Many leading centres involved in enhanced recovery after surgery (ERAS) are engaged in the implementation of novel and improved care processes. A key to success lies in this change from traditional management to use of evidence-based best practice (Table 5.5.1), a change that frequently takes time.

### Table 5.5.1 ERAS care compared with traditional perioperative care

<table>
<thead>
<tr>
<th>Traditional care elements</th>
<th>ERAS treatments</th>
</tr>
</thead>
</table>
**Enhanced recovery after surgery**

<table>
<thead>
<tr>
<th>Patient information is often short and often unstructured</th>
<th>Specific and detailed information about the entire care process including preoperative, intraoperative, and postoperative care elements with an emphasis on patient involvement. Expectations, including short recovery time and early discharge planning are clearly defined and laid out to the patient and caretakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>No special preparation of patient’s physical status</td>
<td>Preoperative assessment of patient condition. Specific optimization to improve preoperative nutritional, medical and functional status</td>
</tr>
<tr>
<td>Preoperative bowel cleansing the afternoon before surgery. No food, only clear liquids the afternoon and evening before surgery</td>
<td>No bowel cleansing, normal food the day before surgery</td>
</tr>
<tr>
<td>Fasting from midnight, nil by mouth</td>
<td>Intake of clear fluids and specific carbohydrate drinks until 2 hours before surgery</td>
</tr>
<tr>
<td>Long-acting sedatives as pre-anaesthetic medication</td>
<td>Avoidance where possible of sedative premedication. Analgesic premedication prior to surgery</td>
</tr>
<tr>
<td>No specific prophylaxis for postoperative nausea and vomiting (PONV)</td>
<td>Active screening for risk patients for PONV and liberal use of multimodal PONV prophylaxis</td>
</tr>
<tr>
<td>General anaesthesia using opioids and long-acting drugs</td>
<td>General anaesthesia using short-acting substances, avoiding long-acting opioids. Thoracic epidural for open surgery and surgery expected to take several hours or with high conversion rates</td>
</tr>
<tr>
<td>No specific temperature control</td>
<td>Maintenance of temperature above 36.5°C using heating blankets and warmed infusions</td>
</tr>
</tbody>
</table>
Enhanced recovery after surgery

<table>
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<tr>
<th>Open surgery</th>
<th>Laparoscopic and minimally invasive techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crystalloids to control volume status</td>
<td>Strict fluid balance. Use of goal-directed therapy monitoring of stroke volume, using crystalloids (or colloids) and vasopressors to control haemodynamics</td>
</tr>
<tr>
<td>Nasogastric tubes until bowel movements</td>
<td>No nasogastric tubes after surgery</td>
</tr>
<tr>
<td>Urethral catheters for several days after surgery</td>
<td>Removal of urinary catheters the day after surgery</td>
</tr>
<tr>
<td>No oral intake on day of surgery, slow resumption of oral fluids and food</td>
<td>Free intake of fluids immediately after surgery, intake of solids optional day of surgery</td>
</tr>
<tr>
<td>Intravenous low caloric glucose for several days</td>
<td>Intravenous fluids discontinued the day after surgery</td>
</tr>
<tr>
<td>Slow mobilization</td>
<td>Immediate and active mobilization</td>
</tr>
<tr>
<td>Postoperative pain control using opioids</td>
<td>Avoidance of opioids, multimodal pain control based on thoracic epidural, paracetamol and NSAIDs</td>
</tr>
<tr>
<td>Slow resumption of food intake</td>
<td>Food and oral nutritional supplements to secure energy and protein intake</td>
</tr>
<tr>
<td>Slow in-hospital recovery</td>
<td>Enhanced recovery and early discharge</td>
</tr>
</tbody>
</table>

Why does enhanced recovery after surgery work?

ERAS protocols are based on the best available evidence in the medical literature. Experts in the field perform careful review and grade the evidence for effective perioperative management. Processes shown to have positive effects on outcome are included into a complete perioperative care programme that is then protocolized. Studies show that the more of these evidence-based treatments that the patients receive, the better the outcome.
Based on such work, societies and healthcare organizations (e.g. the International ERAS Society (http://www.erassociety.org) and the United Kingdom’s National Health Service) run programs promoting the implementation of ERAS principles (http://www.institute.nhs.uk/quality_and_service_improvement_tools/enhanced_recovery_programme.html) One of the key aspects of these programmes is an emphasis on the coordinated training of teams of professionals from all disciplines directly involved in the patient’s journey. An important aspect of the training concerns the use of audit. This ensures that, where outcomes do not meet the desired goals, they are reviewed and adjusted accordingly.

An important concept of ERAS is a common approach and a common view of the patient’s journey. Silo working, where the patient passes through departments with little communication, leads to a lack of coordinated care. ERAS ensures that a treatment plan is developed that fits the patients’ overall needs allowing them to pass seamlessly through the surgical process and achieve the optimal outcome (Figure 5.5.1).

