The need for Paediatric Emergency Laparotomy Audit (PELA) in the UK

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ABSTRACT

INTRODUCTION The National Emergency Laparotomy Audit (NELA) has raised serious concerns about the processes of care and outcomes in adult emergency laparotomies in the UK. To date, no comparable data have been published for children. The aim of this study was to investigate the need for a similar audit in children.

METHODS Data were collected retrospectively following NELA guidelines. Results were analysed using QuickCalcs (GraphPad Software, La Jolla, CA, US).

RESULTS The study period spanned 7.5 years. A total of 161 patients were identified for inclusion in the audit. The median patient age was 2.8 years. Half (49%) of the cohort were deemed ASA (American Society of Anesthesiologists) grade ≥ 2 . A history of previous abdominal surgery was noted in 37% of the patients. The median time from admission to operation was 15 hours. Over a third (39%) of the operations were performed out of hours. The most common indications for surgery comprised adhesive bowel obstruction (37%), intussusception (27%) and volvulus (9%).

The median length of hospital stay was 8 days with the median postoperative stay being 6 days (NELA data 10.6 days). Half (51%) of the cases required intensive care following surgery. The 30-day mortality rate was 3.1%. The overall mortality rate was 4.3% (NELA data 16%). Patient care was led by a consultant surgeon in 100% of cases (NELA data 89%).

CONCLUSIONS This is the first study in children that provides baseline data about the standards of care and outcomes from a single centre paediatric emergency laparotomy audit. A larger study using data from multiple centres would be of great benefit.

KEYWORDS

Paediatric – Emergency – Laparotomy – Audit

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Introduction

The National Emergency Laparotomy Audit (NELA) has raised serious concerns about the processes of care and outcomes in adult emergency laparotomy in the UK. The NELA reports have also shown that the mortality rate within 30 days of surgery in adults is over 10% and the overall mortality rate is over 15%, with mortality being even higher in the aged population.^{1,2} Besides mortality, the NELA project team has also looked into various aspects of patient care including indications for surgery and care standards. The EPOCH (Enhanced Peri-Operative Care for High-risk patients) trial evaluated the effect of quality improvement interventions and an integrated perioperative care pathway on survival at 90 days following emergency laparotomy in adults. This recently published study found no survival benefit from the quality improvement programme for patients undergoing emergency abdominal surgery.⁵

Emergency laparotomy is a challenging surgical procedure in paediatric practice and data are scarce for this age group.⁴ For this reason, we performed the first paediatric emergency laparotomy audit (PELA) in the UK,

based on the NELA and EPOCH trial frameworks, to investigate the demographics, processes of care, standards of care and outcomes in the paediatric age group with a view to identifying the current status compared with adult practice.

Methods

All cases of paediatric emergency laparotomy from June 2008 to December 2015 were identified retrospectively using hospital, theatre and handover databases. Further information was extracted from patient case notes. Parameters to be assessed were derived from the NELA model and the EPOCH trial. Cases of appendicitis and cholecystitis as well as operations performed laparoscopically were excluded from the study. Owing to the nature of the different disease processes and the abundance of data in the literature, neonatal laparotomies (for those aged <1 month) were also excluded. Our outcomes were compared with NELA outcomes as well as with the available literature. Data were analysed using QuickCalcs (GraphPad Software, La Jolla, CA, US). A p -value of ≤ 0.05 was considered statistically significant.

Results

During the 7.5-year study period, 161 laparotomies were performed on children with an age range of 1 month to 18 years (median age: 2 years 10 months). There were 96 male and 65 female patients (male-to-female ratio of 3:2). The preoperative ASA (American Society of Anesthesiologists) grade was 1 in 51% of cases ($n=82$), 2 in 24% ($n=38$), 3 in 19% ($n=31$), 4 in 5% ($n=8$) and 5 in 1% ($n=2$). A history of previous surgery (eg appendectomy, Ladd's procedure, intussusception) was identified in 37% of cases ($n=60$).

Table 1 summarises the standards of care and outcomes. The median length of hospital stay was 8 days (range: 1–507 days), with a median postoperative stay of 6 days (range: 0–135 days). The overall mortality rate was 4.3%, the overall readmission rate was 11% and the reoperation rate was 5.0%.

