Preoperative Preparation in Colorectal Surgery

Arne-Christian Mohn
Haugesund Hospital, Helse Fonna HF
Norway

1. Introduction

In august 1954 Robert J. Gosling Read said at the 59th Annual Convention of the National Medical Association, Washington, D.C: "…Through the personal knowledge of the patient's life history and interest he (*the good family physician*) has offered advice based on common sense rather than specialized training. This is the concept of accelerated recovery…"

This was the first time in the literature the concept was used. Interesting enough, several points of today's enhanced recovery are also common sense since all items are not evidence based. Evidence-based medicine is defined as the integration of best research evidence with clinical expertise and patient values to optimise clinical outcomes and quality of life.[1]

The concept returned in surgery in 1990. Krohn et al[2] published from Good Samaritan Hospital in Los Angeles a four days discharge from hospital after open-heart surgery. He called it rapid sustained recovery. This was the first paper on enhanced recovery after surgery (ERAS).

In 1994 Hartford Hospital and Baystate Medical Center[3] introduced the term "fast-track surgery" which included 1: preoperative education, 2: early extubation, 3: methyl-prednisolon sodium succinate before surgery followed by dexamethasone for 24 hours postoperatively, 4: prophylactic digitalization, metoclopramide HCL, docusate sodium, and ranitidine HAL, 5: accelerated rehabilitation, 6: early discharge, 7: a dedicated fast-track coordinator to perform both daily telephone contact and a 1-week postoperative examination and 8: a routine 1-month postoperative visit with a PA or MD. This showed a systematically control of all patients and a multimodal focus to enhance the recovery time. But all the interventions were not evidence based and the study was an observational study.

Why didn't the literature focus on recovery before1990?

One reason was that until the 1980´s the preoperative preparation was optimizing the organ function medically to tolerate the narcosis, bowel preparation to avoid anastigmatic leakage and infection and disinfection of the surgeons' hands and the patients' skin. There were no systematic antibiotics given, no thrombi-prophylaxis and no epidural anaesthetics.

Another reason was the lack of methodical trials and evidence based medicine on ancillary procedures. Variations in surgical procedures and peri-operative care have been recognised since the early 1980s and are generally interpreted as evidence of uncertainty among practitioners regarding optimal care.[4] How different surgeons or hospitals provided the procedures varied enormously, leading to and "expertise bias". They tended to be accepted with little question and which, fore some surgeons, had become indispensible rituals. Most of the surgery was done the way you learned it from your mentor. He had his own meaning based on his experience and a standard saying was: "In our hospital we do it my way" or said by Edmund Burke: "custom reconciles us to everything."

Further, randomised trials to peri-operative care questions were often difficult or impractical to perform. A valid randomised controlled trial may also be impossible in many circumstances and may limit the generalisability of the results.

In the 1990s there was a change. The main reason was the specialization. Earlier the surgeon did the anaesthetics themselves, but today we have specialists in this area, which make us treat patients. The securing of a safe anaesthesia during operations is more important than ever before, partly because of the mere number of operations, and partly because of the greater extent to which other operative risks — haemorrhage, shock and infection — have been overcome. The risk from the anaesthetic is now so very small that the joint aim of the surgeon and anaesthetist to abolish it altogether is not far from being accomplished.[5] The specialty of anaesthesia has seen major advances thanks to the development of safer anaesthetic agents, improved knowledge of pain physiology and pain management, and incorporation of a better understanding of peri-operative patho-physiology into peri-operative care. Concomitantly, development of minimally invasive surgery has further reduced stress responses and pain, thereby providing potential for enhanced recovery. However, an increasing proportion of elderly patients with organ dysfunction have led to demands for further reductions in postoperative complications and the costs of treating them.

The transition from inpatient surgery to ambulatory procedures has proceeded at a rate that was unthinkable a few decades ago, but could all surgical procedures ultimately be done on an outpatient basis?[6] The forthcoming years will, as before, pose several challenges for anaesthetists to improve peri-operative care and to take part in the multidisciplinary collaboration of fast-track surgery. Anaesthetists should consider the development of "peri-operative medicine" as a multidisciplinary effort that should not involve conflict between the anaesthetic and surgical specialities, but rather serve as a mutual platform for improvement of peri-operative care. All together there are more and more emphasis on the joint aim: peri-operative preparations and recovery.

Through the 1980´s and the 1990´s, evidence based medicine became the state of the art, but still it is troublesome to change the way of thinking.

2. ERAS

Kehlet et al gave some answers to these questions in 1997[7]: He focused on the improvements on the administration of opioid analgesics in new ways, such as continuous or on demand intravenous or epidural infusion. These methods allowed lower total opioid dosages, provided a more stable concentration of opioid and correspondingly better analgesic effects, and also fewer unwanted side effects. The introduction of rapid short acting volatile anaesthetics, opioids, and muscle relaxants also facilitated expansion of ambulatory surgery for minor to moderate procedures. The emphasis on ambulatory surgery and accelerated surgical stay programs, both with a focus on early recovery of organ function and provision of functional analgesia, provided an opportunity for a reappraisal of opioid use in these settings. However, the same techniques may be used to facilitate early recovery and decreased need for prolonged monitoring and stay in recovery and high dependency wards after major procedures.

The key factors that keep a patient in hospital after uncomplicated abdominal surgery include the need of parenteral analgesia (persisting pain), intravenous fluid (persisting gut function), and bed rest (persisting lack of mobility).[8] ERAS change the way of thinking to minimal these factors.

Traditionally the complication rate in colorectal surgery is between 20-40%. The hospital stay is between one and two weeks.[9,10] Early clinical pathways had showed reduced length of stay in major surgery.[11] Kehlet published his first results[8,12,13] with a hospital stay of two days after colonic surgery. He established the concept accelerated recovery and started to compile an interest group, which later became the ERAS-group. Studies showed reduction in hospital stay, reducing ileus and cardiopulmonary complications.[10,13-23] Also in rectal cancer surgery the peri-operative "fast-track" multimodal rehabilitation program is effective and safe.[24,25] Randomised controlled trials (RCT) have showed the same results,[19,20,22,23,27-29] though Behrns patients were discharged on liquid diets.

Advances in peri-operative patho-physiology have indicated multi-factorial reasons for post-operative morbidity[30], length of stay and patient recovery. It is therefore required to deal with these causes by multifaceted interventions. First of all, the patient's medication must be optimized according to organ function like cardiac disease, chronic obstructive lung disease, diabetes mellitus etc. Further the patient must be evaluated according to malnutrition. Malnutrition can prolong the stress response and increase the likelihood of complications. Likewise, heavy drinkers and smokers should abstain from alcohol and smoking a month before surgery if possible. Otherwise they have higher incidence of complications. Thereafter the treatment should focus on pain relief, reducing stress response and reducing nausea and vomiting. Further on the patients should avoid hypothermia, immobilization and semi-starvation. Finally, the postoperative ileus should be minimized. There are reasons to believe that including as many ERAS elements as possible in a clinical pathway may result in a cumulative effect and contribute to enhanced recovery in patients.[31]

The major premise behind fast-track surgery is that patients regain function more rapidly and that this allows a reduction in the period during which the patient is unable to perform activities of daily living.[21]

Better adherence to the elements of the ERAS protocol is crucial to improve surgical outcome. Nearly all, preoperative and per-operative ERAS interventions, influenced postoperative outcomes beneficially.[32] Patients with high adherence to the ERAS protocol had a 25% lower risk of postoperative complications and nearly 50% lower risk of postoperative symptoms delaying discharge. They also had a higher tendency toward reaching length of stay within the target limits compared with patients operated on under less optimal ERAS protocol adherence. As the enhanced recovery field develops, certain interventions may turn out to be nonessential. However, before omitting specific components in the protocol, such a decision should be based on a closer understanding of the importance of each element in the program.

