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Review Article

Pre-optimisation of patients undergoing emergency laparotomy: a review of best practice

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Summary
Although the concept of pre-operative optimisation is traditionally applied to elective surgery, there is ample opportunity to apply similar principles to patients undergoing emergency laparotomy. The key challenge is achieving meaningful improvements in a patient's condition without introducing delays to time-sensitive surgery, which may be required in a matter of hours. Optimisation can be considered in two parts: that of the patient's condition; and that of the care pathway. Optimising the patient's condition is less about improving long-term pathology, and more about correcting physiological derangement, such as electrolyte and fluid balance, blood loss, prompt treatment of sepsis, and ensuring appropriate continuation of medication in the peri-operative period. Optimising the care pathway involves ensuring that the system is designed to deliver reliably the appropriate interventions, such as prompt antibiotics, and access to computed tomography scanning and the operating theatre with minimal delay.

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Introduction
Approximately 30,000 emergency laparotomies are performed annually in England and Wales [1, 2]. Emergency laparotomy encompasses a wide range of procedures performed for a variety of surgical pathologies (Table 1). The presentation may be acute or subacute, and around 6% arise as complications of elective surgery. Almost half of patients are aged > 70 years, and 55% of patients have ASA physical status grade ≥ 3 [3].

The majority of patients undergoing emergency laparotomy have potentially life-threatening conditions that require prompt intervention (Table 2). The small proportion of patients who require an emergency laparotomy following elective surgery may have had the benefit of pre-optimisation for their elective procedure. However, for most, there is often limited time to carry out investigations and instigate treatment to optimise comorbidities. The time required to optimise a patient needs to be balanced against the risk of delay for time-sensitive pathologies. Data from the National Emergency Laparotomy Audit (NELA) shows that around 50% of patients have a surgical urgency < 6 h, 33% 6–18 h and 17% > 18 h [3]. As such, pre-optimisation for emergency surgery needs to be viewed in a different light to elective surgery. There is still significant opportunity to improve a patient's condition before emergency laparotomy, but this needs to be balanced against the surgical urgency.

Table 1 Primary surgical procedure performed during an emergency laparotomy (data from the 2018 National Emergency Laparotomy Audit). Values are proportion.

Primary surgical procedure	
Colonic resection	36%
Adhesiolysis	17%
Small bowel resection	16%
Drainage/washout of abscess/collection	5%
Peptic ulcer – suture repair of perforation	5%
Other	22%

Table 2 Main indications for an emergency laparotomy (data from the 2018 National Emergency Laparotomy Audit – N.B. more than one option may apply). Values are proportion.

Indication for surgery	
Small bowel obstruction	37%
Perforation	25%
Peritonitis	21%
Large bowel obstruction	14%
Sepsis	8%
Ischaemia	7%
Abdominal abscess	7%
Incarcerated hernia	5%
Colitis	4%
Volvulus	3%
Haemorrhage	3%

The approach to pre-optimisation can be considered in two parts: optimising the patient's condition; and optimising the care pathway to reduce delays.

Optimising the patient's condition

Timely antibiotics

Current recommendations advise that antibiotic prophylaxis for abdominal surgery is given on induction of anaesthesia or ≤ 60 min before the start of surgery [4, 5]. However, more than one-third of patients have signs of sepsis present on admission or at the time that the decision for surgery was made [3]. Patients with signs and symptoms consistent with sepsis should receive antibiotics as a matter of urgency after the diagnosis is suspected, irrespective of the timing of surgery. This may well mean that antibiotics are administered in the emergency department. The literature on sepsis describes a 'golden hour' for early administration of antibiotics, with observable increases in mortality for every hour of delay in delivering the first dose [6, 7].

Since the presentations and indications for emergency laparotomy are multiple, and antimicrobial stewardship is an important consideration, the urgent administration of broad-spectrum antibiotics will not apply to all patients. Hospitals should ensure they have their own systems in place to identify patients with sepsis and be able to manage them appropriately.

