

Preoperative optimization and enhanced recovery after surgery

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Abstract

Enhanced recovery pathways have been repeatedly shown to reduce length of stay and complication rates for patients undergoing elective major surgery across multiple surgical specialties. The success of the enhanced recovery approach relies on excellent patient preparation and reliable implementation of evidence based, standardized care components at each stage of the surgical journey. Multidisciplinary team engagement and continuous audit of outcomes are crucial in sustaining a successful enhanced recovery after surgery programme.

Keywords Enhanced recovery pathway; length of stay; optimization

Introduction

Enhanced recovery after surgery (ERAS) has been described previously in this journal.¹ This article aims to provide an update regarding developments in this important field.

ERAS programmes lead to reduced length of stay and lower complication rates. This is achieved by aggregating marginal gains made from evidence based interventions at multiple points along the surgical pathway. Since the first ERAS pathways for colorectal surgery were described over 30 years ago,² the approach has become widespread for many types of surgery.

The ERAS society now presents comprehensive guidelines for cardiac, colorectal, gynaecology oncology, liver, bariatric, lung, hepatobiliary, upper gastrointestinal, breast and head and neck surgery. These are freely available at www.erassociety.org. Specific recommendations are made for each subspecialty; however, several components are fundamental to all ERAS programmes (Box 1). The aim of all ERAS interventions is to modify the stress response to surgery, aiming for rapid return to physiological normality and minimal organ dysfunction.

The development and implementation of enhanced recovery programmes requires engagement and effort from all members of the multidisciplinary team, including the patient and their family/caregivers. To ensure success, the whole team must be involved in devising and adhering to standardized care pathways, with regular audit and feedback of the results. The difficulty of changing practices that are 'set in stone', based more on

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Common elements of ERAS programmes

Preoperative components

- Meticulous patient preparation to optimize comorbidities and support cessation of smoking and excessive alcohol intake, and nutritional screening
- Provision of excellent information about the procedure and its impact on health and recovery
- Minimizing disruption to normal medications and normal nutrition/bowel function by avoiding bowel prep and prolonged starvation
- Carbohydrate preload
- Thrombosis prophylaxis

Intraoperative components

- Prophylactic antibiotics
- Minimally invasive surgery wherever possible
- Avoidance of surgical site drains
- Carefully planned anaesthesia that aims to use short acting agents
- Multimodal analgesia to minimize use of opiates (including epidural analgesia for open surgery)
- PONV prophylaxis
- Goal directed fluid therapy (with use of vasopressors to support blood pressure control)
- Use of warm air flow blankets and warmed intravenous fluids to ensure normothermia

Postoperative components

- Removal of NG tubes prior to reversal of anaesthesia
- Early post operative mobilization (Ideally on day of surgery)
- Early feeding (Ideally on day of surgery)
- Early removal of urinary catheters and IV fluids
- Clear daily goals for patients to aim for including likely date of discharge
- Multimodal opioid sparing analgesia
- Multimodal approach to nausea and vomiting prevention

Regular audit of process and outcome measures with feedback of results to the whole multidisciplinary team.

Box 1

dogma than evidence of benefit to patients, should not be underestimated.

The preoperative period

ERAS pathways should be started in the primary care setting when patients are referred to surgical teams for consideration of surgery.³ The time between referral and admission for surgery should be used to help patients prepare for surgery, by modifying unhealthy behaviours such as smoking, excessive alcohol intake and inactivity. The optimization of common comorbidities such as anaemia, diabetes and hypertension should also be started by the primary care team.

For most patients who undergo planned surgery in the UK, a formal assessment of their ability to recover from surgery starts