Many of the peri-operative interventions that have been widely adopted into clinical practice are supported by very limited evidence. For a number of interventions the data are either limited in quantity or quality, or are inconsistent. Systematic reviews should be

Elements	Guidelines
Preoperative information	Oral and written information to patients and relatives. Achieve patient management. Patient education before and after surgery.
Bowel preparation	No bowel preparation is necessary before colon surgery. Preparation still before rectal surgery.
Admission	The day before or operation day. Oral supplements given at home before admission.
Preoperative fasting	Fasting only 2 hours before surgery, food and milk rinks 6 hours before.
Carbohydrate loading	Drinks the evening before (800ml) and 2-3 hours before surgery (400ml)
Preoperative medication	Paracetamol (1g x 4) reduces postoperative pain, Alvimopan (12mg x2) reduces postoperative ileus
Preoperative anticoagulation	No-risk – no anticoagulation. Moderate-risk once a day at least 5 days. High-risk once a day 28 days
Preoperative antibiotics	Oral and intravenous or intravenous only. Cephalosporins (2g) or combination doxycycline (0,4g) and metronidazol (1,5g).
Preoperative epidural anaesthesia	Mid-thoracic EDA* during surgery (bolus and continous infusion) and EDA or PCA$ postoperatively for 2-3 days reduces PONV#, ileus, pain, and hospital stay.
PONV	Peroperative and early postoperative oxygen. On moderate-risk TIVA% or an antiemetic drug. In high-risk combination og TIVA and dexamethasone.
Surgical incisions	Less is better, laparoscopy even best.
Nasogastric tubes	Have no place routinely in elective colorectal surgery
Peroperative normothermia	Normothermia during surgery, reduces wound infections
Postoperative fluid management	Restricted, goal-directed fluid therapy is preferably
Drainage of the abdominal acity	No need in colon surgery. In rectal surgery still needed.
Urinary drainage	1 day after colon surgery and about 3 days after low-rectal surgery
Postoperative ileus	Complex aetiology with many contributors, but opioids exacerbate the ileus
Postoperative nutritional care	Oral intake 4 hours after surgery and normal food intake the day after.
Mobilization	Out of bed operation day and 6 hours the day after and thereafter

*EDA = epidural anaesthesia, $PCA = patient-controlled anaesthesia, #PONV = postoperative nausea and vomiting, %TIVA = total intravenous aenesthesia

Table 1. **Elements of ERAS (Enhanced Recovery After Surgery)**

conducted with the same methodological rigour expected for randomised controlled trials. Systematic reviews conducted under the auspices of Cochrane Collaboration have an established methodology and peer review process, and they may be less prone to bias than non-Cochrane systematic reviews.[1]

There is supportive evidence from studies that enhanced recovery programs should be considered as standard peri-operative care.[33] Still, there are controversies. Meta-analysis,[31,34,35] show reduction of complications, but not major complications. There may be a decrease, but it is not statistical significant. One reason may be the lack of robust RCT's. The reduction of hospital stay is real and the readmission rate does not increase. However, a Bayesian meta-analysis showed significant reduction in hospital stay, complications and no difference in readmission rates and mortality.[36] A Bayesian model has a number of advantages like full allowance for all parameter uncertainty, the ability to include other pertinent information that would otherwise be excluded, and the ability to extend the models to accommodate more complex, but frequent occurring, scenarios.[37]

The debate is still going and the conclusion is unclear, but ERAS should be considered the new standard. The markedly shortened hospital stay in fast-track rehabilitation should change the capacity of operative departments considerably. At the same time denotes the implementation of fast-track rehabilitation a paradigm shift away from invasive postoperative monitoring and regulation attempts of today's intensive care medicine to intensified pain therapy and reinforced physical rehabilitation.

Today the ERAS-group has consensus guidelines. They recommend as many elements as possible (for instance 17 out of 20), but as mentioned above – still several elements are highly debatable. We will therefore in this chapter discuss the elements mentioned in Table 1, to see if there are evidence today to change the way of preparing the patients and go into the next area: Optimize the preparation, peri-operative treatment, the logistics and the recovery.

But first, we will look at the concepts stress response and insulin resistance.

3. Stress response and insulin resistance

Surgical stress response is a major contributing factor to postoperative morbidity. Advances in surgical technique and peri-operative management the last years have allowed better control of the stress response intra-operatively and improved patient outcome.

Surgical stress response is mediated via neuro-endocrine mechanisms leading to alterations in protein homeostasis (increased catabolism), hyper-metabolism, altered carbohydrate metabolism (increased gluconeogenesis and insulin resistance) and increased lipolysis.[20]

The underlying hypothesis is that the reaction to a physical stress depends in part on the metabolic state at the onset of the stress. In many of its features, postoperative insulin resistance resembles type 2-diabetes mellitus. The reduction in insulin sensitivity develops after surgery in patients with and without type 2 diabetes.[38]

A state of insulin resistance has been confirmed in several different types of stress, including burn injury, accident trauma, and sepsis. During the 1990s studies of insulin resistance in elective surgery have been performed.[39] The degree of postoperative insulin resistance was significantly correlated with the length of stay postoperatively. The duration of surgery was closely associated to the relative decrease in whole body insulin sensitivity. These findings suggest that the relative change in insulin sensitivity is related to the degree of surgical stress.[40]

4. Preoperative information

It is very important to inform both the patient and relatives days before the surgery. An effective implementation and a consequent huge rate of compliance are essential in terms of achieving uniformity of patient management. A thorough information orally and a written preadmission information describing what will happen during their hospital stay, what they have to expect, and what their role in their recovery, are essential.[8,41] The success relies on the patients understanding and appreciating their responsibilities.[42] Preoperative education may reduce anxiety and aid in coping, generally enhancing postoperative recovery with an earlier return of gastrointestinal motility after surgery.[43,44] Some patients require extensive education in issues relating to stoma care, self-monitoring for signs of dehydration, and sexual function. This education starts before operation and continues after the operation.[45]

It is well established that intensive preoperative patient information can facilitate postoperative recovery and pain relief, particularly in patients who exhibit most denial and the highest level of anxiety.[9] Teaching the patient to cope with pain and the importance of pain control and the expectation of some degree of nausea are important task to understand before surgery. Patients should also understand the importance of getting out of bed the evening of the operation or the envisioned discharge on the third or fourth postoperative day.

Further on an evaluation of the home environment is important beforehand. In that way it is easier to plan an early, realistic discharge day. Family or caregiver support is crucial to ensure a safe transition from hospital to home and to decrease the risk of readmission.

A cornerstone in the achievement is motivated surgeons, anaesthesiologists and study nurses.[9,46] Fast-track surgery requires a multidisciplinary, concentrated and coordinated effort, with nurses as essential to the success of these programs.[47,48] The dedicated and motivated team consists of anaesthesiologists, surgeons, residents, dieticians, physiotherapists, social workers, dieticians, and nursing team. The nurses should concentrate on individual tasks and spend much time on managing complications as they occur. They must challenge the traditional nursing practices and expend this role to avoid that patients become passive recipients of care. The nurses partner with the patient to achieve well-defined goals to improve patient's outcome.

