

Enhanced Recovery After Surgery

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Abstract

Enhanced recovery after surgery (ERAS) is a multimodal perioperative care pathway designed to achieve early recovery for patients undergoing major surgical procedures. Meta-analyses, randomized controlled trials, and large prospective cohort studies were reviewed. Each item of the perioperative treatment pathway in the English language was examined and reviewed. Enhanced recovery after surgery items that were the strongest predictors for a shorter hospital stay and lower morbidity were absence of a nasogastric tube, early mobilization, early oral nutrition, early removal of the epidural, early removal of the urinary catheter, and utilization of nonopioid analgesia. Based on evidence available for each element of the perioperative care pathway, ERAS provides a protocol for perioperative care. This protocol allows for further evidence-based studies that are adequately powered between institutions.

There are over 234 million major surgical procedures performed worldwide annually (Feldheiser, et al., 2016). Enhanced recovery after surgery (ERAS) clinical pathways have been developed to improve the quality of perioperative care with the goal of minimizing loss of functional capacity and enhancing the recovery process. Reduction of perioperative morbidity is the overall goal, with decreased length of stay an effect of ERAS protocols (Joliat et al., 2015; Nussbaum et al., 2015).

The ERAS Society, an international group, was formed in 2010 to construct comprehensive and evidence-based frameworks for the best perioperative care for various

surgeries. Data were retrieved from databases and reviewed for strength of evidence to create these protocols (Lassen et al., 2013). The American Nurses Credentialing Center in 2015 challenged hospitals to focus on delivering quality care while integrating evidence-based practices (Bohnenkamp, Pelton, Rishel, & Kurtin, 2014). Enhanced recovery after surgery clinical pathways are an example of the integration of evidence-based practices to improve perioperative care.

METHODS

A literature search was conducted to identify a comprehensive range of relevant publications. Databases searched included the Cumulative Index to Nursing and Allied Health

Literature (CINAHL), PubMed, Scopus, Google Books, and ProQuest Dissertations & Theses (PQDT). The following key words and medical subject heading (MeSH) phrases were used: enhanced recovery after surgery, fast track surgery, early feeding after surgery, postoperative care, and clinical pathways after surgery. The search was limited to accessible full-text research articles, review articles, books, and expert content (textbooks) in English. The search dates were limited to between January 2010 and March 2016. Disciplines outside of nursing were sought. Inclusion criteria included mention of a clinical pathway or enhanced recovery after surgery and gastrointestinal surgical procedures (colorectal, gastric, and pancreaticoduodenectomy). Exclusion criteria included mention of pediatric surgical cases or pediatric surgery. Data ranges were not used as exclusion criteria, and all relevant literature available in the above-mentioned databases was reviewed.

RESULTS

Databases were searched (CINAHL, PubMed, Scopus, Google Books, PQDT), resulting in 2,160 titles and abstracts. After removal of duplicates and nonrelevant titles, 100 articles remained and were read in their entirety. Of these, 76 papers were then excluded based on the inclusion or exclusion criteria specified above or a lack of focus on enhanced recovery after surgery. Of those remaining, 10 focused on early feeding after surgery, 1 discussed facilitating early recovery of bowel motility, 1 discussed the nurse's role in implementation of an enhanced recovery pathway, 2 concentrated on consensus statements or guidelines of professional organizations regarding enhanced recovery after surgery, 9 focused on the implementation of an enhanced recovery after surgery protocol and improved outcomes, and 1 was related to a cost-benefit analysis of an enhanced recovery protocol.

DISCUSSION

Enhanced recovery after surgery protocols consist of multimodality perioperative management to improve postoperative recovery. Enhanced recovery after surgery pathways encompass the interval prior to surgery to the day of discharge. These standardized multidisciplinary guide-

lines address a specific diagnosis or procedure. Enhanced recovery after surgery protocols are a quality improvement tool to reduce postoperative morbidity (Nussbaum et al., 2015). These protocols have been shown to decrease length of stay and cost through improved postoperative pain control, better nausea control, integration of preoperative, intraoperative, and postoperative care, and education for the patient and family to participate in care (Pędziwiatr et al., 2015). The clinical pathways are detailed treatment strategies based on best practice guidelines. These pathways are only utilized for uncomplicated postoperative courses. If a patient requires fluid resuscitation or vasopressor support, the patient is not a candidate for an ERAS pathway. (See Table 1 illustrating different areas of oncology with published ERAS protocols.)

Preexisting Health Conditions

The goal of preoperative ERAS protocols is to optimize preexisting health conditions such as alcohol use, tobacco use, anemia, and anxiety. Patients with a moderate alcohol use (defined by the World Health Organization as 3 drinks/day) have an increased risk for bleeding and wound infection (Feldheiser et al., 2016). Alcohol impairs the metabolic stress response and the body's immune function. A minimum of 4 weeks' abstinence from alcohol is needed to reduce these risks. Patients may need 8 to 12 weeks to return to a normal baseline.