Rational approach to fluid resuscitation and electrolyte balance

Patients presenting with intra-abdominal pathology may be hypovolaemic, either due to fluid losses from the gastrointestinal tract through diarrhoea or vomiting, sequestration of fluid within the bowel lumen, intra-abdominal haemorrhage or a relative hypovolaemia due to distributive shock in the presence of sepsis or severe inflammation. In some cases, fluid resuscitation will need to continue before, during and after surgery. When presented with a hypovolaemic patient, the approach to fluid resuscitation should be consistent with the underlying cause.

Patients with acute haemorrhage may require blood products as opposed to large quantities of clear fluids. Although the evidence suggests that a restrictive approach to the management of upper gastrointestinal bleeding is preferable [8, 9], shocked patients or those with evidence of continuing significant bleeding should be managed with early, balanced transfusion. Hospitals should therefore ensure they have the capacity to supply packed red blood cells (O negative or cross-matched) and other blood products rapidly in the event of major haemorrhage. Applying evidence from the trauma literature, access to thromboelastography may also help to rationalise the use of specific blood products. In the event of major haemorrhage, tranexamic acid should be considered as part of resuscitation, along with the avoidance of hypothermia, acidosis and coagulopathy. In any patient with continuing bleeding, the priority should be urgent haemostasis, either through surgery, endoscopic intervention or interventional radiology [10].

Patients presenting for emergency surgery due to cancer causing bowel obstruction may also be anaemic. Treatment with intravenous (i.v.) iron before elective surgery is becoming an established part of pre-operative optimisation that reduces allogenic transfusion requirements. However, its role within the emergency situation is unclear [11, 12]. Guidelines suggest that in the absence of evidence of iron deficiency, the routine use of iron supplementation is not recommended during critical illness [13]. For planned surgery, the target pre-operative haemoglobin concentration is ≥ 130 $g.l^{-1}$, however, a range of 70–90 $g.l^{-1}$ is generally acceptable for critically ill patients, unless modified due to specific comorbidities or acute illness [13, 14].

Patients with significant gastrointestinal tract fluid loss may be both fluid volume and electrolyte depleted. There remains significant debate over the best (or least bad) fluid to use in this situation. In critically ill patients, a balanced crystalloid solution would appear preferable to saline, in order to avoid a high sodium and chloride load [15]. Hydroxyethyl starch solutions have been widely withdrawn from routine use; however, this remains the subject of review [16, 17]. Although hydroxyethyl starch solutions do remain available for the initial management of hypovolaemia secondary to acute haemorrhage, they should not be used in sepsis or other critical illness, and UK guidelines continue to recommend against their use for fluid resuscitation [17, 18]. Other colloids, such as gelatins and albumin, remain available, but any additional benefit over crystalloids remains unproven [19]. Patients with subacute presentation, such as acute-on-chronic bowel obstruction, may have suffered several weeks of worsening fluid losses resulting in chronic fluid and electrolyte imbalance. Restoration of intracellular cations is unlikely to be accomplished by peripheral administration of i.v. fluids alone. Central venous cannulation may be required in order to administer concentrated potassium or other electrolyte infusions. However, the time required to restore electrolyte concentrations to normal levels, when the maximum infusion rate for $K+$ is 10 $mmol.h^{-1}$, needs to be balanced against surgical urgency.

In the patient with relative hypovolaemia secondary to vasodilation, fluid resuscitation may only be transiently effective. Excessive administration of fluid may cause an increase in extravascular lung water (compromising oxygenation or ventilation) or worsen tissue oedema (affecting healing of wounds and surgical anastomoses, and compromising organ perfusion). These patients are likely to require the use of vasopressors or inotropes in addition to i.v. fluid; however, the end-points to aim for are not clear. There is research in progress to ascertain whether the intra-operative use of goal directed fluid therapy benefits patients undergoing emergency laparotomy [20].

In general, patients undergoing emergency laparotomy require meticulous monitoring of fluid input and output, including from urinary catheters, stomas, drains, nasogastric tubes and other gastrointestinal losses. Clinicians should bear in mind that in patients with obstruction or ileus, the bowel lumen may contain a significant volume of unmeasured fluid. Intravenous fluid for maintenance and i.v. fluid for resuscitation should be viewed separately, with resuscitation fluid given as titrated boluses. Intravenous fluid resuscitation should be de-escalated as early as possible, and high continuing fluid input should be prompt review by a senior clinician [18].

