



# The application of enhanced recovery after surgery in emergency abdominal surgery

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**Abstract:** Enhanced recovery after surgery (ERAS) is a multidisciplinary, evidence-based, standardised approach to minimise the stress response to surgery, promote organ function and subsequently improve patient outcome. A large evidence base is now available demonstrating improved patient outcomes and cost savings within elective surgery. Emergency abdominal surgery is performed for a variety of different pathologies in a complex patient population and is associated with a high mortality rate globally. Only recently is evidence emerging demonstrating how similar principles of ERAS can be applied to this cohort of patients. The aim of this article is to collate and review the literature that contributes to the evidence base of ERAS in emergency abdominal surgery. Evidence from a number of studies, the National Emergency Laparotomy Audit (NELA) and other quality improvement projects were identified and reviewed. The overriding theme from this evidence is that when the principles of ERAS (evidence based, standardised protocols) are applied to patients undergoing emergency abdominal surgery, outcomes can be improved while patient safety is preserved. Given the time-critical nature of emergency abdominal surgery, some of the elements of ERAS programmes will not be applicable. Tailored protocols are therefore required to meet the needs of these unique patients. Future developments should focus on identifying ERAS components that improve patient outcomes and incorporating them into effective time-based pathways.

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## Background

Emergency abdominal surgery is performed for a variety of different pathologies, often causing patients considerable systemic disturbance. These patients are frequently elderly with multiple co-morbidities and advanced disease processes that may not have been treated optimally (1). This patient population therefore poses unique challenges to all those involved in their care. An emergency laparotomy is a common emergency procedure used in the approach to these patients, which is known to have a high mortality rate globally, with a significant risk of death demonstrated in

the UK, USA and Denmark (2-4). In 2010, the Emergency Laparotomy Network (ELN) demonstrated a crude 30-day mortality rate in the UK as 14.9%. This mortality rate also demonstrated significant variation between different hospitals, possibly reflecting differences in effective clinical management (2). The National Emergency Laparotomy Audit (NELA) in the UK was subsequently developed to gather data on patient care and associated outcomes in all patients undergoing emergency laparotomy in England and Wales from December 2013 (5).

Enhanced recovery after surgery (ERAS) is a multidisciplinary, evidence-based, standardised approach

to minimise the stress response to surgery, promote organ function and subsequently improve patient outcome (6). Since it was pioneered in the 1990s, a substantial evidence base is now available demonstrating improved patient outcomes and cost savings within elective surgery (7). It has subsequently been incorporated into many guidelines for perioperative care of elective colorectal patients (8). Only recently is evidence emerging highlighting how similar principles of care can be applied to those patients undergoing emergency abdominal surgery (9-11). Although not all of the elements of enhanced recovery protocols can be utilised in these patients, the central theme of standardised, evidenced based, patient-centred pathways can still be applied.

## Evidence

In 2011, Møller *et al.* published a trial in the *British Journal of Surgery* evaluating the effect of a multimodal, multidisciplinary perioperative care programme on the mortality of patients with a perforated peptic ulcer. Seven centres across Denmark were included in the study between January 2008 and December 2009. The 30-day mortality rate following the implementation of the protocol was reduced by more than one-third compared to historical and concurrent national controls, corresponding to a relative risk reduction of 37% and a number needed to treat of 10 (10).

A study published from the UK in 2014 demonstrated that the introduction of an emergency laparotomy pathway quality improvement care (ELPQuiC) bundle was associated with a substantial reduction in the risk of death following emergency laparotomy. This care bundle was introduced across four different sites over an eight-month period within the UK and consisted of: initial assessment with early warning scores, early antibiotics, surgery within six hours following decision to operate, goal-directed haemodynamic therapy and post-operative intensive care. Following the implementation of this care bundle, there was an increase in the number of lives saved from 6.47 to 12.44 per 100 patients treated. There was also no significant difference between patient groups as determined by the mean Portsmouth Physiological and Operative Severity Score for the enumeration of mortality and morbidity risk (P\_POSSUM) (9). A further study went on to analyse the cost of implementing the care bundle from both a hospital and societal perspective. This was conducted in accordance with the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) guidelines. Two decision trees were designed- a short term hospital management

model and a long-term societal perspective model. It concluded that implementation of the ELPQuiC bundle is associated with lower mortality and higher in-hospital costs but reduced societal costs (12).

In 2014, Lohsiriwat published a study comparing ERAS care to conventional care in patients undergoing emergency bowel resection for obstructing colorectal cancer at a University Hospital in Bangkok, Thailand. Between January 2011 and October 2013, 20 patients were managed according to an ERAS programme compared with 40 patients who received conventional care. These patients were matched for age, gender, type of surgery and ColoRectal Physiological and Operative Severity Score for the enumeration of mortality and morbidity score. Median length of stay in the ERAS group was reduced by over 2 days, bowel function recovered faster and patients were able to commence neoadjuvant chemotherapy sooner. However, no significant difference in the incidence of post-operative complications was identified (13). The components within this sizable ERAS programme consisted of:

### Pre-operative

- ❖ Detailed pre-operative advice and guidance including respiratory physiotherapy, mobilisation, nutrition aims and predicted length of stay.