Smokers also have an increased risk of poor wound and tissue healing. Smoking cessation for 4 weeks prior to surgery improves wound healing. Nicotine replacement therapy and counseling can be used for preoperative smoking cessation.

Anemia is a predictor of postoperative complications and mortality. Transfusions should take place prior to surgery to bring the hemoglobin to a baseline level. Iron, folate, vitamin B12 supplements and/or erythropoietin should be planned 3 to 4 weeks prior to surgery in order for the supplementation to take effect.

Other medical conditions, such as those that are cardiac or pulmonary, should also be optimized with preoperative evaluation and clearance by a health-care provider. Anxiety is a predictor for postoperative pain intensity. Education and

Table 1. Enhanced Recovery After Surgery Recommendations by Disease Site

Type of surgery	Preoperative	Intraoperative	Postoperative
Colorectal	<ul style="list-style-type: none"> • Increase exercise • Stop smoking 1 month prior to surgery • No OMBP • Clear liquids up to 2 hr before surgery and solids up to 6 hr prior to surgery • Education • Prophylactic antibiotics • Compression stockings 	<ul style="list-style-type: none"> • Rapid awakening • PONV prophylaxis • Multimodal analgesia • NG tube not used routinely and removed before reversal of anesthesia • Normothermia • Crystalloid fluids preferred • Vasopressors if needed 	<ul style="list-style-type: none"> • Remove Foley catheter postoperative day 1 or 2 • Early enteral feeds • Early mobilization • Tight glucose control • NSAIDs
Liver	<ul style="list-style-type: none"> • Preoperative education • BMI < 18.5; oral nutrition supplements for 7 days and postpone for 2 weeks • Fluids up to 2 hr prior to surgery, solid food 6 hr prior to surgery • No OMBP • Low-dose heparin • Prophylactic antibiotics • Shower with chlorhexidine night before and day of surgery • No NG tube 	<ul style="list-style-type: none"> • Minimally invasive approach • Normothermia • Crystalloid fluids 	<ul style="list-style-type: none"> • Regular diet postoperative day 1 • Tight glucose control • Early mobilization • No TEA
Bladder	<ul style="list-style-type: none"> • Preoperative education • No OMBP • Clear fluids 2 hr prior to surgery and solids 6 hr prior to surgery • Compression stockings • Low-dose heparin • Prophylactic antibiotics • Shower with chlorhexidine night before and day of surgery • PONV prevention 	<ul style="list-style-type: none"> • Epidural analgesia • Minimally invasive approach • No drain • Normothermia • No NG tube 	<ul style="list-style-type: none"> • Discontinue catheter postoperative day 1 • Gum and oral magnesium to promote gastrointestinal mobility • Early mobilization • Food given 4 hr after surgery
Gynecologic	<ul style="list-style-type: none"> • Avoid fasting before surgery • Carbohydrate-loaded beverages night before surgery • Preoperative education • Shower with chlorhexidine night before and day of surgery • Prophylactic antibiotics • Increase physical activity 	<ul style="list-style-type: none"> • Colloid IV fluids • Epidural analgesia • Normothermia • Compression stockings • No NG tube 	<ul style="list-style-type: none"> • Early mobilization • Low residue diet 4 hr after surgery • Bowel regimen • No patient-controlled analgesia • Scheduled NSAIDs • Discontinue IV fluids postoperative day 1

Note. Information is based on strong evidence and strong recommendations. Low or moderate evidence and low or moderate recommendations were not included. OMBP = oral mechanical bowel preparation; PONV = postoperative nausea and vomiting; NG = nasogastric; NSAID = nonsteroidal anti-inflammatory drug; BMI = body mass index; TEA = thoracic epidural analgesia; IV = intravenous; PEG = percutaneous endoscopic gastrostomy; DVT = deep vein thrombosis. Information from Arsalani-Zadeh, ELFadl, Yassin, & MacFie (2010); Cerantola et al. (2013); Coyle et al. (2016); Dangayach, Caridi, Bederson, & Mayer (2017); de Groot et al. (2015); Dort et al. (2017); Fiore et al. (2016); Gustafsson et al. (2013); Hagan et al. (2016); Hughes, McNally, & Wigmore (2014); Jones, Edmonds, Ghosh, & Klein (2013); Kagedan, Ahmed, Devitt, & Wei (2014); Kalogera et al. (2013); Lassen et al. (2013); Melloul et al. (2016); Mortensen et al. (2014); Zhuang, Ye, Zhang, Chen, & Yu (2013).


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Table 1. Enhanced Recovery After Surgery Recommendations by Disease Site (cont.)