Omitting/optimising medications

The approach to adjusting or omitting medications should be individualised for the patient, considering their past medical history and the clinical situation.

Acute kidney injury is not uncommon in patients requiring emergency laparotomy due to fluid and electrolyte imbalance, coupled with an elderly patient population. Nephrotoxic medications should be reviewed and omitted where possible, especially in the shocked patient. NHS England introduced an acute kidney injury alert system in 2014 to standardise the identification and treatment of acute kidney injury [21]. It is likely that such patients will have been 'flagged' by a hospital's pathology results system, and it is important that this information is recorded and acted upon. Renal function and blood pressure should be considered before giving any antihypertensive drugs, especially ACE-inhibitors or angiotensin receptor blockers [22]. Administration of β-blockers to patients who are already on therapy should be reviewed on a case by case basis, since there is evidence to support continuing their existing use peri-operatively [23]. The same also applies to patients who are already prescribed statins.

Where the absorption of medication via the enteral route is not possible due to the surgical pathology, consideration should be given to finding alternatives for certain essential medications (anti-epileptics, treatment for Parkinson's disease, immunosuppression for transplant patients, etc). These patients should be discussed with the relevant speciality and the pharmacist to try to identify alternative options in the peri-operative period.

Medications with a narrow therapeutic window should be monitored due to the effect that acute illness or drug interactions may have on metabolism and clearance.

Anticoagulants and antiplatelet medications should not be discontinued without first establishing why they were originally prescribed. Patients taking antiplatelet medications following recent endovascular stenting should be discussed with the relevant speciality. In many instances, it may be necessary to stop or reverse anticoagulation, but the indication for the anticoagulant will determine what additional action is required [24, 25]. For instance, patients with a mechanical aortic value will require bridging therapy with low molecular weight or unfractionated heparin, as will patients with a recent venous thromboembolism. Patients with a recent venous thromboembolism in whom full anticoagulation is contraindicated may benefit from insertion of a temporary inferior vena cava filter [26]. Again, the specific circumstances of the patient should be considered.

This list is by no means exhaustive, and early discussion with a pharmacist and the relevant medical specialties is advised for other medications.

Nutrition

Adequate nutrition is vital for recovery from major surgery and it is recommended that nutritional status be formally assessed both pre- and postoperatively [27]. Where time allows, the nutritional status of patients should be optimised pre-operatively in discussion with a dietician.

Peri-operative nutritional therapy is indicated in patients with malnutrition or those at risk, such as patients not anticipated to be able to eat for > 5 days peri-operatively, or those not expected to be able to maintain > 50% of their recommended intake for > 7 days [27]. Although the enteral route is preferred, numerous indications for emergency laparotomy are contraindications to enteral feeding. In these instances, parental feeding is an alternative. It is common to site a multilumen central venous catheter during surgery, and reserve one lumen for parenteral feeds only.

Even if oral diet or feeding via the enteral route is possible, if energy and nutritional requirements cannot be met (e.g. an intake < 50% of calorific requirement) for 7 days, supplementation with parenteral nutrition is recommended. Where it is indicated, parenteral nutrition should be administered as soon as possible [27].

Glycaemic control

Periods of fasting, either before surgery or because enteral nutrition is not tolerated, coupled with the stress response associated with acute illness, are likely to affect the glycaemic control of diabetic patients.

Due to the unpredictable nature of the timing, duration and recovery from emergency surgery, most patients with diabetes who require emergency laparotomy should be managed with i.v. insulin and glucose, either in the form of a variable rate i.v. insulin infusion or a glucose-potassium-insulin infusion, depending on the specific hospital guideline [28, 29]. Patients usually treated with an insulin pump should be managed according to the local policy.