Care was led by consultants (ie consultant directly involved in decision making and discussing cases with registrars prior to surgical interventions) in 100% of the cases, in terms of both surgeons and anaesthetists. However, care was delivered by consultant surgeons (ie consultant surgeon scrubbed as primary surgeon) in 84% ($n=135$) and by consultant anaesthetists (ie consultant anaesthetist present in theatre as lead anaesthetist) in 94% ($n=151$) of cases. The remaining 6% of cases ($n=10$) were documented as having been delivered primarily by registrars. Postoperatively, 51% of patients ($n=82$) were transferred to the paediatric intensive care unit (ICU)/high dependency unit (HDU).

Over a third of cases ($n=63$, 39%) were undertaken out of hours (6pm – 8am). Of these, 34 were operated on

between 6pm and midnight, and 29 between midnight and 8am.

The most common indication for emergency laparotomy was adhesive bowel obstruction (37%). This was followed by intussusception (27%) and volvulus (9%) (Table 2). While many laparotomies involved multiple procedures, the most common operative procedure was adhesiolysis ($n=46$, 29%), followed by open reduction of intussusception ($n=37$, 23%) and bowel resection ($n=29$, 16%). Of the 68 patients who had intestinal ischaemia, stoma formation was required in 12 cases (18%) and primary closure (ie anastomosis) was performed in 56 cases (82%).

Almost a quarter of emergency laparotomy patients ($n=35$, 22%) re-presented to the accident and emergency department, with half of these ($n=17$) re-presenting within 30 days. Seventeen patients (11%) required readmission; five of these (3.1%) were readmitted within 30 days. Further surgical intervention was necessary in 47% of the readmitted patients ($n=8$), the overall reoperation rate being 5.0%. None of the reoperated cases resulted in mortality. A mortality rate of 4.3% was identified across the entire cohort ($n=7$). In all seven cases resulting in death, operative care and anaesthesia was delivered by consultants. The rate for mortality within 30 days of operation was 3.1% ($n=5$) and all of these deaths occurred within 5 days of surgery. The remaining two deaths occurred on days 36 and 108.

The mortality rate for patients undergoing surgery out of hours was 4.7% (3/63) compared with 4.1% (4/98) for those operated on during normal working hours. This difference was not statistically significant ($p=1.0$). For patients whose surgery was performed between 6pm and midnight, the mortality rate was 2.9% (1/34) while for

Table 1 Summary of standards of care and outcomes in local paediatric audit and in the NELA reports^{1,2}

Standards of care and outcomes	Paediatric audit	NELA
Overall mortality rate	4.3%	16%
Mortality within 30 days	3.1%	11%
Consultant-led care (surgeon)	100%	89% of patients with death risk of $\geq 5\%$
Consultant-led care (anaesthetist)	100%	82% of patients with death risk of $\geq 5\%$
Consultant-delivered care (surgeon)	84%	Not mentioned in NELA reports
Consultant-delivered care (anaesthetist)	94%	Not mentioned in NELA reports
Immediate postoperative care on ICU/HDU	51%	62% of patients with death risk of 5–10% 85% of patients with death risk of $>10\%$
Median length of postoperative hospital stay	6 days	10.6 days
Emergency re-presentation to A&E department	22%	Not mentioned in NELA reports
Within 30 days of discharge	11%	
Overall readmission rate	11%	Not mentioned in NELA reports
Readmission within 30 days of discharge	3.1%	Not mentioned in NELA reports
Reoperation rate	5.0%	9.3%
Mortality within 30 days in reoperation cases	0%	17%
A&E = accident and emergency; HDU = high dependency unit; ICU = intensive care unit; NELA = National Emergency Laparotomy Audit		

those whose operation took place between midnight and 8am, it was 6.9% (2/29). Again, this difference was not significant ($p=0.59$). Table 3 shows further details of the cases resulting in death. Comparing the deceased cohort with the surviving cohort, there was a trend for those patients who died being younger and having a higher ASA grade but the differences were not statistically significant (Table 4).

Discussion

The NELA project team publishes annual data on key processes of care for adult patients. Increased adherence to the standards from which these processes of care are drawn has led to improved outcomes following emergency laparotomy.^{1,2} Our audit parameters were taken from those in the first and second NELA reports in order to define the current status of processes of care and outcomes in the paediatric population.