Changes also need to be made to organisational strategies and the medical professionals involved in pre, intra and especially postoperative care require support, perhaps via continuing education.[47] A protocol is not enough and the importance of this collaboration has been widely described.[5,9,11,13,19,46,49-51]

- Orally and written information to reduce anxiety and postoperative pain
- Achieve patient management and avoid passive recipients of care

5. Bowel preparation

It was unquestionably a great convenience to the surgeon to operate on an empty bowel rather than on one loaded with faeces. It was also supposed through a century that operations on the bowel, especially those involving a suture line or an anatomises, were safer and less likely to be associated with gross contamination and sepsis if the intestine is in a relatively or completely empty condition.[52] The assumption, which formed the basis for the practice of mechanical bowel preparation prior to major colorectal surgery, was so widely accepted as sensible and logical, that nobody saw the need of any really stringent scrutiny. Until recently it was thought that vigorous preoperative mechanical cleansing of the bowel (mechanical bowel preparation), together with the use of oral antibiotics, reduced the risk of septic complications after non-emergency (elective) colorectal operations. Mechanical bowel preparation was performed routinely prior to colorectal surgery until 1972, when this procedure started to be questioned. Even though ES Hughes in 1972[53] concluded in a randomised clinical study that vigorous mechanical preparation was not necessary, most surgeons continued the bowel cleansing until late 1980s.

But in the late 1980s some started to question the necessity of bowel cleansing when using intravenous antibiotics.[54] The cleansing was time consuming and associated with discomfort. Even though Burke[55] stated that bowel preparation does not influence outcome after elective colorectal surgery and a review concluded with limited evidence in the literature to support the use of mechanical bowel preparation[56], still until late 1990s it was standard along with antibiotics preoperatively. The question wasn't answered until two well-designed randomized clinical trials were performed and printed in The Lancet and Br J Surg in 2007.[57,58]

Reviews and meta-analysis cannot show higher leakage rate with than without bowel preparation. Some studies and even meta-analysis have shown the opposite with higher frequencies after preparation,[59,60] but the evidence based answer today is that there are no differences and therefore it is not necessary with any preparations before colon surgery.[61] It is too early to conclude on rectal surgery, so still one may do the preparation before the surgery here. Further research on mechanical bowel preparation or enemas versus no preparation in patients submitted for elective rectal surgery and laparoscopic colorectal surgery is warranted.

There are also some controversies about what kind of preparation to use. No bowel preparation method meets the ideal criteria for bowel cleansing prior to surgery. The new generation of bowel purgatives include oral sodium phosphate preparations and polyethylene glycol-electrolyte lavage solutions. Both are well tolerated by the patients with the oral sodium phosphate preparation as the most preferred because of less fluid to drink for the patients and possibly more effective,[62,63] but there are still some safety issues without a clear solution. Both cleansing methods make some electrolyte disturbances even though it seems like the polyethylene glycol-electrolyte lavage solutions are less dangerous.[64] Therefore adequate hydration is important before, during, and after bowel preparation.[65]

Furthermore, in children and elderly, patients with kidney disease or decreased intravascular volume, and those using medicines that affect renal perfusion or function (diuretics, angiotensin converting enzyme (ACE) inhibitors, angiotensin receptor blockers (ARBs), and possibly non-steroidal anti-inflammatory drugs (NSAIDs)) should not use oral sodium phosphate. There is a possibility to develop acute phosphate nephropathy. They should instead use polyethylene glycol-electrolyte lavage solutions.[66]

- No need for bowel preparation in colon surgery
- Still need in rectal surgery

6. Admission

Earlier the patients admitted to the hospital two days before surgery. On the admission day they were given a full liquid diet, and on the day before surgery, a clear liquid diet. Bowel cleansing was given the day before.

Today the history of the patient and co-morbidity are evaluated in an outpatient manner by the surgeon and the anaesthetist. The oral carbohydrate feeding and/or protein feeding are done home by the patient. It is a common view that nutritional support in the peri-operative phase is associated with decreased morbidity, particularly in severely nutritionally depleted patients.[9,67] Patients receiving oral nutritional supplements over an extended peri-operative period lost significantly less weight than those who received no supplements or postoperative supplements only. The incidence of minor complications was significantly lower than in those receiving no supplements or preoperative supplements only. The benefit of outcome occurred independently of nutritional status.[68]

The use of laxatives is still debatable, as the standard measure of return of bowel function would be the ability to tolerate oral feeding rather than just bowel movement.[31]

The patient, at home, may handle the injection of anti-coagulant, the evening before surgery. If the patient lives distant from the hospital, he can be admitted the day before surgery or stay at a hospital hotel.

- Admission the day before or operation day
- Patients receive and administrate oral nutrition supplements at home

7. Preoperative fasting and carbohydrate loading

The overnight fasting routine was first suggested in 1848 after Hannah Greener's death in Winlaton, as a result of the first reported death following general anesthesia.[69] Later the same century it was suggested that a better preparation for the patient was to allow a cup of tea or beef tea some hours before the operation.[70] In the early 1900s, reports of complications from aspirations resulted in the strict recommendation of nil by mouth.[66] General anaesthetic reduces reflexes that stop regurgitated gastric juices reaching the lungs. As this can be dangerous, people were often advised to have nothing to eat or drink from the midnight before surgery.

The main reason for questioning the nil by mouth rules was to improve patient’s well being, by reducing thirst and for caffeine drinkers avoiding headaches from withdrawal symptoms. Norway was the first country to adopt new guidelines in 1993, the Norwegian Consensus Guidelines for preoperative fasting in elective surgery, and a national survey was performed three years later, which showed no increase in aspirations due to the new routines.[72] Fasting before general anaesthesia aims to reduce the volume and acidity of stomach contents during surgery, thus reducing the risk of regurgitation-/aspiration.[73] Recent guidelines have recommended a shift in fasting policy from the standard 'nil by mouth from midnight' approach to more relaxed policies, which permit a period of restricted fluid intake up to 2 hours before surgery. Food or drinks containing milk make the emptying slower and need six hours.[74,75] Emptying of the stomach usually occurs within less than 90 minutes in elective patients after consumption of clear fluids, and after a 12,5% carbohydrate loaded drink 120 minutes.[76]

Practice has been slow to change. There was no evidence to suggest a shortened fluid fast results in an increased risk of aspiration, regurgitation or related morbidity compared with the standard 'nil by mouth from midnight' fasting policy. Permitting patients to drink water preoperatively resulted in significantly lower gastric volumes. Clinicians should be encouraged to appraise this evidence for themselves and when necessary adjust any remaining standard fasting policies (nil-by-mouth from midnight) for patients that are not considered 'at-risk' during anaesthesia. Some people are considered more likely to regurgitate under anaesthetic, including those who are pregnant, elderly, and obese or have stomach disorders. More research is needed to determine whether these people can also safely drink up to a few hours before surgery.[75]

Beverages including water, tea, coffee, or juices without fruit meat cannot be expected to cause any major changes in metabolism, and thus, even with the new and more liberal fasting guidelines, the patient will be operated in a metabolic state of fasting. Infusions of carbohydrates before elective abdominal surgery were shown to improve postoperative insulin sensitivity.[77] Carbohydrate feeding given shortly before elective colorectal surgery displayed less reduced insulin sensitivity (reduced insulin resistance) after surgery compared to patients who were operated after an overnight fast[40] and not associated with aspiration.[78]

The patients were given 800 ml 12,5% carbohydrate drink (malto-dextrin) the evening before the operation and another 400 ml about 2-3 hours before the operation. Insulin resistance has been shown to be an independent factor explaining the variation in length of stay.[79] This study showed that preparation with a carbohydrate-rich drink increased preoperative wellbeing compared with intake of placebo (water) or overnight fasting. These drinks lead to reduced anxiety and significantly reduced postoperative hospital stay, and a trend towards earlier return of gut function when compared with fasting or supplementary water.[8,32,38,80] This earlier return of bowel function may be a contributory factor for shorter hospital stay. Consumption of an appropriate potion composed of water, minerals and carbohydrates offers some protection against surgical trauma in terms of metabolic status, cardiac function and psychosomatic status.