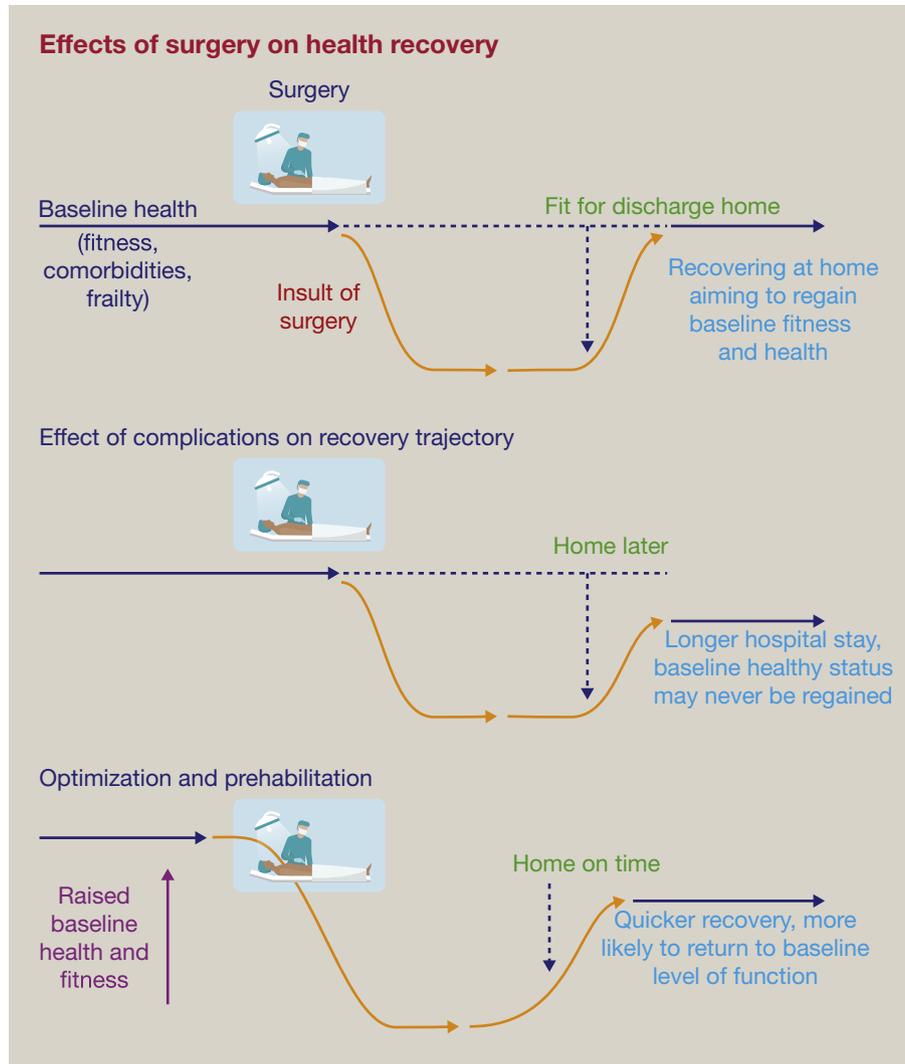


Figure 1 Major surgery causes an acute deterioration in level of health. This recovers back to baseline over a number of days. In the event of a complication, the rate of recovery slows and the baseline level of health may never be regained. Patients with poor preoperative functional status are more likely to experience complications and delayed recovery. Prehabilitation aims to raise the baseline health or functional status of the patient, with the result that even if surgery results in return to a lower level of health and fitness, the overall outcome leaves the patient close to or better than the original baseline level of function.

when they are seen by the surgeon. In the traditional pathway, the assessment continues at the preoperative assessment clinic, often shortly before the planned date for the operation. Most patients are screened for comorbidities using nurse-led protocols. Patients undergoing major surgery and those with poorly optimized conditions (e.g. hypertension, angina, atrial fibrillation, anaemia, diabetes) may undergo dynamic assessment of fitness with cardiopulmonary exercise testing, (CPET) as part of assessment by an anaesthetist. There is increasing evidence that patients with poor physiological reserve have poorer outcomes after major surgery⁴ (Figure 1).

Patients contemplating major surgery should be provided with clear information about the risks and benefits of all available treatment options for their condition, including non-surgical options. This information, (along with an individualized assessment of perioperative risk informed by objective physiological assessments such as CPET), should be used by the patient and

caregivers to reach a shared decision about the best treatment approach for them.

‘Surgery schools’ use a combination of informal classroom teaching, videos and written information as a way of providing patients with good information about how to prepare for surgery. Patients learn what to expect in terms of their experience at the time of surgery and postoperatively, how long they can expect to remain in hospital and what they can do to help their own recovery. One centre in Manchester adopted a respiratory care bundle called ICOUGH (incentive spirometry; cough/deep breathing; oral care; understanding (patient education); get out of bed; head of the bed elevated), and used a surgery school setting to provide information and teach patients to do incentive spirometry. They showed a reduction in rates of pulmonary complications from 19.3% to 10.5% in patients undergoing major elective surgery who were admitted to critical care postoperatively.⁵

Prehabilitation aims to improve functional capacity through exercise regimes, nutritional support and psychological preparation. Evidence is accumulating suggesting that prehabilitation leads to improved outcomes after major surgery.⁶ Several UK centres are now developing prehabilitation programmes, particularly for patients undergoing cancer treatment.