Type of surgery	Preoperative	Intraoperative	Postoperative
Breast	<ul style="list-style-type: none"> • Preoperative education • Clear fluids up to 2 hr before surgery • Carbohydrate loading before surgery • Preoperative anxiolytic medication 	<ul style="list-style-type: none"> • Epidural analgesia • PONV prophylaxis • Normothermia • No drains 	<ul style="list-style-type: none"> • Early mobilization • Compression stockings • Discharge support
Head and neck	<ul style="list-style-type: none"> • Preoperative education • Psychological optimization • Preoperative exercise • Nutritional drinks 3 days prior to surgery • Carbohydrate drink 2 hr before surgery • Antibiotic prophylaxis • Shower with chlorhexidine night before surgery and morning of surgery • Preoperative anxiolytic medication 	<ul style="list-style-type: none"> • No routine tracheostomy • Normothermic • Propofol or sevoflurane anesthesia • Near zero fluid balance • Superficial cervical plexus block 	<ul style="list-style-type: none"> • Enteric feeding (NG or PEG) 12 hr after surgery • Early mobilization • Early discontinuation of IV fluids • Discontinue catheter postoperative day 1 • Pulmonary physical therapy
Pancreas	<ul style="list-style-type: none"> • Preoperative education • No biliary drainage • Discontinue smoking and alcohol use 1 month prior to surgery • Immunonutrition for 5–7 days • No OMBP • Clear liquids 2 hr before surgery, solids 6 hr before surgery • Carbohydrate loading night before surgery • Antibiotic prophylaxis 	<ul style="list-style-type: none"> • Epidural • Normothermia • No NG tube 	<ul style="list-style-type: none"> • DVT prophylaxis with anticoagulation medication • Tight glucose control • Early removal of drains • No somatostatins • Discontinue catheter 1–2 days after surgery • Early diet per patient • Early mobilization
Gastrectomy	<ul style="list-style-type: none"> • Optimize nutrition prior to surgery 	<ul style="list-style-type: none"> • No NG tube • No drains 	<ul style="list-style-type: none"> • Food and drink on postoperative day 1
Brain	<ul style="list-style-type: none"> • Preoperative education • Discontinue smoking and alcohol 1 month prior to surgery • Preoperative nutrition and carbohydrate loading • Compression stockings, no anticoagulation • Antibiotic prophylaxis 	<ul style="list-style-type: none"> • Scalp blocks • Minimally invasive approach • Normothermia • Mixture of colloids and crystalloid fluids • PONV prophylaxis 	<ul style="list-style-type: none"> • PONV with serotonin antagonists and dexamethasone • Remove catheter postoperative day 1 • Early mobilization • Tight glucose control • Prevention of postoperative ileus

Note. Information is based on strong evidence and strong recommendations. Low or moderate evidence and low or moderate recommendations were not included. OMBP = oral mechanical bowel preparation; PONV = postoperative nausea and vomiting; NG = nasogastric; NSAID = nonsteroidal anti-inflammatory drug; BMI = body mass index; TEA = thoracic epidural analgesia; IV = intravenous; PEG = percutaneous endoscopic gastrostomy; DVT = deep vein thrombosis. Information from Arsalani-Zadeh, ELFadl, Yassin, & MacFie (2010); Cerantola et al. (2013); Coyle et al. (2016); Dangayach, Caridi, Bederson, & Mayer (2017); de Groot et al. (2015); Dort et al. (2017); Fiore et al. (2016); Gustafsson et al. (2013); Hagan et al. (2016); Hughes, McNally, & Wigmore (2014); Jones, Edmonds, Ghosh, & Klein (2013); Kagedan, Ahmed, Devitt, & Wei (2014); Kalogera et al. (2013); Lassen et al. (2013); Melloul et al. (2016); Mortensen et al. (2014); Zhuang, Ye, Zhang, Chen, & Yu (2013).

counseling with preoperative analgesia and anxiolytics should be addressed preoperatively. Short-term benzodiazepines should be avoided in those

older than 60 years of age. Long-acting sedatives and opioids should be avoided due to impairment of mobility resulting in increased length of stay.

Oral Intake

One of the foci of ERAS is early oral intake of fluid and food (Dummigan, 2014; Fujii et al., 2014). Supplements high in protein are recommended in order to prevent catabolism (Brady, Keller, & Delaney, 2015). Traditionally, on the day of surgery patients are allowed nothing by mouth (npo) at midnight, although guidelines support the safety of allowing clear liquids up to 2 hours and solid food up to 6 hours before the induction of anesthesia (Feldheiser et al., 2016). Complete gastric emptying takes place in 90 minutes (Feldheiser et al., 2016). There is not enough evidence to support that by ensuring an empty stomach, the aspiration risk is less. Studies have shown that fasting after midnight increases insulin resistance, patient discomfort, and decreases intravascular volume (Conchin, Muirhead, Ferrie, & Carey, 2013).