- No fluid intake 2 hours before surgery, milk drinks and food until 6 hours before
- Carbohydrate drinks (>12,5%) the evening before and 2-3 hours before surgery

8. Preoperative medication

Patients should not receive pre-anaesthetic anxiolytic or analgesic medication.[8] Paracetamol used, as preoperative medication to reduce postoperative pain is well established. The use of diclofenac to strengthen the effect (postoperatively) has caused unwanted side effects both in animal studies and retrospective clinical studies.[81] This study showed significant more anastomotic leakages. Therefore it is recommended to use other non-steroid anti-inflammatory drugs or opioid antagonists like Alvimopan.

Alvimopan is a novel, oral, peripherally acting antagonist, a μ-opioid receptor that has limited ability to cross the blood-brain barrier and is currently being evaluated for the management of postoperative ileus.[82] The use is 12 mg 2 hours before surgery and then twice daily beginning on first postoperative day until hospital discharge or for a maximum of 7 days of postoperative treatment. Alvimopan act within the gastrointestinal tract and does not affect the centrally mediated analgesia. Alvimopan significantly accelerate gastrointestinal recovery in bowel resection patients; reduce postoperative morbidity rates, hospital stay, and rates of hospital readmission[83] with a mean daily opioid consumption of 26 mg. However, opioids provide better pain control compared with other analgesics such as anti-inflammatory drugs.

Glucocorticoids (GCs) are well known for their analgesic, anti-inflammatory, immune-modulating, and antiemetic effects, although the mechanisms by which glucocorticoids exert their action are far from clarified.[84] Preoperative GCs decrease complications—including infectious complications specifically and length of stay after major abdominal surgery. Although inflammation is a necessary precursor for healing, it is the excessive amplitude of the inflammatory response after major abdominal surgery that is thought to contribute to postoperative morbidity and delay recovery. GCs do not seem to increase the risk of complications in colorectal surgery.[85] As an intervention; administration of GCs is inexpensive and simple allowing for clinical implementation without difficulty. Earlier there was not found a significant effect or no effect on postoperative nausea and vomiting and pain in studies. In the concept of enhanced recovery, the effects have been found[84] but Fukami et al found no effect in a randomized controlled trial[86] Another trial found that 8 mg dexamethasone preoperatively has no significant effect on reducing postoperative inflammatory response and also does not improve outcomes of colorectal surgery.[87]

The analgesic effects of GCs are provided through inhibition of the phospholipase enzyme and accordingly blockage of both the cyclooxygenase and the lipoxygenase pathway in the inflammatory chain reaction. The mechanism by which GCs alleviate nausea and vomiting is not fully understood, but the effects are probably centrally mediated via inhibition of prostaglandin synthesis or inhibition of the release of endogenous opioids.

Postoperative fatigue appears to be an important problem following only certain forms of surgery. Preoperative administration of dexamethasone resulted in a significant reduction in early postoperative fatigue, associated with an attenuated early peritoneal cytokine response. Peritoneal production of cytokines may therefore be important in postoperative recovery.[88] The reduction in fatigue was moderate and was associated with a diminished peritoneal pro-inflammatory cytokine reaction on day 1, supporting the hypothesis that peritoneal inflammation is an important contributor to fatigue after major abdominal surgery.

Because of divergence in the trials, we need larger randomised trials before we can recommend the use of GCs before surgery.

- Paracetamol given preoperatively reduce postoperative pain
- Alvimopan is an alternative to reduce postoperative ileus

9. Preoperative anticoagulation

Venous thrombo-embolism (VTE) is the most common preventable cause of death in surgical patients. Thrombo-prophylaxis, using mechanical methods to promote venous outflow from the legs and antithrombotic drugs, provides the most effective means of reducing morbidity and mortality in these patients. Despite the evidence supporting thrombo-prophylaxis, it remains underused. The reasons for its underuse are not fully understood, but those having abdominal surgery are often considered to be at a lower risk than orthopaedic patients. In addition, there are still concerns about an increased risk of bleeding complications.[89,90]

The overall incidence of venous trombo-embolism (VTE) without anticoagulation is 20-25% for patients more than 40 years old in general surgery. For patients having cancer, the incidence slightly rise to 30-40%.[89-93] Fatal embolism occurred in about 1%. After low molecular weight heparin (LMWH) the incidence of VTE is 6% and fatal embolism 0,01%.[92,94,95] Complication rates are low and should not prevent the use of prophylaxis in most patients.[91] Patients undergoing surgery of the large bowel and the rectum have a considerable risk of developing vascular complications expressed as venous thrombosis and/or thrombosis in the lungs (pulmonary embolism). These complications can lead to lifelong impaired venous function in the legs or occasionally sudden postoperative death. The clinical importance of asymptomatic proximal and distal deep vein thrombosis (DVT) remains uncertain and controversial. Unrecognised DVT may lead to long-term morbidity from post-phlebitic syndrome and predispose patients to recurrent VTE. Because VTE in hospitalized patients often is asymptomatic, it is inappropriate to rely on early diagnosis. Furthermore, non-invasive tests, such as compression ultrasonography, have limited sensitivity for a diagnosis of asymptomatic DVT. The high mortality rate in patients with asymptomatic proximal DVT underscores its clinical relevance and supports asymptomatic proximal DVT as an appropriate endpoint in clinical trials.[96,97] Thrombo-prophylaxis is, therefore, the most effective strategy to reduce morbidity and mortality from VTE in surgical patients. Low-dose unfractioned heparin (UFH) and LMWH appear to be equally effective and safe in this patient group, and either agent can be used. Because patients with underlying cancer are at higher risk, it is reasonable for them to use elastic stockings in conjunction with these agents.

The advantage of LMWH is that it can be administered once daily and it is less likely to cause heparin-induced thrombocytopenia and thrombosis than standard heparin preparations. Among the most important risk factors are a previous history of thrombotic disease, advanced age (risk levels increase above 40 years), prolonged immobility, and coexisting cancer and its treatment.[90]

In low-risk patients, who undergoing minor or relatively short operations, are less than 40 years old and with no additional risk factors, no prophylaxis is necessary except early and frequent mobilization.

In moderate-risk patients who are more than 40 years old and undergoing major surgery with no additional risk factors, LMWH given once daily (>3,400 anti-Xa Units) or graduated compression stockings used properly, is sufficient for at least 5 days.[98]

In high-risk patients more than 40 years old with additional risk factors, LMWH given once daily supplied with graduated compression stockings may be sufficient. But the length of anticoagulation has been discussed. A review demonstrates that this combined treatment also is effective within the high-risk group of patients undergoing surgery of the large bowel or rectum.[97]

In addition to ensuring optimal timing for the initiation of prophylaxis, it is also important to establish the duration of prophylaxis. A review suggests that prophylaxis should be administered for at least one month after surgery.[99] The ENOXACAN II study showed, at least in high-risk patients, a significant benefit of an extended 4-week prophylactic period compared with the standard 1-week regimen, with no increase in adverse effects, confirmed by a meta-analysis.[87,100,101] It is now some evidence that late thrombotic events can occur up to 6-7 weeks after operation.[90] Even if there are no difference in mortality, the patients with lower limb DVTs have almost 60% higher relative risk of suffering from post-thrombotic syndrome. Furthermore there are associations between higher 90 days mortality and asymptomatic proximal DVT, which explain the large number of fatal pulmonary emboli in autopsy series.

In laparoscopic surgery and fast-track surgery there are not any RCTs to tell if it is sufficient to give the prophylaxis for a shorter period. Until then one must carefully include selected high-risk patients, major cancer surgery or they who have previously had VTE, to continuing thrombo-prophylaxis after hospital discharge with LMWH for up to 28 days.