Older patients undergoing major surgery are a particularly high risk group for adverse outcomes and prolonged hospital stays. Several UK centres have now set up multidisciplinary preoperative assessment services for older patients. The Proactive care of older people undergoing surgery, ('POPS') service was developed at St Thomas' Hospital in London, by Dr Jugdeep Dhesi. The POPS team consists of a geriatrician, nurse specialist in older people, occupational therapist (OT), physiotherapist (PT) and social worker. Patients assessed by POPS undergo a comprehensive geriatric assessment of their physical health, mobility, mental health and cognitive functioning, and medications are reviewed. Socioeconomic/environment and functional problems are assessed during a home visit from the OT and PT. Following the assessment, medical problems and medications are optimized, aids and equipment needed for discharge are provided, and where needed, the social worker organizes discharge care packages or intermediate care. Evaluation of the service showed improved outcomes for older patients.⁷

By the day of surgery, patients should have received sufficient information to enable them to start a robust consent process. Their physical and mental health should have been optimized as far as possible, and they should embark on their surgical journey with a clear idea of how long they expect to be in hospital, what is likely to happen to them and how they can contribute personally to ensuring a high quality outcome.

Day of surgery admission

The principal aim of ERAS is to minimize psychological and physiological stresses at all stages of the surgical journey. Admission on the day of surgery allows patients to maintain a normal routine close to family and friends and facilitates good quality rest prior to surgery.

The *routine* use of bowel preparation has largely been abandoned, as it can result in relative dehydration and electrolyte imbalance. Prolonged fasting prior to surgery is avoided, as it results in dehydration and severe discomfort. Patients should fast for 6 hours for solids and 2 hours for clear liquids to reduce the risk of pulmonary aspiration of gastric contents during anaesthesia, although shorter fasting times are under active scrutiny.

Carbohydrate drinks are currently recommended 12 and 2 hours prior to surgery. The suggested benefits of oral carbohydrate loading are improved comfort, reduced insulin resistance and reduced protein loss and catabolism.⁸

Recent studies highlight deficiencies in our understanding of the effects of carbohydrate rich drinks on perioperative insulin resistance. There are almost no data regarding the effect of preoperative carbohydrate drinks in diabetic patients, who represent an increasing proportion of the surgical population. In addition, many patients are now given dexamethasone perioperatively as an antiemetic. This increases whole body insulin resistance, undermining the theoretical goal of carbohydrate drinks as reducers of preoperative insulin resistance. Until the benefits and

safety of preoperative carbohydrate drinks is demonstrated, it may be better to exclude patients with diabetes from this element of ERAS programmes.⁹

The intraoperative period

The surgical and anaesthetic teams ensure that patients receive optimized evidence based management during their operation:

Anaesthesia

The anaesthetist plays an important role in completing crucial safety steps including administration of prophylactic antibiotics (60 minutes or less prior to skin incision), venous thromboembolism prophylaxis, preventing hypothermia and monitoring blood sugar. Adherence to this set of interventions is improved by use of the World Health Organization (WHO) surgical safety checklist.

There is no proven consensus as to the ideal induction or maintenance agents for anaesthesia in the context of ERAS. The chief goal for the anaesthetist is to provide an anaesthetic that has a quick offset to allow rapid recovery. Therefore, sedative premedication is avoided. Tracheal intubation is the usual approach for major intra-abdominal surgery. The use of neuromuscular blocking agents is therefore commonplace.¹⁰

Prevention of postoperative nausea and vomiting is crucial in ensuring that patients are able to meet the postoperative goals of early resumption of eating and drinking. This involves avoidance of nitrous oxide intraoperatively alongside the use of anti-emetic medications.

Throughout the intraoperative phase, the anaesthetist must consider the impact of all aspects of care on the later wellbeing of the patient. Therefore, positioning to avoid later joint and muscle discomfort, care of skin and pressure areas and ventilation strategy aiming to minimize postoperative pulmonary complications are all of the utmost importance.

Intraoperative goal-directed fluid therapy

Intravenous fluid is used to replace fluid losses and maintain the circulating volume. It is well known that insufficient fluid leads to hypotension, organ hypoperfusion and impaired oxygen delivery to the tissues. Excess intravenous fluid can lead to increased postoperative pulmonary complications and cause tissue oedema which can lead to delays in restoration of gastrointestinal function, breakdown of surgical anastomoses and impaired wound healing.

Administration of a fluid bolus can increase cardiac output and consequently blood pressure. The Frank–Starling mechanism describes how a fluid bolus increases preload, stretches cardiac muscle fibres and leads to an increase in stroke volume. This is true up to a certain preload but over distention of the cardiac muscle fibres results in no increase or a reduction in cardiac output.