Once an i.v. insulin infusion is established, most regular oral antidiabetic medications should be stopped until the patient is eating and drinking normally, with the exception of GLP-1 analogues, which may be continued [28, 29]. Although there are no formal UK guidelines at the time of writing, SGLT-2 inhibitors should be stopped 2–3 days before surgery due to the risk of euglycaemic ketoacidosis. If this is not possible, blood ketones should be monitored in addition to blood glucose [30–32]. If the patient usually takes a long-acting subcutaneous insulin, this may be continued at 80% of the normal dose together with i.v. insulin, as this may help to stabilise glycaemic control and facilitate return to the patient's normal regimen [28, 29].

Any patient undergoing urgent surgery who is receiving insulin will require regular monitoring of blood glucose and continuous supply of substrate. Aiming for tight glycaemic control is not recommended, but instead the target blood glucose level in the pre-operative or anaesthetised patient should be 6–10 $mmol.l^{-1}$, accepting values of $\leq$ 12 $mmol.l^{-1}$ in patients where control is more difficult [28, 29].

Patients with diabetes should be managed in an environment where the staff are familiar with their care. Early involvement of the hospital's diabetes team should be considered.

Pre-operative chest physiotherapy

Postoperative pulmonary complications are common after major abdominal surgery. Some small studies have demonstrated that pre-operative prophylactic physiotherapy can reduce the incidence of such complications [33, 34]. These studies do not account for the specific challenges relating to emergency surgical patients, and were not powered to examine outcomes such as mortality or length of stay. As such, there are no formal recommendations for prophylactic physiotherapy, but this could be a useful area for further study.

Damage control surgery

Although typically associated with trauma patients, some of the elements of damage control surgery are equally applicable to unstable general surgical patients with significant peritoneal contamination or major intra-abdominal haemorrhage. Here the focus is on short-term physiological correction rather than definitive surgery [35]. There are four phases to the process of damage control surgery, as outlined in Table 3. Phases 0 to 3 could be viewed as an extended period of optimisation before the final definitive procedure in phase 4.

Clearly not every emergency laparotomy requires this approach, but the principles should be considered when dealing with patients with significant physiological disturbance or haemodynamic compromise.

Table 3 Phases of damage control surgery.

Phase	Location	Aims	Priority
0	Pre-operative (e.g. Emergency Department, ward)	Resuscitation Prompt access to an operating theatre Avoidance of hypothermia	Physiological optimisation
I	Operating theatre	Damage control laparotomy Control of bleeding Washout of contamination	
II	Critical Care Unit	Further resuscitation Physiological/organ support	
III	Operating theatre	Restoration of bowel continuity, ± closure of abdomen	Definitive procedure

Optimising the care pathway

Reducing delays

Since one of the challenges of emergency surgery is the limited time for pre-operative investigations and optimisation of the patient, it is vital that the care pathway runs as smoothly as possible to avoid unnecessary delays. Delay to emergency surgery has been associated with lower rates of survival [36]. Hospitals should investigate the performance of their own internal systems to ensure that: patients requiring an emergency laparotomy are promptly identified and referred to senior decision makers; any pre-operative investigations can be requested and the results reviewed in a timely manner; and there is sufficient capacity to allow access to an operating theatre in a timeframe appropriate to the clinical urgency.

Hospital systems are complex, and a patient requiring emergency laparotomy will require input from numerous professionals from multiple departments. There is not, therefore, a single right way to structure this pathway, but different solutions will work best according to a hospital's own specific infrastructure and resources. Clinicians should endeavour to optimise this pathway through regular data collection and quality improvement methodology.

Timeliness of access to and reporting of radiology and CT investigations

Interventional radiology plays an important part in the treatment of certain surgical pathologies and may avoid the need for emergency laparotomy. It is the treatment of choice for some types of abdominal bleeding and drainage of abdominal collections. The lack of universal availability of interventional radiology may be overcome through network arrangements with neighbouring hospitals, such that there is a defined pathway to refer patients who would benefit from Interventional radiology and potentially avoid an emergency laparotomy.