It should be emphasized that epidural analgesia per se reduces thrombo-embolic complications by 50% in lower body procedures, but this has not been demonstrated after abdominal procedures.[8]

- In low-risk patients no prophylaxis is necessary
- In moderate-risk patients LMWH once daily or compression stockings, 5 days
- In high-risk patients LMWH supplied with stockings recommended for up to 28 days

10. Preoperative antibiotics

Without any prophylactic antibiotics, one may consider more than 40% wound infections after colorectal surgery, or at least 27% found by Raahave et al[102] with extensive bowel cleansing. In that case it is unethical to operate without any coverage as pointed out in the first meta-analysis on the field.[103] The conclusions were that the chosen antibiotics were not the crucial point, but the timing, coverage and duration were the most important variables. The latest Cochrane Analysis confirms this.[104]

The antibiotics must cover the copious mixture of both anaerobic and aerobic species, which are in the large intestinum. [104] The optimal drug should be one that is not used as a first-line choice in the treatment of surgical infection. But the most common drug used worldwide is cephalosporin, which also is used in the treatment of infections. However, doxycycline, used in Scandinavians studies[105,106] and still used in Scandinavia, is not an antibiotic commonly used in the treatment of established surgical infection, nor is it prominently associated with causing C. difficile colitis, and it is not expensive. But to cover the anaerobic agents, doxycycline is given together with metronidazol with the same limitations as cephalosporin. Doxycycline has not been studied extensively in comparison to other established goldstandard antibiotic recommendations, but perhaps it should be. According to timing it is well accepted that one hour before surgery is optimal and there is no need for a second dosage because of increased risk of resistant organisms and Clostridium difficile colitis. A combination of oral and intravenous antibiotics seemed to be better than intravenous only, but because of current recommendations before surgery; it should probably be given intravenously.

- Antibiotics given intravenously or a combination of oral and intravenous antibiotics
- Cephalosporin (2g) or Doxycycline (400mg) and Metronidazol (1,5g) preoperatively

11. Preoperative Epidural Anaesthesia (EDA)

Prevention and treatment of postoperative pain is the central goal of interdisciplinary anaesthetists and surgeons. The use of epidural anaesthesia is not for pain control only. Effective analgesia reduces the intensity of autonomous and somatic reflexes, but of importance is the blockade of afferent fibres from the surgical site in order to positively modulate posttraumatic stress reaction either by peripheral nerve blockade, spinal or epidural analgesia.[41] It leads to a modification of the endocrine metabolic action after major surgical procedures, whilst postoperative inflammation is not affected. Mid–thoracic epidural activated before the onset of surgery also blocks stress hormone release and attenuates postoperative insulin resistance.[8]

Both afferent pain fibres and sympathetic efferent fibres contribute to ileus. Because postoperative pain activates the autonomic system and indirectly causes adverse effects on various organ systems, blockage of these pain signals both intra-operatively and postoperatively with epidural anaesthesia and analgesia can blunt the stress response and minimize the effect of surgery on bowel motility.[107,108] There is experimental evidence that the sympathectomy produced by local anaesthetics is associated with increased gastrointestinal blood flow. Shortened duration of postoperative ileus after abdominal operations using these techniques may be translated into decreased length of stay and patient satisfaction.[109]

Regional anaesthesia and analgesia, particularly neural blockade, produce a host of benefits for surgical patients, accelerates recovery of organ function including gastrointestinal and pulmonary function, decreased cardiovascular demands, superior pain relief, reduce the amount of general anaesthetic used (allowing faster recovery), and allows intensified early mobilisation.[49,107,110] Administration of epidural local anaesthetics to patients undergoing laparotomy reduces gastrointestinal paralysis compared with systemic or epidural opioids, with comparable postoperative pain relief. Addition of opioid to epidural local anaesthetic may provide superior postoperative analgesia with activity compared with epidural local anaesthetics alone, and can be accomplished with less toxicity than either class of drug.[1,109-111] The activation of nociceptive afferent and sympathetic efferent nerves are believed to reduce pain and peri-operative opioid requirements, which may lead to reduced postoperative nausea and vomiting (PONV).

Most important may be the significant and prolonged response in the stress response when the epidural anaesthesia is continued postoperatively. To produce the benefit reliably, it appears that epidural analgesia with local anaesthetics should be instituted before the surgical stress and continued until postoperative ileus has resolved, typically 2-3 days later. This peri-operative analgesia may contribute to lower risk of death after surgery. The low risk of serious adverse consequences suggest that many high-risk patients undergoing major intra-abdominal surgery will receive substantial benefit from combined general and epidural anaesthesia intra-operatively with continuing postoperatively epidural analgesia.[112,113] The effect of additional epidural opioid on gastrointestinal function is so far unsettled even if it is indicated that epidural local aesthetic/opioid provide the most superior treatment.[8,110]

The effect of using epidurals on the postoperative pain outcome was investigated in two studies using visual analogue score (VAS).[19,20] Improved postoperative pain relief is important for patient comfort and may decrease the hospital stay and lead to reduction in morbidity. Improved blood flow consequent on sympatholysis has additional potential benefits, including a reduction in thrombo-embolic complications.[1]

Some studies have shown that thoracic epidural analgesia with a mixture of local anaesthetics and opioids, in contrast with patient-controlled anaesthesia (PCA) IV opioids, provides superior pain relief and contributes to a faster restoration of bowel function.[49,108] However, other trials with patients on a fast-track care pathway with intravenous PCA analgesia did not get further benefits with use of a pre-emptive thoracic epidural.[111,114] In a Cochrane Database analysis,[110] although epidural administration of local anaesthetics was found to accelerate gastrointestinal recovery and reduce nausea after abdominal surgery compared with epidural or systemic opioids, it did not reduce length of stay compared with patient-controlled opioid analgesia.[83]

And therefore, research continues to find the optimum infusion (constituents, concentration and total volume) and the optimum timing and duration of infusion to find significant difference between mid-thoracic epidural analgesia peri-operatively and PCA on the length of stay, too.

A practical problem may evolve during operations. The blockade of these fibres leads to hypotension and the laparotomy intensifies low blood pressure. Then it is very tempting to fill up with intravenous fluid to achieve normal tension. But, as we will discuss later, the risk is intravenous fluid overload. Therefore remember, peroperative hypotension is safely treated with vasopressors.

- Mid-thoracic EDA during surgery and EDA or PCA postoperatively at least for 2-3 days, reduces PONV, postoperative ileus and pain and therefore reduces hospital stay
- Addition of opioid to epidural local anaesthetic provide superior analgesia

12. Preventing and treating postoperative nausea and vomiting

Postoperative nausea and vomiting and postoperative ileus are well-recognized syndromes that lead to significant morbidity and prolong hospitalization. Anaesthesia is given worldwide to more than 75 million surgical patients annually. Untreated, one third of surgical patients suffer from PONV.[115] Patients often rate PONV as worse than postoperative pain. Volatile anaesthetics, nitrous oxide and opioids appear to be the most important causes. Female gender, non-smoking and a history of motion sickness and PONV are the most important patient specific risk factors.[116] Vomiting increases the risk of aspiration and has been associated with suture dehiscence, oesophageal rupture, subcutaneous emphysema, and bilateral pneumothorax. Numerous patho-physiological mechanisms are known to cause nausea or vomiting but their role for postoperative nausea and vomiting is not quite clear.