A typical example of how a decision early in the journey can cause problems further down the line is in poor fluid management. The surgeon may prescribe bowel preparation. At the anaesthetic pre-assessment a standard overnight fast may be ordered. Both these decisions will risk a dehydrated the patient coming to theatre. Once the patient is anaesthetized, hypotension will develop more readily in view of the dehydration. This is likely to cause the attending anaesthetist to infuse intravenous fluid to counteract the hypotension. This may be continued postoperatively, which can lead to over hydration with a significant weight gain due to fluid retention. The fluid accumulating in the gastrointestinal tract can lead to a postoperative ileus delaying recovery. By employing the ERAS approach, this problem could potentially be avoided.

Fig. 5.5.1
The patients’ journey through surgical care.

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Preoperative considerations

Patient involvement

An important aspect of the ERAS process is patient involvement. Tailored and in-depth information is given to the patient and his/her carer/relative. This is ideally given both orally and in writing. A folder or booklet using easy to understand and clear descriptions of the procedure and the perioperative care is helpful. Pictures and lay language are important to make the information understandable. If the patient has serious pathology it is sensible to give the diagnosis at a different interview to the details of any required procedure and care pathway. An emotive diagnosis, such as cancer, will often be a shock to a patient and they will be unlikely to absorb anything else. It is, therefore, wise to plan for a second visit a few days prior to surgery to go over the details.

At the second visit a more in-depth discussion should focus on what the patient can expect while in hospital. Issues such as pain and its management should be addressed. Actions that the patient can perform to enhance their recovery, such as ensuring good nutrition and the advantages of early mobilization, are stressed. It is also an opportunity for the patient to meet some of the professionals they may encounter in hospital such as physiotherapists, dieticians, and stoma nurses. Training in the management of a stoma prior to surgery can facilitate early discharge. The benefits of informing staff early if they have pain or nausea so they can be promptly treated to avoid slowing down recovery must be mentioned. Many institutions use patient diaries with targets outlined for food intake and mobilization. This can be very useful and motivating for patients. Older patients with daily or weekly care at home need to have the care givers involved in preparation for early discharge.

In the preoperative phase it is also important to screen for nutritional status. Any unplanned weight loss, reduction in food intake, and loss of appetite is of concern. It should prompt a full nutritional assessment and liberal use of preoperative oral nutritional supplements to promote caloric and protein intake. Inadequate nutrition will increase the risk of the patient becoming catabolic and also the risk of perioperative complications.

The patient should be advised to stop smoking as it has been shown that even a few weeks of refraining from smoking can improve outcomes substantially. Similarly, patients with excessive alcohol intake should consider reducing their intake. As both these life style changes are difficult it is often advisable to consult specialist units for support.

Prescribed medication should be reviewed and advice given where necessary. There is mounting evidence that even brief periods of physical training in the weeks before surgery can materially improve patient outcome and physical activity should be encouraged. Excessive alcohol
intake should be avoided in the weeks preceding surgery and preoperative anaemia should be corrected using iron therapy.

**Curtailed fast**

Ensuring normal metabolic function in the perioperative period is important. The tradition of starving patients for long periods prior to surgery is unnecessary, lacks evidence, and may be harmful.\(^1\) Overnight fasting has a deleterious effect on preoperative well-being, increasing thirst, hunger, and anxiety. The prolongation of a catabolic state after the operation causes protein and muscle loss hampering mobilization. It also increases insulin resistance, leading to hyperglycaemia.\(^11,12\)

ERAS guidance suggests that a shorter period of starvation for clear carbohydrate drinks and clear fluids permissible up to 2 hours preoperatively.\(^1,2,3\) Carbohydrate drinks can counteract catabolic effects maintaining nitrogen balance and reducing insulin resistance.\(^12,13\)

**Avoidance of bowel preparation**

Bowel preparation has been postulated to decrease the risk of spillage of bowel contents and surgical sepsis in the event of anastomotic breakdown. This tradition is being challenged by increasing evidence that avoiding bowel preparation is safe and the consequent reduction in the risk of dehydration advantageous.\(^14,15\)

**Intraoperative considerations**

**Surgical issues**

**Antibiotic prophylaxis**

Wound infection is a significant concern. A single dose of prophylactic antibiotics, given according to local protocol prior to skin incision, can reduce the risk.\(^16\) Ideally antibiotic prophylaxis should be given 30 to 60 minutes before the incision as this may be more beneficial than when given after the incision.

**Approach and incision**

The surgical approach should be selected to minimize the stress response. In practice this means considering a laparoscopic approach for abdominal procedures. Where this is not possible the incision should be as short as possible and ideally transverse. Recent trials have shown that the combination of minimally invasive techniques and ERAS results in the fastest recovery.