It is recognised that for some patients the decision to perform emergency laparotomy can be taken based on clinical findings alone, and that not all patients require an abdominal computed tomography (CT) pre-operatively. However, the majority of patients who go on to have an emergency laparotomy will have had a CT scan performed before surgery [3]. In such a case, it is important that patients have timely access to diagnostic radiology services, and that these images can be reported by a suitably experienced radiologist so that the results aid surgical decision-making without adding delay.

Such targets for access and reporting of CT scans exist for patients admitted following major trauma (CT access available < 15 min and reported by a consultant radiologist < 60 min of the scan) [37], so it is not unreasonable that similar results could be achieved before an emergency laparotomy. Agreements with the radiology department that ensure appropriate scans are performed and reported urgently would assist surgical planning by identifying the likely extent of pathology, and hopefully reduce the number of non-therapeutic (open-and-close) laparotomies in the event of advanced or untreatable disease.

Standardisation/surgical pathways

National audit data have shown that there are considerable variations in the standards of care that patients undergoing emergency laparotomy receive, both between hospitals and within hospitals [3].

Intra-hospital variation can be reduced through standardisation of processes and modification of systems, such that barriers to providing appropriate care are reduced and inappropriate deviation from good care is made more difficult.

This is not to underestimate the importance of the role that clinicians play in ensuring that management is individualised to the specific patient. Good care pathways should overcome access barriers and serve as prompts to clinicians, so that important evidence-based interventions and national recommendations are at least considered, even if they are not applicable in every case.

Optimising the care of the patient

Recognising high risk (or assuming high risk until proven otherwise)

A strong message from the National Emergency Laparotomy Audit has been that appreciation of risk is associated with improved standards of care for high-risk patients. Pre-operative assessment and documentation of risk has been encouraged, initially using the P-POSSUM model and more recently the NELA risk prediction model, which was developed from the population of patients undergoing emergency laparotomy in England and Wales.

Applying population-level data to an individual patient for risk prediction is difficult and should only assist, not replace, clinical judgement. With an overall 30-day mortality rate of 9.5%, emergency laparotomy is high-risk surgery [3]. It is, therefore, reasonable to treat all patients undergoing emergency laparotomy as high risk unless both clinical judgement and risk prediction scores suggest otherwise.

Consultant-led care – right intervention, right time, right place, right people

Considering the high-risk nature of the surgery, it is important to have consultant-led care throughout the process. This applies not only to the technical aspects associated with performing or overseeing the operation but also the decision to operate, or indeed not to operate.

Early consultant input from surgical and anaesthetic specialities, plus critical care and elderly medicine where appropriate, should aim to ensure that the right operation is carried out, at the right time, performed by the right people, with the right facilities available.

Informed consent, shared decision-making and information to family

All patients with capacity should provide fully informed consent before any surgical intervention [38]. The time pressure that comes with the emergency nature of the surgery, coupled with the baseline characteristics of the population undergoing emergency laparotomy, can make this particularly challenging. The process of shared decision-making is another area where the non-technical expertise of consultants is of vital importance.

Although national data provide high-quality information on postoperative mortality and survival, at present the data relating to quality of life and other patient-reported outcomes are very limited. These quality of life factors may be more important to patients and their families than traditional mortality outcomes. Work is underway to assess the feasibility of collecting quality of life outcomes after emergency laparotomy [39]. However, until data on quality of life are available, consultants overseeing the care of these patients must draw on their experience to ensure that they have considered all options, both invasive and more conservative, and are able to reach a shared decision with the patient who is consistent with their wishes and expectations in terms of quality and quantity of life.

Conclusion

Pre-optimisation of patients undergoing emergency laparotomy needs to be viewed in a different light to elective surgery. The reduced time-frames available due to surgical urgency mean that prompt and senior decision-making is required to minimise delays. The time taken to correct any abnormalities needs to be balanced against the need for prompt surgery, particularly in time-sensitive situations involving sepsis or hypovolaemia. Corrective action and surgery may need to occur simultaneously. Although patients might require active treatment to correct abnormalities, it is equally important to ensure that normal medications are continued where appropriate, and omitted where they may be harmful. The reduced timeframe available for pre-optimisation also means that there needs to be robust systems in place to ensure care is provided promptly and consistently, with minimal delays.

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