Intra-operative and early postoperative supplemental oxygen may reduce nausea and vomiting after colonic surgery, and the effect may be as affective as odansetron.[5]

The use of short-acting volatile and intravenous anaesthetics can influence the postoperative course favourably and reduces the incidence of PONV markedly. At a moderate risk the use of total intravenous anaesthesia (TIVA) or an antiemetic is reasonable because PONV frequently delays discharge from post-anaesthesia care units. In very high-risk patients one may justify the combination of several prophylactic antiemetic interventions. The necessary doses are usually a quarter of those needed for treatment.[116] Management techniques such as TIVA cannot be used once PONV is established. A reasonable treatment strategy in high risk patients would be to use dexamethasone and total intravenous anaesthesia as first- and second-line prophylaxis for postoperative nausea and vomiting, leaving serotonin antagonists as a rescue treatment.[115] But dexamethasone, prevents PONV only when given in the beginning of surgery, probably due to reducing of surgery-induced inflammation. "Rescue" treatment, like serotonin antagonists, is ineffective when the same drug has already been used as prophylaxis. Prophylaxis may therefore be preferable to treatment of established PONV.

- Oxygen supplement intra-operative and early postoperative reduces PONV
- Moderate-risk patients may respond to TIVA or an antiemetic drug peroperative
- In high-risk patients a combination of TIVA and dexamethasone peroperative

13. Surgical incisions

To minimize the inflammatory process and pain, the incisions should be reduced to a minimum. Transverse incisions may cause less postoperative pain and better pulmonary function.[117] Therefore laparoscopic incisions may be even better.[118,119] Laparoscopic colon resections have showed advantages over conventional surgery. Blood loss is less; pain, treated with epidural or patient-controlled on demand analgesia, is less intense; time to return of bowel function is less, lung function is improved with reduced postoperative stay in hospital and improved quality of life in the first 30 days. The operation time is still longer with laparoscopic surgery than with conventional surgery. Re-operation is not more likely after laparoscopic surgery and general complications in the lungs, heart, urinary tract or deep vein thrombosis (DVT) were similar with the two surgery techniques. Wound infections were less in laparoscopic patients.[120-123]

Despite the minimally invasive nature of laparoscopy, host physiologic responses to stress are still variably activated. The sane gamut of metabolic, hormonal, inflammatory, and immune responses activated by open surgery are also induced by laparoscopy, but to a lesser degree and proportionate to the extent of surgical injury.[124]

- Small incisions give smaller inflammatory responses. Laparoscopy even better.

14. Nasogastric intubation

In 1933 Wangensteen and Paine[125] wrote: "It is now twenty-four years since Westermann first used the duodenal tube in the relief of postoperative distension of peritonitis. With the introduction of the smooth tipped duodenal tube for nasal intubation by Levin in 1921 and satisfactory demonstration of the source of gas in postoperative dissention by McIver and his associates in 1926 as being largely swallowed air, the relief of postoperative distension through employment of the duodenal tube has become a matter of general practice." Thereafter the nasogastric tube was used routinely.

The practice was based largely on tradition and perception that nasogastric decompression protected patients from postoperative complications such as nausea, vomiting, aspiration, wound complications, anastomotic leak, and therefore allowed an earlier hospital discharge. Formerly, some used nasogastric tubes for 24 hours when using or more. Many of the early studies advocated nasogastric decompression allowing the patients ad libitum oral intake with the nasograstric tube in place, a practice that would not be advocated by most surgeons today.[126]

Routine nasogastric decompression was widely practiced after elective laparotomy. But the use of nasogastric tubes affect patients considerably. Studies have shown that nasogastric tube decompression does not shorten the duration of ileus and may, in some cases, contribute to postoperative complications such as nasal and pharyngeal injury, fever, atelectasis, increased gastric reflux, regurgitation, and pulmonary infections.[82,127] RCTs could not show any relevant benefit. Although patients may develop abdominal distension or vomiting without nasogastric tube, this is not associated with an increase in complications or length of stay.[126]

The beginning of modifications in practice came after a RCT by Olesen et al 1984,[128] which showed earlier passage of flatus without using tubes and no differences were found regarding duration of postoperative ileus, severity of postoperative paralysis, as measured by occurrence and duration of nausea and vomiting, postoperative per oral fluid intake, and time for defecation. And a meta-analysis showed that patients not having routine tube use had an earlier return of bowel function, a decrease in pulmonary complications and an insignificant trend toward increase in risk of wound infection. On the other hand routine use may decrease the risk of wound infection and subsequent ventral hernia.[127] Although abdominal distension and vomiting are increased without nasogastric decompression, nasogastric tube insertion is required in only 5% to 7% of selectively treated patients,[129] whereas nasogastric tube replacement postoperatively is required in 2% of routinely treated patients. Routine use of nasogastric decompression after elective operations is today not supported by the literature.[127]

- Nasogastric tubes have no place routinely in elective surgery today

15. Preventing intra-operative hypothermia

When compared with normothermic controls, the degree of mild hypothermia has been associated with a twofold to threefold increase in surgical wound infections.[5]

Maintenance of normothermia is critical for the surgical patient. Hypothermia has been shown to impair coagulation and increase the stress response and cardiovascular demands. Using forced-air warmer devices and providing adequate clothing and covering during surgery, can help to reduce postoperative wound infections, blood loss, untoward cardiac and overall rate of nitrogen excretion and catabolism.

- Maintenance of normothermia reduces wound infections

16. Peri-operative fluid management

Intravenous fluid and electrolytes are given to resuscitate the patient from losses sustained during surgery and to maintain homeostasis during periods when oral intake may not be possible. In major surgery, the need for intravenous fluid is greater. However, the optimum fluid replacement strategy remains controversial.

Avoidance of intravenous fluid overloading is an important element in many protocols. Current practice in fluid regimens has been based on 40-year old concepts.[130] It was postulated a decrease in functional extracellular fluid after surgery but this decrease has never been found.[27,131]

However, a study on dogs back in 1937, showed that a modest positive salt and water balance caused weight gain after elective colonic surgery and was associated with delayed recovery and gastrointestinal motility, increased complication rate and hospital stay.[132] The same was found in humans in 2002.[133] An excess of salt and water may lead to more complications than restriction of fluid.

Francis Moore first recommended restriction in fluid regimen.[134] He argued that the metabolic-endocrine response to trauma, (conservation of salt and water), required a fluid restriction. Shires' recommendations have led to 4-6 litres or more intravenous substitution during surgery and 24 hours after, despite minimal blood loss. In contrast, "dry" regimen has been considered beneficial in thoracic surgery.[135] Intravenous fluid overload or excess early sodium and fluid prescription during and after surgery have been shown to give adverse outcome like decrease in muscular oxygen tension and delayed recovery of gastrointestinal function after segmental colonic resection with moderate fluid restriction. Postoperative weight gains after intra-operative fluid overload have been associated with poor survival and complication.[27,136,137] The pattern peri-operative intravenous fluid administration has a major effect upon cardio-respiratory and anastomotic complications, and restricted peri-operative intravenous fluid management and a preoperative carbohydrate drink were found to be of specific importance for beneficial outcomes.[32]

Factors that allow successful use of restricted intra-operative fluid regimen include preventing the patient from coming to the theatre in a dehydrated state by avoiding bowel preparation or excessive duration of preoperative fasting. There was no apparent difference between the effects of fluid-restricted and standard or liberal fluid regimens on outcome in patients undergoing elective open abdominal surgery in a meta-analysis. However, patients managed in a state of fluid balance fared better than those managed in a state of fluid imbalance.[50,138] It is clear that restriction of intravenous fluid during and after operation is safe in well-hydrated patients undergoing major elective abdominal surgery[50] without finding any significant effect on postoperative gastrointestinal function or hospital stay between conservative intra-operative fluid control, and postoperative restriction of fluids and sodium. On the other hand, restricted postoperative IV fluid management, as performed in one trial, in patients undergoing major abdominal surgery, appears harmful as it is accompanied by an increased risk of major postoperative complications and a prolonged postoperative hospital stay.[139] But this study was not an ERAS protocol and had no multimodal approximation.