### Intra-operative

- ❖ Standardised anaesthetic regime (balanced general anaesthesia) and surgical care;
- ❖ Transverse abdominal incision for ascending colon cancer surgery;
- ❖ Manual colonic decompression before anastomosis in obstructing left sided colorectal cancer;
- ❖ No intraabdominal or pelvic drainage;
- ❖ Utilisation of an of O-ring wound retractor®;
- ❖ Active patient warming using heated intravenous fluid, a forced air warmer and warm saline soaked swabs around the intestine;
- ❖ Local anaesthetic infiltration into the facial layer and skin;
- ❖ Administration of antiemetics depending on risk factors.

### Post-operative

- ❖ Intravenous fluid to maintain urine output

0.5–1 mL/kg/h with deliberate administration of colloid solution if needed;

- ❖ Early removal of the nasogastric tube at 24–48 h postoperatively unless excess drainage;
- ❖ Early ingestion and oral intake after NGT removal;
- ❖ Multimodal analgesia with favoured use of selective COX-2 inhibitors;
- ❖ Trial without urinary catheter at 48–72 h postoperatively in a stable patient;
- ❖ Routine mobilisation and daily physiotherapy;
- ❖ Targeted patient discharge on postoperative day 5.

### *Following discharge*

- ❖ Telephone call 3 days and 1 week following discharge;
- ❖ 2 week and 30 day follow up clinic.

In 2016, Wisely *et al.* published a retrospective cohort study comparing emergency patients undergoing major abdominal surgery for various disease processes before and after the introduction of an ERAS programme. Three hundred and seventy patients were included in the study and baseline variables were similar. Following the implementation of an ERAS programme, patients received significantly less intravenous fluids. They also were less likely to have a urinary catheter, abdominal drain and patient controlled analgesia at 48 hours. Urinary tract infections, urinary retention and pulmonary infections were all significantly reduced. Although inpatient mortality, re-operation, re-admission and duration of hospital stay between both time periods were similar, the study concluded that the introduction of an ERAS programme in this patient population is not harmful and further study on patient outcomes is required (14).

Shida *et al.* published a study in 2017 in *BMC Surgery* evaluating patient outcomes in 122 consecutive bowel resections for obstructing colorectal cancers at a general hospital in Tokyo. The first set of 42 patients were managed using conventional care and the subsequent 80 patients with a modified ERAS protocol. Differences between the modified ERAS protocol and traditional care included preoperative counselling, perioperative intravenous fluid management, reducing the post-operative nil by mouth period and providing early oral nutrition, use of an intraoperative forced air warmer, encouraged postoperative mobilization, prevention of ileus, removal of urinary catheter at the earliest opportunity and a multidisciplinary team approach to care. The ERAS patient group showed

a reduced median hospital stay by 3 days yet a comparable rate of post-operative complications, mortality and readmission rates. Again, this study concluded that ERAS can be incorporated into the care of patients undergoing emergency colorectal resections with no safety concerns and further randomised studies should be performed (15).

Tengberg *et al.* published a large single centre control study in 2017 evaluating the use of a new protocol for patients undergoing acute high-risk abdominal (AHA) surgery. This consisted of continuous staff training, consultant driven care, early resuscitation with high dose antibiotics, surgery performed within 6 hours of decision to operate, perioperative goal directed fluid therapy, intermediate level of care for the first 24 hours following surgery, standardised analgesia, encouraged mobilisation postoperatively and early enteral nutrition. Six hundred patients were included in this study compared to six hundred historical controls. The 30-day mortality within the control group was 21.8% compared to 15.5% in the intervention group. Those patients within the intervention group also showed a 7.3% reduction in 180-day mortality (11).

A large retrospective analysis of patients undergoing emergency surgery for obstructing colorectal cancer at 4 institutions was conducted in China and published in 2018 in *Medicine (Baltimore)*. It compared 356 cases using a modified ERAS protocol and 483 cases using traditional protocols. Propensity score matching was performed to adjust biases in patient selection. Patients cared for using the modified ERAS programme showed improved gastrointestinal function recovery, including time to first flatus, first defecation and prolonged ileus. Patients who received care using the modified ERAS also had fewer grade 2 or higher post-operative complications, a reduced post-operative hospital stay and a shorter time before commencing neoadjuvant chemotherapy. The study concluded that applying a modified ERAS protocol in this cohort of emergency patients was safe and is also associated with many clinical benefits (16).

