9.6%)	552
≥ 75	470 (82.2%)	102 (17.8%)	572
Missing	0	1	1
ASA grade (n=2154)			
ASA I	191 (97.9%)	4 (2.1%)	195
ASA II	678 (98.8%)	8 (1.2%)	686
ASA III	778 (92.5%)	63 (7.5%)	841
ASA IV	288 (75.6%)	93 (24.4%)	381
ASA V	30 (58.8%)	21 (41.2%)	51
Missing	74	15	89
Clinical Frailty Scale (n=1432)			
CFS 1	323 (97.9%)	7 (2.1%)	330
CFS 2	432 (97.6%)	20 (2.4%)	452
CFS 3	278 (89.4%)	33 (10.6%)	311
CFS 4	155 (82.9%)	32 (17.1%)	187
CFS 5	65 (84.4%)	12 (15.6%)	77
CFS 6	45 (80.4%)	11 (19.6%)	56
CFS 7	11 (57.9%)	8 (42.1%)	19
Missing	730	82	812
Median NELA Score (range) **(n=1079)**	3.0% (0.1% - 91.0%))	21.1% (0.2% - 100%)	
Sepsis Antibiotics Administered **(n=891)**	793 (89.0%)	98 (11.0%)	891
Post-operative Destination (n=2239)			
Ward	368 (97.1%)	11 (2.9%)	379
HDU	1171 (95.9%)	50 (4.1%)	1221
ICU	498 (77.9%)	141 (22.1%)	639
Missing	2	3	5

Table 2: Comparison of ELLSA process measures by frailty, Age and ASA Grade subgroups

Process Measures between stages (in minutes)	**Clinical Frailty Scale**				
	CFS 1-3 (Not frail)	CFS 4 (Pre-Frail)	CFS 5 (Mildly Frail)	CFS 6-7 (Moderate-Severely Frail)	*p*
Time from admission until CT scan requested (n=943)	530 (1383.50)	600 (1385.50)	551 (1440.25)	1308 (6479)	0.002
Time from admission until CT scan performed (n=1024)	724 (1581)	946 (1373)	1065 (3496)	1724 (6220)	0.001
Time from admission until care of Anaesthetics (n=1386)	1855 (4336)	2140 (5066)	2569 (5837)	4842.50 (8964)	<0.0001
Time from admission until surgery start (n=1383)	1885 (4192)	2191 (4888)	2588 (5846)	4120 (9123)	<0.0001
Pre-operative time in care of Anaesthetics (n=1367)	37 (30)	44 (31)	41 (31)	40 (27)	0.012
Time from CT request to CT performed (n=969)	69 (110)	66 (145)	68.50 (123)	119 (154)	0.210
Time from CT performed until care of Anaesthetics (n=1028)	780 (2082)	407.50 (1501)	419.50 (2279)	1549 (2746)	0.310
Time from CT performed until surgery start (n=1021)	816 (2081)	495 (1440)	458.50 (2290)	1554 (2826)	0.321
Process Measures between stages (in minutes)	**Age**				
	< 65	65-74	≥75	*p*	
Time from admission until CT scan requested (n=1458)	513 (1421.50)	587 (2833.25)	744 (1650)	0.332	
Time from admission until CT scan performed (n=1633)	743.50 (1684)	1032.50 (2775)	958 (1986)	0.440	
Time from admission until care of Anaesthetics (n=2154)	1924 (4995)	2546 (4904)	2475.50 (4949)	0.806	
Time from admission until surgery start (n=2069)	1915 (4850)	2727 (4835)	2535.50 (4944)	0.590	
Pre-operative time in care of Anaesthetics (n=2041)	36 (26)	41 (32)	42 (34)	<0.0001	