Some studies have used Doppler-guided fluid administration as goal-directed therapy. Oesophageal Doppler-guided fluid management may improve outcome following major intra-abdominal surgery. However, comparison with fluid restriction strategies, including a cost-effectiveness analysis is required.[139] Evidence regarding use of Doppler-guided fluid administration is limited by heterogeneity in trial design, and recent advances in surgical techniques and peri-operative care may largely offset the initial clinical benefits observed.[140]

All together when using standardized definitions, restricted rather than standard fluid amount according to current textbook opinion, and goal-directed fluid therapy rather than fluid therapy guided by conventional hemodynamic variables, reduce morbidity after colorectal resection.[141]

- Avoiding unnecessary bowel preparation or excessive duration of preoperative fasting
- Restricted, goal-directed fluid therapy seems to be the best regimen

17. Drainage of peritoneal cavity following colonic anastomosis

Drainage of chest empyema and ascites go back to the Hippocratic era. Ambroise Pare was the first to describe drainage of the abdominal cavity, but abdominal drainage had probably been used in practice earlier.[142] During the last 2 centuries, surgeons also used drains for prophylactic purposes. Prophylactic drains have been employed to remove intra-peritoneal collections such as ascites, blood, bile, chyle, and pancreatic or intestinal juice.[143] Another assumed potential function of prophylactic drains is their signal function to detect early complications, such as postoperative haemorrhage and leakage of enteric suture lines.

F. Manley Sims[144] was the first surgeon who used prophylactic drains after gynaecological operations in the end of 19th century. Since that time, surgeons have routinely used prophylactic drainage of the peritoneal cavity after abdominal surgery.[143] Many surgeons use prophylactic drainage after colorectal anastomoses worldwide to prevent anastomotic dehiscence by evacuating fluid collections. Previous authors have suggested that drainage is important to prevent accumulation of exudative fluid, but randomised trials that examined pelvic fluid accumulation in the presence and absence of a drain demonstrated no reduction in fluid accumulation despite the presence of a functioning drain.[145,146] And there is no evidence that fluid exuded from the pre-sacral fascia will remain in the pelvis rather than communicate with the free peritoneal cavity, and may therefore not be susceptible to capture by a pelvic drain. In addition, a drain will usually not serve to control an anastomotic leak as many surgeons expect. The fact is that only in very few instances leaks among drained patients in evaluated studies, pus or faeces emerging from the drain.[146,147]

These traditional practices can impede mobility and cause discomfort and thereof increased morbidity. The use should be selective and not used routinely. Many surgeons continue to place a prophylactic drain in the pelvis after completion of a colorectal anastomosis, despite considerable evidence that this practice may not be useful. If drainage tubes first have been inserted they are normally left in situ for several days until drainage ceases. During the last 3 decades, surgeons have made effort to investigate the value of prophylactic drainage after abdominal surgery in controlled randomised clinical trials. Despite evidence-based data questioning prophylactic drainage in many instances, most surgeons around the world continue to use them on a routine bases. A possible reason for the persistence of practice may be that the surgeons are not convinced by the negative results of the existing trials. The relatively small sample size and the rarity of the outcomes in these studies limit their power to exclude a true benefit, should one exist.[142]

The large variability of drainage duration may indicate the need for future RCT focused on drainage duration, especially on short-term drainage (24-48 hours). But reviews and meta-analysis of the literature found no evidence that justifies routine drainage of colon and rectal anastomosis after uncomplicated surgery today.[143,147] They showed no difference in all outcome measures (mortality, clinical anastomotic dehiscence, radiological anastomotic dehiscence, wound infection, reoperation, length of hospital stay, extra-abdominal complications).[145,148]

However, due to the lack of statistical power after stratification to the level of the anastomosis, anastomosis in the pelvic still may need short-time drainage. Especially concerning the increase in the rate of neoadjuvant radiotherapy and the increase of Gy used, the reactive hyperaemia should indicate the need of drainage.

- No drainage after colon surgery is needed
- Because of increasing use of radiation, drainage may be used in pelvic surgery

18. Urinary drainage

Some prefer to leave the catheter in situ for several days after surgery, until the patient is fully mobilized. Others remove it the day after surgery on colonic resections, leaving the catheter for seven days after pelvic surgery. Few RCTs are available to define the optimal duration of such drainage, but patients require a shorter period of urinary catheterisation, are able to mobilise more quickly, and had an earlier return of gut function in optimized pathways.[5,20] One study recommend in major low-rectal operations, urinary bladder drainage to be limited to about 3 days and to 1 day after types of colonic surgery.[5]

- 1 day after colonic surgery, about 3 days after low-rectal operation

19. Prevention of postoperative ileus

The aetiology of postoperative ileus is complex, and major intrinsic contributing factors include surgical stress (i.e., from physical manipulation of the bowel), secretion of inflammatory mediators and endogenous opioids in the gastrointestinal tract, and changes in hormone levels and electrolyte and fluid balance, pharmacological agents such as inhalation anaesthetics, and use of opioids for postoperative analgesia implying that both stimulation of nociceptive afferent and sympathetic efferent nerve pathway initiate ileus.[82,108,113] Opioids are the most widely prescribed analgesics used to treat postoperative pain. However, opioids bind to μ-opioid receptors within the gut, exacerbating postoperative ileus.[83] The μ-opioid receptors have been the subject of investigative targets to block and thereby add a pharmacologic adjunct that has previously been lacking.[149]

Postoperative ileus is defined as a disruption of the normal peristaltic motion of the gut, resulting in failure to propel intestinal content through the gastrointestinal tract. Symptoms associated with postoperative ileus include abdominal distension and bloating, nausea and/or vomiting, lack of bowel sounds, gas and fluid accumulation in the bowel, delayed passage of flatus and stool, and inability to tolerate solid diet. Small bowel ileus resolves within hours of manipulation, but gastric and colonic motor function does not return until 48 to 72 hours postoperatively.[23] It is due to inhibition of extrinsic motility regulation in the colon. The potential benefits from prompt resolution of postoperative ileus may include reduction in the incidence of bowel complications, the potential for more rapid return to normal bowel function, improved patient comfort, reduced length of stay, and reduced healthcare costs.[82]

Postoperative ileus has been shown reduced in fast-track groups[47] even though Lewis[67] found an increased risk of vomiting among patients fed early. This meta-analysis did not include patients in an ERAS protocol. And again, including many ERAS elements in a clinical pathway may result in a cumulative effect not found studying one at the time.

The greatest advance in limiting postoperative ileus to date has probably resulted from the expanded use of laparoscopic surgery and the advantage of limiting tissue trauma. Animal and clinical trials have demonstrated significant reductions in postoperative ileus after laparoscopic colectomy compared with open techniques, which translate into decreased hospital stay.[149]

Postoperative ileus is one of the most common causes of prolonged length of hospital stay. Furthermore, postoperative ileus may be a significant contributing factor for hospital readmission.

- Opioids exacerbating postoperative ileus, but the aetiology is very complex and many elements may contribute

20. Postoperative nutritional care

Standard before ERAS was no oral alimentation until flatus passed, and then progressive diet was initiated. Initially, clear fluids were given, followed by full liquids, and than a regular diet. On average, fluids were commenced on the third or fourth day, with discharge of the patient on the seventh or the eighth day following surgery. Intravenous fluid was administered until the patient was able to drink ad libitum. Until intestinal activity was demonstrated to have reasserted itself in a normal way, by the detection of vigorous peristaltic sounds on regular auscultation of the abdomen and the passage of flatus per rectum, normal diet was banned.