Goal-directed fluid therapy uses advanced haemodynamic monitoring to guide perioperative fluid bolus administration to optimize the circulating volume. It enables individualized fluid therapy tailored to the individual patient's circulation. The most commonly used cardiac output monitoring devices are the oesophageal doppler and arterial waveform analysis. Oesophageal doppler calculates cardiac output extrapolated from measurements of blood flow velocity in the descending aorta. Arterial waveform analysis calculates cardiac output using information

from an arterial line trace. Information from the device is interpreted and boluses of 250 ml of balanced crystalloid solution are given. If there is a 5–10% increase in stroke volume then the patient is considered to be fluid responsive and further fluid boluses can be given. In situations where there is no rise in stroke volume with a fluid bolus in the presence of hypotension, inotropic or vasopressor drugs should be considered to increase blood pressure and improve organ perfusion.

There have been multiple studies looking at the impact of goal directed fluid therapy. There is evidence that optimized fluid management with a balanced crystalloid solution is associated with reductions in morbidity, critical care length of stay, hospital length of stay & time to return of bowel function.¹¹

Analgesia

Successful analgesia is crucial for ERAS. Many centres now use protocol based intraoperative and postoperative analgesic plans for major surgical procedures. Improved pain control can result in reduced length of stay, earlier mobilization and reduced complications.

Traditional perioperative analgesic regimens are based on the WHO analgesic ladder. These include paracetamol, non-steroidal anti-inflammatory drugs and opiates.

Administration of large doses of strong opiates carries significant risks and side effects. These include sedation, respiratory

depression, nausea and vomiting, constipation and urinary retention. There is emerging evidence that they also can cause opioid induced hyperalgesia and immunosuppression.¹²

ERAS analgesic strategies aim to reduce or avoid opiate analgesia to reduce dose dependant side effects and promote early restoration of normal gastrointestinal function. These involve the use of regional anaesthesia and multi-modal analgesia.

Regional anaesthesia comprises neuraxial techniques (spinal and epidural blockade) and peripheral nerve blockade. Neuraxial techniques involve the administration of local anaesthetic and opiates which act upon the spinal cord. The opiates exert their analgesic effects at much lower doses with reduced systemic side effects. Minimally invasive surgical techniques result in significantly less postoperative pain. As more surgery is achieved with minimally invasive techniques, epidural analgesia is used less commonly compared to spinal anaesthesia with intrathecal opiates. This allows for earlier postoperative mobilization and avoids potential complications associated with epidural analgesia. Regional anaesthesia has been shown to provide improved postoperative pain control, reduce systemic opiate requirements and reduce PONV.¹³

Multimodal analgesia is the use of two or more drugs that target different pain pathways. Ketamine is an NMDA receptor antagonist. At doses of 0.25–0.5 mg/kg it has valuable analgesic properties. It can also be given as a postoperative infusion in a critical care setting. Magnesium is also commonly used at a dose

Evening after Surgery	Day 1	Day 2	Day 3	Day 4	Day 5
Sit out of bed for at least 2 hours <input type="checkbox"/>	Sit out of bed for 6hrs. <input type="checkbox"/>	Sit out of bed for 6hrs. <input type="checkbox"/>	Sit out of bed for 6hrs. <input type="checkbox"/>	Sit out of bed for 6hrs. <input type="checkbox"/>	Sit out of bed
	Walk 20-60m (To Blue walking target) 1 <input type="checkbox"/> 2 <input type="checkbox"/>	Walk 20-60m (To Blue walking target) 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/>	Walk 20-60m (To Blue walking target) 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/>	Walk 20-60m (To Blue walking target) 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/>	Walk
Practice deep breathing exercises hourly	Practice deep breathing exercises hourly	Practice deep breathing exercises hourly	Practice deep breathing exercises hourly	Practice deep breathing exercises hourly	
Free Fluids commence	Soup+ sweet/ light diet	Normal diet	Normal diet	Normal diet	Normal diet
Ensures x 2 1 <input type="checkbox"/> 2 <input type="checkbox"/>	Ensures x 4 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/>	Ensures x 4 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/>	Ensures x 4 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/>	Ensures x 4 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/>	
	Stoma teaching	Stoma emptied/ change	Stoma emptied/ change	Stoma emptied/ change	Stoma emptied/ change
	Shower/ Dress in own clothes	Shower/ Dress in own clothes	Shower/ Dress in own clothes	Shower/ Dress in own clothes	Shower/Dress in own clothes
		PCAS/Epidural stopped & Catheter out			HOME

Figure 2 Example patient diary to illustrate diet and mobility goals for ERAS

of 50 mg/kg. The use of ketamine and magnesium has been shown to improve analgesia and reduce opiate requirements.¹⁴ Intravenous lignocaine is associated with improved pain scores, decreased opiate requirements, and after bowel surgery an earlier restoration of gastrointestinal function.¹⁵ There is also some evidence for the use of the alpha 2 agonists clonidine and dexmedetomidine, and gabapentin as part of multi modal post-operative analgesic regimens.