Time from CT request to CT performed (n=1502)	74 (128)	75 (127)	74.50 (154)	0.602
Time from CT performed until care of Anaesthetics (n=1648)	605 (1968)	909 (2266)	960.50 (2353)	0.514
Time from CT performed until surgery start (n=1580)	586.50 (1770)	1011 (2282)	990 (2327)	0.676
Process Measures between stages (in minutes)	**ASA Grade**			
	ASA I-II	ASA III	ASA IV-V	*p*
Time from admission until CT scan requested (n=1416)	500 (1192)	560.50 (2304.25)	877 (3842.50)	<0.0001
Time from admission until CT scan performed (n=1577)	732 (1300)	906 (2395)	1090 (3838)	<0.0001
Time from admission until care of Anaesthetics (n=2073)	1753 (3948)	2512 (5911)	2620 (7626)	<0.0001
Time from admission until surgery start (n=2001)	1759 (3859)	2536 (5799)	2686 (7484)	<0.0001
Pre-operative time in care of Anaesthetics (n=1974)	35 (29)	40.50 (32)	40 (37)	<0.0001
Time from CT request to CT performed (n=1459)	74 (143)	76 (131)	65 (117)	0.790
Time from CT performed until care of Anaesthetics (n=1593)	797 (2175)	1068 (2364)	407 (1327)	0.761
Time from CT performed until surgery start (n=1534)	852 (2232)	1024 (2339)	461 (1330)	0.443

Table 2. Data presented as Median (Interquartile range). Data in minutes. A one-way ANOVA was used to compare subgroups.

Supplementary Table 1: 30-day Mortality by Operation type

Operation Type	Day 30 Mortality (n=2244)		
	Alive	Dead	Total
Abdominal wall closure	25 (100%)	0 (0%)	25 (1.1%)
Abdominal wall reconstruction	8 (100%)	0 (0%)	8 (0.4%)
Adhesiolysis	244 (96.4%)	9 (3.6%)	253 (11.3%)
Colectomy: left (including anterior resection)	72 (94.7%)	4 (5.3%)	76 (3.4%)
Colectomy: right (including ileocaecal resection)	262 (92.6%)	21 (7.4%)	283 (12.7%)
Colectomy: subtotal or panproctocolectomy	121 (89.0%)	15 (11.0%)	136 (6.1%)
Colorectal resection – other	43 (86.0%)	7 (14.0%)	50 (2.2%)
Debridement	4 (80.0%)	1 (20.0%)	5 (0.2%)
Drainage of abscess/collection	16 (69.6%)	7 (30.4%)	23 (1.0%)
Enterotomy	19 (100%)	0 (0%)	19 (0.8%)
Evacuation of haematoma	3 (75.0%)	1 (25.0%)	4 (0.2%)
Exploratory/relook laparotomy only	45 (71.4%)	18 (28.6%)	63 (2.8%)
Gastrectomy – partial or total	10 (90.9%)	1 (9.1%)	11 (0.5%)
Gastric surgery – other	25 (83.3%)	5 (16.7%)	30 (1.3%)
Haemostasis	9 (75.0%)	3 (25.0%)	12 (0.5%)
Hartmann’s procedure	237 (92.6%)	19 (7.4%)	256 (11.4%)
Intestinal bypass	8 (88.9%)	1 (11.1%)	9 (0.4%)
Laparostomy formation	14 (93.3%)	1 (6.7%)	15 (0.7%)
Other	104 (90.4%)	11 (9.6%)	115 (5.1%)
Peptic ulcer – oversew of bleed	7 (87.5%)	1 (12.5%)	8 (0.4%)
Peptic ulcer suture or repair of perforation	125 (91.9%)	11 (8.1%)	136 (6.1%)
Reduction of volvulus	14 (93.3%)	1 (6.7%)	15 (0.7%)
Removal of foreign body	8 (88.9%)	1 (11.1%)	9 (0.4%)
Repair of intestinal fistula	2 (100%)	0 (0%)	2 (0.1%)
Repair of intestinal perforation	33 (84.6%)	6 (15.4%)	39 (1.7%)
Repair or revision of anastomosis	22 (95.7%)	1 (4.3%)	23 (1.0%)
Resection of Meckel’s diverticulum	9 (100%)	0 (0%)	9 (0.4%)
Resection of other intra-abdominal tumour(s)	9 (100%)	0 (0%)	9 (0.4%)
Small bowel resection	328 (87.9%)	45 (12.1%)	373 (16.6%)
Stoma formation	110 (95.7%)	5 (4.3%)	115 (5.1%)
Stoma revision	16 (94.1%)	1 (5.9%)	17 (0.8%)
Washout only	77 (90.6%)	8 (9.4%)	85 (3.8%)
Missing	10 (90.9%)	1 (9.1%)	11 (0.5%)
Total	2039	205	2244