**Drains, tubes, and catheters**

Drains,\(^17\) nasogastric tubes,\(^18\) and urinary catheters\(^19\) are often uncomfortable, can delay mobility, and are not without risks. A nasogastric tube can impair the integrity of the oesophageal sphincters.
enhanced recovery after surgery

leading to pulmonary aspiration of gastric contents. There is evidence that they can delay the return of gastric motility. Routine drainage after abdominal procedures is not associated with significant benefit. Urinary catheters should be removed as soon as is practical.

**Hypothermia**

Surgical patients can lose heat in a number of ways. Transfer to theatre down cold corridors risks heat loss via convection and radiation. An anaesthetized patient lacks the compensatory mechanisms to raise their body temperature. An unheated operating table may increase conductive heat losses. Fluid evaporating from exposed bowel will lead to a drop in temperature, as will the infusion of cold fluid. The ensuing hypothermia can lead to an increased incidence of surgical site infection, impaired coagulopathy, myocardial ischaemia, and arrhythmias. A patient who is cold also risks splanchnic vasoconstriction and the additional oxygen consumption caused by postoperative shivering is not to the patient’s benefit.

Patients should reach theatre with a normal body temperature and some preoperative warming may be necessary to achieve this. If surgery is expected to last over 30 minutes measures to warm the patient should be considered. Warming may be passive, using blankets and foil wraps, or active with forced air warming or heated blankets. Fluid should be warmed and the theatre should not be too cold.

**Fluid management**

ERAS relies on meticulous attention to fluid management. Unfortunately, it is often neglected and frequently left to inexperienced doctors. Poor fluid management causes major disturbances in homeostasis and has been shown to lead to a substantial rise in postoperative complications. Uncontrolled intraoperative fluid management can lead to a 4–6 kg increase in body weight even after removal of large organs such as the colon. The traditional postoperative fluid regime of 2 litres of 0.9% saline and 1 litre of 5% glucose a day often resulted in massive overload of sodium, chloride, and water. The ensuing splanchnic oedema can slow down the return of gut function, by affecting gastric emptying and enteral motility.

It is not only over-use of intravenous fluids that may cause problems. Inadequate fluid replacement will also have adverse effect on outcome. Maintaining the right balance of fluids and electrolytes will achieve the best results.

As discussed, the first stage in fluid management is ensuring the patient is well hydrated at the outset. Provision of clear fluids up to 2 hours prior to induction of anaesthesia and the avoidance of mechanical bowel preparation help ensure that patients are not fluid depleted. Once in
theatre the aim of fluid management is to ensure optimal tissue oxygenation. The key components to consider in achieving this are cardiac output, oxygenation, and prevention of anaemia.

Anaemia may occur from blood loss, best avoided by meticulous attention to surgical technique, or from haemodilution by over hydration. Oxygenation is maintained by the anaesthetic team ensuring that the PaO$_2$ is adequate. There is some evidence that maintaining a supra-normal PaO$_2$ may be beneficial, although this needs to be balanced against the potential pulmonary risk.

Maintenance of cardiac output is achieved by use of judicious fluid boluses and vasopressors. Modern monitoring has made the process of estimating the cardiac output possible. The two principle techniques used in theatre are oesophageal Doppler and pulse contour analysis. The oesophageal Doppler monitors flow in the descending aorta whereas pulse contour devices analyse the arterial waveform.$^{23,24,25}$

Oesophageal Doppler

Small fluid boluses (200–250 mL) are given and the resultant change in stroke volume and cardiac output noted. If there is no increase in stroke volume and cardiac output in response to a fluid bolus the heart is at the optimum position on the Starling curve. Further fluids will not increase the output further and vasopressors should be considered if hypotension is affecting end organ perfusion.

Pulse contour analysis

An alternative to oesophageal Doppler is the monitoring of the stroke volume variability. This occurs as a result of the variations in intrathoracic pressure with respiration. Keeping the stroke volume variability below 10% is in keeping with an adequate circulating volume.

Postoperatively over hydration is best avoided by early oral or enteral nutrition and discontinuation of intravenous fluids (see Box 5.5.1).