In our audit, 100% of surgical care was consultant-led with regard to both surgeons and anaesthetists. Care was delivered by the consultant surgeon as the primary scrubbed surgeon in 84% of cases and a consultant anaesthetist was present as lead anaesthetist in 94% of

cases. There was no difference in outcome, and all of the patients who died received consultant-delivered care. This is likely to be a reflection of the more severe nature of the disease processes in those patients. Our findings are in contrast to the NELA results as a consultant surgeon was present in theatre in only 89% of adult cases with a mortality risk of $\geq 5\%$ and a consultant anaesthetist in only 82% of cases.² This suggests a different process of care in the paediatric population but a multicentre study is needed to confirm whether consultant-delivered care is common practice in paediatric cases.

NELA recommendations state that high risk patients identified by a specific scoring system should be escalated directly to the ICU/HDU following surgery. This was adhered to in 62% of adult cases with a 5–10% risk of mortality and in 85% of cases where there was a risk of death of $>10\%$.² Furthermore, 3.8% of all patients who returned to a surgical ward postoperatively required escalation to a critical care unit and in these cases, it is likely that there was a negative impact on outcome.²

The decision to transfer children to the ICU/HDU at our institution was based entirely on the clinical judgement of the consultant anaesthetist and surgeon. No specific scoring system was employed but the decision was made according to various physiological and clinical factors. In our audit, 51% of all cases were taken directly to the paediatric ICU following surgery. In the absence of any data in the literature for comparison, this would suggest that roughly half of all children undergoing emergency laparotomy might require transfer to an intensive care setting following surgery but our data need further validation from larger audits.

The median postoperative length of stay in our paediatric population was just over half that in the NELA population (6 vs 10.6 days). This probably reflects the process of care, and also the nature of paediatric disease and physiology. The 2014–2015 Hospital Episode Statistics data showed an overall mean hospital stay of 2.2 days for all medical and surgical patients aged 0–14 years.⁵ In paediatric surgical patients, a similar median length of stay of 2 days has been reported.⁶ Our mean length of stay was 19 days (range: 1–507 days) but these data were skewed by a number of outliers. This illustrates (as might be expected) that this cohort of paediatric patients had a more severe pathophysiology.

Emergency readmission within 30 days of discharge occurred in 3.1% of cases. This is comparable with a previously published overall readmission rate (including emergency and elective cases) of 2%.⁶ Nevertheless, the evidence for rates of readmission within 30 days in paediatric surgical practice is limited, and varies between 0.54% and 6.5%.^{7,8} In adult practice, the readmission rate has been reported to be around 13%.^{9,10} These readmissions have been linked to surgery specific factors or failures.

The reoperation rate was 5.0% in our study whereas the NELA reoperation rate was almost twice as high (9.3%).² This is important as reoperation rate is often considered an indicator of quality of care in surgery. There was 0%

Table 2 Indications for paediatric emergency laparotomies

Diagnosis	n
Adhesive bowel obstruction (includes band obstruction)	60 (37%)
Intussusception	43 (27%)
Volvulus	15 ^a (9%)
Perforation	13 ^b (8%)
Malrotation without volvulus	11 (7%)
Meckel's diverticulitis	3 (2%)
Small bowel stricture	3 (2%)
Abscess (postoperative)	2 (1%)
Haemorrhage	2 ^c (1%)
Anastomosis leak	1 (1%)
Choriocarcinoma bleed (postoperative)	1 (1%)
Infected mesenteric cyst	1 (1%)
Duplication cyst	1 (1%)
Spontaneous bacterial peritonitis	1 (1%)
Recurrent diaphragmatic hernia (following injury)	1 (1%)
Diaphragmatic injury (stab wound)	1 (1%)
Colonic pneumatosis	1 (1%)
Right ovarian torsion	1 (1%)
Total	161 (100%)

^a5 associated with malrotation; ^b8 associated with trauma;
^c1 spleen trauma, 1 mesenteric trauma

mortality among our reoperated cases. In contrast, the NELA results demonstrate raised 30-day mortality in cases requiring reoperation (16.9% vs 10.2% for those not requiring return to theatre).² This highlights the different physiology and nature of the disease process, and probably also a different norm of practice in children compared with adult patients.

In our audit, the overall mortality rate was 4.3%. We could find only one previously published paper, from the US, also looking at paediatric mortality following surgery, which noted an overall paediatric surgical inpatient mortality rate of 0.85%.¹¹ However, that study included all

surgical specialties and procedures so the data are not directly comparable with the emergency laparotomy cases included in our audit.