Surgical factors

Minimally invasive surgery reduces surgical trauma and is preferable wherever possible. However, it is still possible to achieve impressive results with open surgery within an ERAS pathway. Surgical robots are being used increasingly, their enhanced dexterity providing the option of minimally invasive surgery in some circumstances where previously open surgery would have been the only option. The NHS enhanced recovery partnership programme recommendation is that where open surgery is necessary, incision length is limited and transverse incisions are considered where possible.¹⁰

The routine use of surgical drains has not been shown to confer any advantage and may actually cause complications such as infection. In addition, drains cause discomfort and may impair mobilization. Where the use of a drain is absolutely necessary, it should be removed as soon as possible postoperatively, i.e. between 24 and 48 hours.

Nasogastric tubes have been shown to delay gastric emptying and increase the likelihood of postoperative nausea and vomiting. Therefore they should be removed at the end of surgery unless there is a specific reason to keep them in. Urinary catheters should be removed as early as is practical, depending on the surgical procedure.

The postoperative period

'Dreaming'

The Perioperative Quality Improvement Programme (www.pqip.org.uk) suggests that wherever possible, patients should be 'Dreaming' (drinking, eating and mobilizing) within 24 hours of the end of surgery. To facilitate this, all members of the post-operative healthcare team should regularly ask themselves: 'Why is my patient still in bed?', 'Why is my patient still in hospital' and 'Can I get rid of any drips and tubes'. Importantly, patients need to know what they can be expected to safely do in the days following their surgery. At our centre, we use a patient diary as a visual aide, so that patients know what we will ask them to do, enabling them to track their own progress (Figure 2).

Early enteral feeding after surgery is now known to be safe and beneficial, with evidence of reduced length of stay and postoperative infection rates. Some clinicians also advocate the use of chewing gum to stimulate gastrointestinal motility.

Early transfer to oral fluids should always be the goal for ERAS. However, in some situations, this will not be possible. In such cases, maintenance postoperative IV balanced crystalloid (to avoid sodium and chloride excess) at a rate of 1–3 ml/kg/h is a reasonable starting point. Careful regular assessment of fluid balance is important, and 'permissive oliguria' (urine output of 0.3–0.5 ml/kg/hour) should be tolerated and not chased with excessive

amounts of IV fluid. For higher risk patients such as those having undergone oesophagectomy, there is likely to be value in continuing goal directed fluid therapy into the postoperative period.

Patients need support to ensure that they can meet their ERAS mobility and nutrition goals. Reasons for poor mobilization include unpleasant symptoms such as pain, nausea and vomiting, dizziness or a general feeling of weakness/exhaustion and general malaise. Therefore, careful symptom control and well considered blood pressure control with fluid replacement and use of vasopressors where necessary, is essential.

There is still work to be done to overcome the psychological barriers among patients, relatives and healthcare staff, many of whom still feel that patients should be in bed, rather than dressed and mobile.

Preparing for discharge – attention to detail

Preparations for safe discharge from hospital need to begin early. Where there are complex care needs, multidisciplinary input is required (including medicine for the elderly, occupational therapy, social work) to ensure that planning is not left until the patient has recovered from surgery, thus causing delays to discharge.

Any hospital admission is an opportunity to review long-term medications and ensure that patients only go home on medicines that are still necessary, and that new medicines do not interact with pre-existing treatments. It is particularly important that medicines intended only for the perioperative period – particularly opiates and gabapentinoids – are not continued after discharge home.

Patients must be given clear information on how to access help and advice should they develop any problems after discharge. It is good practice to follow patients up by telephone on the first day after discharge as part of the ERAS programme.

Tracking success and improving for the future

ERAS programmes use a 'bundle' approach to providing optimal preoperative care. It is not clear how each element contributes to the overall success of the approach. What is clear, is that patients need to achieve around 80% compliance with all of the ERAS elements in order for results to be seen.¹⁶ Therefore, ERAS programmes cannot be set up and left to run, there must be continuous audit and feedback of results to maintain and improve adherence to the desired standards. ◆

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