The immediate advantage of caloric intake could be a faster recovery with fewer complications. In the 1990s, early oral intake after elective abdominal colorectal surgery was found safe and was tolerated by the majority of the patients, though they were on a clear liquid diet on the first postoperative day, and advanced to a regular diet within the next 24-72 hours,[150,151] and there was a significant attenuation in gut mucosal permeability.[152] Early studies showed early feeding as a key factor in reducing acute hospital stay,[153,154] and later studies reduced infection rate and the length of stay, but did not significantly reduce mortality.[1] A recent meta-analyse by Lewis et al[155] concluded with reduced mortality, but increased vomiting. However, the trend was in the direction of reduced complication rate and hospital stay. There is no advantage keeping the patient "nil by mouth".

Reduction in complication rates may explain the shortened length of stay as might faster return of gastrointestinal function upon early commencement of enteral feeding.[78] Early enteral feeding is predicated on radiologic and electro-physiologic studies that indicate a return of small bowel function in 4 to 8 hours post incision, right colon function by 24 hours and left colon function by 72 hours. Severity in duration of the atony can be attenuated by laparoscopy, reduction in opioid-based anaesthesia and analgesia, as well as blockade of the sympathetic reflex circuit through effective continuous thoracic EDA with local anaesthetics.

Early oral intake has become a routine feature in management after elective colonic surgery. And when is it appropriate to start? Patients should be encouraged to commence oral fluid intake 4 hours after surgery.[8]

- There is no advantage keeping the patient "nil by mouth".
- Patients should be encouraged to commence oral fluid intake 4 hours after surgery and normal food intake the day after surgery

21. Early mobilization

Previously, active movements were encouraged in bed after surgery. On the second or the third evening, the patient was usually helped out of bed for a few minutes whilst the bed was made. Thereafter the ambulation was gradually increased.

However, immobilization, over a longer period, can lead to organ dysfunction, loss of lean body mass, reduced muscle power and fatigue.[20] Bed rest not only increases insulin resistance but also decreases pulmonary function and tissue oxygenation and give an increased risk of thromboembolism.[8] To avoid pulmonary complications caused by reduced pulmonary function due to immobilization and reduced tissue oxygenation, mobilizing the patients as soon as possible is important. Mobilization starts on the day of surgery or on the first operative day.[107]

Patients should be nursed in an environment that encourage independence and mobilization. A care plan that facilitates patients being out of bed for up to 2 hours on the day of surgery and 6 hours thereafter is recommended.

To be considered fit for discharge patients had to be apyrexial, fully mobile, passing flatus or faeces, and using oral analgesics only for pain control.[50]

- Out of bed the operation day and 6 hours first operation day and thereafter

22. Economic consideration

In colorectal surgery, cost-analysis of enhanced recovery protocols is limited. Two early clinical pathway programmes proved useful in standardising patient care and reducing costs,[11,48] and were probably instrumental in the development of modern ERAS protocols.[156] None of these studies addressed the set-up costs of an ERAS protocol nor provided a detailed breakdown of where cost savings were achieved in the postoperative recovery phase. However, there has been a huge paradigm shift in postoperative care principles in colorectal surgery since that time, making the cost-analysis reported in those studies inapplicable to current programmes.

Cost-effective analysis has shown that an ERAS programme is a very cost-effective intervention in elective colonic surgery in the setting of an elective hospital.[156] Another case-control study by King et al 2006[157] focussing on quality-of-life after colonic and rectal surgery, showed in hospital stay half as long as those receiving conventional care, with no increased morbidity, deterioration in quality of life or increased cost.

Evidence from the literature, supports the view that the ERAS pathway seems to reduce the overall healthcare cost.[114,158,159] The largest reduction was in expenses for nursing care, although significant reduction were recorded also in costs of laboratory tests, medications (pharmacy), medical service and other expenses.[114] From a health economics point of view, the data suggests that, with the decrease of complications and hospital stay and similar readmission rates, the cost of treatment per patient would be significant lower for those treated with an ERAS pathway than those receiving traditional care, despite the need for dedicated staff to implement the pathway.[33]

23. Implementation

Improved adherence to the standardized multimodal ERAS protocol is significantly associated with improved clinical outcomes following major colorectal cancer surgery, indicating a dose-response relationship.[32] In spite of a large evidence base for peri-operative care aiming to alleviate postoperative catabolism and organ dysfunction, surgical patients remain exposed to unnecessary starvation, suboptimal stress reduction, and fluid overload.[160]

Although the concept of multimodal postoperative rehabilitation seems rationale and simple, implementation in daily practice has been surprisingly slow so far. This can be partly explained by the need to break with longstanding traditions such as preoperative fasting, postoperative advancement of oral feeding and delayed mobilization.[47] Partly that the ERAS concept as such possibly appears elusive because the relative contribution of each intervention in the program remains uncertain. The most plausible explanation is that a successful multimodal rehabilitation program requires the reorganisation of peri-operative care, with increased collaboration between the patient, anaesthetist (acute pain service), surgical nurse and surgeon. Furthermore, major efforts must be made for educational programmes, with emphasis on peri-operative patho-physiology, as well as a revision of traditional postoperative care programmes with drains, gastrointestinal tubes, catheters, restrictions etc.[48]

The step from best evidence to best practice is simple. However, most of the time it is not, and we need various strategies targeting obstacles to change at different levels, which could even present conflicting values for individual practitioners. Therefore, changes in clinical practice are only partly within doctor’s control. Obstacles to change are generally not only in the professional setting but also in the patient, the organisation of care processes, resources, leadership, or the political environment. The prevailing professional and organisational culture towards quality determines the outcome to a large extent.[161]

For instance, patients were not expecting to go home in less than seven days and surgeons were cautious with early discharge.[108] Patients made an early functional recovery, but discharge was generally 2 days later.[9] Strict discharge criteria were met approximately 1,5 days before actual discharge. Social factors, patient’s needs, and physician care all influenced the actual discharge date or length of stay.[107]

Introducing ERAS protocols usually requires a major shift in clinical routines, and many units may have difficulties in making all these changes at once. The delay in integrating novel management strategies with routine practice may be ascribed to the time required to develop guidelines, the implementation process, the target group of professionals, the patients, the cultural and social setting, and the organizational and economic environment.[9] Much may be achieved simply by raising the quality of surgical care according to existing evidence. In many ways, this is far more difficult task than simply doing more research.[4]

Nevertheless, some of the elements in the ERAS program, such as omission of routine bowel preparation for colonic resections, no routine use of postoperative drains, early removal of nasogastric tubes, and early feeding and mobilization, have already been incorporated in traditional care. The effect of the different peri-operative ERAS interventions as well as the importance of adherence to the protocol in terms of clinical outcomes, such as postoperative symptoms, morbidity, and length of stay (LOS), remain unclear.[32]

If you would like to start tomorrow to change practice and implement evidence, prepare well: involve the relevant people; develop a proposal for change that is evidence based, feasible, and attractive; study the main difficulties in achieving the change, and select a set of strategies and measures at different levels linked to that problem; of course, within your budget and possibilities. Define indicators for measurement of success and monitor progress continuously or at regular intervals. And, finally, enjoy working on making patients' care more effective, efficient, safe, and friendly.[161]

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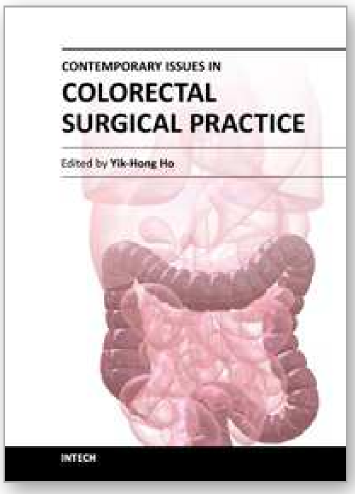

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中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821