While mortality in our population was much lower than in the NELA reports (4.3% vs 15.6%),² the timing of death was similar. In both patient cohorts, approximately three-quarters of the deaths occurred within 30 days of operation. It is likely that the lower mortality in our paediatric population reflects the different nature of the disease process, diagnoses and physiological response in children compared with adults. Nevertheless, it is worth noting that 100% of the paediatric cases were led by a

Table 3 Details for deceased patients

Patient	Age	Sex	Indication for surgery	Operative procedure	Cause of death	Days from operation to death
1	12 years	M	Blunt abdominal trauma, massive haemorrhage	Exploratory laparotomy, bilateral thoracotomies	Mesenteric vessel disruption, small bowel injury, cardiorespiratory arrest	0
2	2 months	F	Giant exomphalos, ileal perforation	Laparotomy repair	Septic shock, respiratory acidosis, gross faecal peritonitis	1
3	4 months	F	Gastroschisis with midgut devascularisation, formation of jejunostomy, colonic mucous fistula, intestinal stenting	Bowel resection, anastomosis	Severe acidosis, prolonged hypoperfusion, septic shock	0
4	17 years	F	Anorexia nervosa, duodenal ulcer, duodenal perforation, enterocutaneous fistula, wound dehiscence	Laparotomy repair	Lung collapse, cardiac arrest	36
5	2 months	M	Malrotation + volvulus, 80cm of gangrenous bowel resected, sepsis	Ladd's procedure, small bowel resection	Infection, cardiovascular collapse, acidosis, renal failure, brain death	5
6	5 months	F	Gastroschisis, adhesive bowel obstruction	Adhesiolysis	Septic shock, disseminated intravascular coagulation	108
7	10 years	F	Sudden cardiac arrest outside hospital	Negative laparotomy	Cardiorespiratory arrest, metabolic acidosis, arrhythmia	1

Table 4 Comparison of deceased and surviving cohorts

	Median age (range)	Male	Prior comorbidity	Previous relevant surgical history	ASA grade ≥ 2	Surgery performed out of hours	Postoperative ICU admission
Survived ($n=154$)	2 years 10 months (1 month – 17 years)	94 (61%)	48 (31%)	58 (38%)	74 (48%)	62 (40%)	75 (49%)
Died ($n=7$)	4 months (2 months – 17 years)	2 (29%)	2 (29%)	3 (43%)	5 (71%)	1 (14%)	7 (100%)
<i>p</i> -value	0.14	0.11	1.00	1.00	0.27	1.00	0.01
ASA = American Society of Anesthesiologists; ICU = intensive care unit							

consultant surgeon compared with only 89% of adult patients with a mortality risk of $\geq 5\%$ in the NELA data.² Furthermore, patient care (including transfer decisions and care in the ICU) was largely consultant-delivered in our institution. The deceased patients showed a trend towards being younger and having higher ASA grades than the survivors although these differences were not statistically significant.

Operating out of hours has many implications in terms of patient safety as well as integrity and security of the entire team along with the skill mix available, which greatly compromises effective, safe and robust management plans. Although it was not statistically significant, mortality in our audit was higher in patients undergoing surgery out of hours. This raises concerns about the negative impact of out-of-hours operations. A larger, multicentre study would be helpful in further investigating these factors.

Study limitations

Given the lack of comparable paediatric studies in this field, it was difficult to compare our outcomes against any established benchmark. Another drawback of this study was its retrospective nature, which has its own limitations, such as bias and confounding as a result of inaccuracies in data coding and incomplete datasets. Moreover, owing to the retrospective design, it was not possible to use a scoring system (eg PRISM [Pediatric Risk of Mortality] or PeLOD [Pediatric Logistic Organ Dysfunction]) for ICU admission and we did not evaluate how many of the children who were initially transferred to a surgical ward were subsequently transferred to the intensive care team. Analysis of such data would enable us to determine whether ICU requirement is being suitably identified in a timely fashion. Despite the above limitations, our study provides a starting point for planning a prospective, multicentre audit investigating paediatric emergency laparotomy.

Conclusions

To our knowledge, this is the first study that reflects the quality of care in the paediatric population for emergency laparotomy cases in a tertiary care unit. It also provides a baseline to further audit the outcomes in children who require emergency laparotomy, with a view to establishing standards of care, benchmarks for comparison of outcomes and possible measures for improvement. A larger study using data from multiple paediatric centres would be of great benefit.

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