In addition to the previous literature, the NELA has been collecting data on all patients over the age of 18 years undergoing a non-trauma related general surgical emergency laparotomy in NHS hospitals within England and Wales since 2013. The aim of this ongoing audit is to collate data and publish reports to facilitate improvement in the delivery of care for these patients. The most recent report from NELA has shown that since 2013 UK national 30-day mortality has fallen from 11.8% to 9.5% and hospital length of stay has fallen from 19.2 to 15.6 days (5).

The Emergency Laparotomy Collaborative was a large 2-year quality improvement project which involved the upscale of the ELPQuIC care bundle to 24 NHS Trusts between 2015 to 2017. Using NELA data, it was determined that the implementation of the care bundle reduced crude mortality from 9.8% to 8.7% and the mean length of stay decreased by 1.3 days (17).

Despite the successes of the above studies, the recently published Enhanced Peri-operative Care for High-risk patients (EPOCH) trial failed to demonstrate any improved patient outcomes. Patients aged 40 years or older undergoing urgent open major abdominal surgery were included in this cluster randomised trial. Eligible UK NHS hospitals were divided into 15 geographical areas and started the quality improvement programme in a random order, with one geographical area initiating the programme every 5 weeks. The study was conducted over 85 weeks and the programme consisted of 37 interventions that were developed from existing guidelines published by the Royal College of Surgeons of England. In total, 15,873 patients were recruited from 93 NHS hospitals with 8,482 patients in the standard care group and 7,374 patients in the quality improvement group. The principle finding of the study was there was no survival benefit associated with the programme and additionally, no difference was observed in hospital length of stay and readmission between the two groups. The robust methodology of this large trial is able to confer causality whereas the observational studies described earlier can only describe association between implementing ERAS and patient outcomes. However, there was wide variation between hospitals in which components of the 37 interventions they were actually able to implement. This could explain the incongruous study results. The duration of the study intervention period was also less compared to other studies, such as the Emergency Laparotomy Collaborative. The authors concluded that future studies should implement fewer, more realistic interventions and ensure hospitals have adequate time to achieve these changes in care (18).

## Discussion

The overriding theme from these studies is that when the principles of ERAS (evidenced based, standardised protocols) are applied to patients undergoing emergency abdominal surgery, outcomes can be improved while patient safety is preserved. The time-critical nature of emergency abdominal surgery will require tailored ERAS programmes that suit the needs of these patients. *Table 1* demonstrates

**Table 1** Elements of an ERAS programme and their potential applicability in emergency abdominal surgery

Elements	Applicability
Primary care	X
Patient preparation	
Shared decision making	✓
Optimising medical conditions	Limited
Pre-op risk assessment	✓
Pt info and expectation managed	✓
Discharge planning	Limited
Pre-op therapy instruction	Limited
Admission	
Shared decision making	✓
Admission on day of surgery	X
Optimising fluid hydration	✓
CHO loading	X
Reduced starvation	X
No bowel preparation	✓
Intraoperative	
Minimally invasive surgery	✓
Use of transverse incisions	✓
No NG tube	Potentially
Use of regional anaesthesia	✓
Goal directed fluid therapy	✓
Prevention of hypothermia	✓
Postoperative	
Planned mobilisation	✓
Rapid hydration and nourishment	Limited
Appropriate IV therapy	✓
No wound drains	Potentially
No NG tube	Potentially
Catheters removed early	Potentially
Regular oral analgesia	✓
Avoidance of systemic opiates	Potentially
Post discharge care	
Discharge when criteria met	✓
Therapy support (stoma, physio)	✓
24 h telephone follow-up	✓

ERAS, enhanced recovery after surgery; CHO, carbohydrate; NG, nasogastric; IV, intravenous.

individual components of ERAS programmes and their potential applicability to emergency abdominal surgery.

The key to ERAS programmes is to:

- (I) Recognise available evidence that has the potential to improve patient outcomes;
- (II) Incorporate this evidence into appropriate pathways tailored to the patient population;
- (III) Develop hospital systems to evaluate compliance with the individual components of the pathway (19).

The future of ERAS in emergency abdominal surgery should focus on each of these key aspects. Components of care within the protocols described in the previous literature demonstrated significant variation. We should continue to analyse and identify key components that should be incorporated into pathways. Hospitals with above average performance should be highlighted using published data and the processes of care that achieves these results analysed more widely (20). Novel ideas such as specialised physicians providing care following emergency surgery should be explored (19). The care of elderly patients should be better understood. The increased incidence of post-operative complications within this cohort leads to many of these patients facing a prolonged stay in hospital, with a reduced likelihood of returning to independent living. Following discharge from hospital, little is known of their ongoing life expectancy, functional status and quality of life. This assessment will help guide a more informed discussion on the suitability of high intensity surgical treatment (20).

## Conclusions

ERAS has been implemented into many elective surgical subspecialties, which has led to significant improvements in patient care. Institutions should now focus on developing and delivering tailored ERAS programmes to patients undergoing emergency abdominal surgery, striving to continually improve patient outcomes in this complex patient population.

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## Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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