---

Box 5.5.1 Suggested algorithm for perioperative fluid therapy

**Preoperative**

Ensure adequate hydration by letting patients drink clear fluids up to 2 hours before induction of anaesthesia and avoiding mechanical bowel preparation

Patients with ongoing losses (e.g. enterocutaneous fistulae) should have fluid losses replaced adequately before being sent to theatre
## Intraoperative

Avoid excess fluid administration (balanced fluid preferable to 0.9% saline)

Optimize stroke volume and cardiac output by administering small boluses of fluid (200–250 mL) in response to data obtained from intraoperative monitoring (e.g. transoesophageal Doppler or pulse contour analysis)

Give blood transfusion when appropriate

## Postoperative

Avoid excess fluid administration – try to achieve state of zero fluid balance (most patients do not need more than 2–2.5 L water, 70 mmol sodium/potassium/day)

Discontinue intravenous fluids once oral intake is adequate (achieved in most patients 1 or 2 days postoperatively)

In patients with inadequate oral intake, supplement with intravenous fluids, avoiding excess. Consider enteral nutrition (or parenteral nutrition in cases of intestinal failure)

## Postoperative considerations

### Analgesia

To move a patient though an enhanced recovery pathway it is necessary to manage pain effectively. While opiates and their analogues are excellent analgesics, avoiding them, except for rescue purposes, is prudent. The side effects of opiates such as nausea, vomiting and ileus can delay recovery. Managing pain starts with the prescription of an analgesic premedicant often combined with an antiemetic. Paracetamol and, where tolerated, a non-steroidal anti-inflammatory drug (e.g. ibuprofen) can be used in combination with an antiemetic drug.\(^1,2,3\)

A general anaesthetic combined with an epidural allows the benefits of the epidural to be continued in to the postoperative period.\(^26,27\) A dense motor block should be avoided and this is best achieved by combining a low dose of a long-acting local anaesthetic with a short-acting opiate such as fentanyl. Epidurals are not without risk. Hypotension that may require vasopressors can occur and this may delay mobilization. The epidural should be kept under constant review and, if the postoperative course is proceeding as planned, should be discontinued within 24 hours of surgery. The paracetamol and non-steroidal started as a premedicant should be continued into the early postoperative period.
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Ward and social issues

The patient and staff involved in ERAS care should be aware of the recovery process. Recovery begins as soon as the patient is lucid after surgery.

Intravenous fluids

Overzealous administration of intravenous fluid should be avoided and vasopressors may be more appropriate to manage hypotension than fluids particularly in patients with epidurals. Where intravenous fluid is required it should be kept to a minimum and excess sodium and chloride avoided by the use of Hartmann’s solution or other balanced crystalloids.

Nutrition

The patient should be offered oral fluids at an early stage, preferably within hours of surgery, and shortly thereafter an attempt should be made to include solids. Later in the day a light dinner may be appropriate. The information the patient received preoperatively will have appraised them that oral intake is a key target.

Early mobilization

On the day of surgery (providing the operation occurs early enough) a second key target is early mobilization. The patient should be out of bed for at least 2 hours, mobilizing with assistance. A structured plan should be in place with a named physiotherapist to facilitate it.

The patient should move to the ward as soon as he or she is stable. While there is no protocol that fits every patient, most patients will be able to follow a protocol provided the earlier parts have been fulfilled. Intravenous infusions should be discontinued the morning after surgery, and bladder catheters should be removed within a day or two regardless of the presence of an epidural. Intra-abdominal drains are usually removed no later than the day after surgery. These actions will help to liberate the patient from anything hindering a return to normal. It may be necessary to maintain the epidural if pain control remains an issue.

A functional programme will allow most patients to recover from their surgery and fulfil discharge criteria (Table 5.5.2) within a few days even after major surgery.

<table>
<thead>
<tr>
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<tbody>
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</table>
Pain control | Using oral analgesics
---|---
Mobilization | Mobile to preoperative levels, managing actions of daily living
No complication | No complication in need of hospital care

In most institutions implementing the postoperative aspect of the ERAS care is difficult. There are many reasons for this, the most common being that the preoperative and intraoperative care have not been optimal. The early ERAS protocol elements are critical to facilitate postoperative recovery, since the treatments given during the earlier phases have a marked impact on what it is possible to achieve in the postoperative phase. Intravenous fluids as discussed in the note are one example. A very common mistake in the preoperative phase is the failure to administer antiemetic prophylaxis. Nausea and vomiting result in poor nutritional intake and can also be caused by the use of long-acting sedatives and opioids. Care delivered in accordance with agreed protocols may avoid these pitfalls.

Most patients and carers have some preconceptions about the length of hospital stay from taking to relatives and friends. This is usually at odds with ERAS standards and is another reason why the preoperative preparation, explaining the targets for recovery, is so important.

Upon discharge, the patient and their carers/relatives should receive clear oral and written instructions for the ongoing care. They will receive information on follow-up events including nurse follow-up phone calls, usually within a couple of days after discharge, removal of sutures, and follow-up in clinic. These instructions should also be clear about early signs of potential problems and when to contact the hospital for advice. It is important to realize that some complications, for instance anastomotic leaks, may occur in the later phases of recovery. For this reason it is important to give the patient the ability to contact a surgical ward that has the experience in handling ERAS patients and can provide appropriate advice and enable readmission, if required, without delay.

**Further reading**

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References


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