Preoperative recommendations are to give the patient oral complex carbohydrate supplements at approximately 800 mL the night before surgery and another 400 mL of carbohydrate supplements 2 to 3 hours before the induction of anesthesia (Feldheiser et al., 2016). This reduces the catabolic state caused by fasting and surgery. Fasting before surgery inhibits insulin secretion and promotes the release of catabolic hormones, such as glucagon and cortisol (Sugisawa et al., 2015). Increasing insulin levels preoperatively with oral carbohydrates reduces postoperative insulin resistance, maintains glucagon reserves, decreases protein breakdown, and improves muscle strength (Lassen et al., 2013). Barriers to implementing this evidence-based recommendation include resistance among surgeons and anesthesiologists.

The stomach and jejunum regain motility 12 to 24 hours after major surgery, while the colon regains motility in 48 to 72 hours (Feldheiser et al., 2016). The small bowel recovers after 4 to 8 hours of surgery (Feldheiser et al., 2016). Prophylactic nasogastric (NG) tubes placed during surgery to evacuate air should be removed prior to the reversal of anesthesia. Fever, oropharyngeal, and pulmonary complications are more frequent in patients with NG tubes. Avoidance of NG decompression is associated with an earlier return of bowel function (Wallström & Frisman, 2013). Even in gastroduodenal and pancreatic surgery, there is no evidence of a beneficial effect of the

use of prophylactic NG tubes (Hwang, Jung, Cho, & Yu, 2014). Traditionally, patients are kept npo or only given sips of water (Rohatiner et al., 2012). The classic sign that a postoperative ileus was resolving was the passage of flatus. Only then would patients be given a diet (Dummigan, 2014). With ERAS protocols in place, the patient is given sips of water or a clear liquid diet the day of surgery (Fujii et al., 2014; Rohatiner et al., 2012). The diet is then rapidly progressed to a regular diet (Gerritsen et al., 2014). Early oral feeding has not been shown to increase postoperative complications, readmission rate, and the incidence of anastomotic leak (Liu et al., 2014; Mahmoodzadeh, Shoar, Sirati, & Khorgami, 2015). Patients who start early feeding protocols have fewer surgical complications and are less likely to be readmitted (Mahmoodzadeh et al., 2015; Sierzega et al., 2015).

Postoperative Nausea and Vomiting

The incidence of postoperative nausea and vomiting (PONV) is 20% to 30% (Feldheiser et al., 2016). Reduction of postoperative fasting, carbohydrate loading, and adequate hydration may decrease PONV. Serotonin antagonists (ondansetron) or application of a scopolamine patch or dopamine antagonists (droperidol) may be given prior to or at the end of surgery to decrease PONV. Dexamethasone at 4 to 5 mg intravenously after the induction of anesthesia has also been shown to be effective. Intraoperative fluid therapy should have the goal of maintaining a zero fluid balance (Nikfarjam et al., 2013). Crystalloid excess increases the risk of pulmonary complications, prolonged ileus, and delayed recovery.

Analgesia

Thoracic epidural analgesia is the gold standard for postoperative pain control in patients undergoing open abdominal surgery (Teeuwen et al., 2010). Epidural analgesia is associated with a 40% reduction of mortality (Teeuwen et al., 2010). Compared with parenteral opioids, epidural analgesia has been shown to provide a sustained analgesia for 72 hours, accelerate the recovery of gastrointestinal function, reduce insulin resistance, and reduce cardiac and respiratory complications (Teeuwen et al., 2010). Nonsteroidal anti-inflammatory drugs and COX-2 drugs, such as celecoxib, have

been shown to improve postoperative analgesia by reducing opioid consumption. (See Table 2 illustrating the perioperative process.)

Delirium

Postoperative delirium is common in critical care and in postoperative patients. Factors such as age, prolonged preoperative fluid fasting times, deep anesthesia time, disturbance of the sleep–wake cycle, the use of sedatives and benzodiazepines, a history of excessive alcohol use, low body mass index, low serum albumin levels, intraoperative hypotension, and perioperative blood transfusions predispose the patient to delirium (Scholz, Oldroyd, McCarthy, Quinn, & Hewitt, 2016). Early detection in the postoperative period is important as delayed treatment can increase complications, the hospital length of stay, and mortality. Nonpharmacologic interventions and the use of haloperidol may be necessary to treat postoperative delirium.

Mobilization

Mobilization occurs early in the postoperative course. Instructions detailing daily mobilization goals are given to the patient and family in the outpatient setting prior to surgery. Patients

may be given a log for daily activity or instructed on exercises to be done prior to surgery. Patients should also be encouraged to increase their activity in the preoperative phase. These instructions are reinforced with written material and should be brought by the patient to the hospital on the day of surgery. This allows the patient and family to review the written materials and to participate in the patient's care.

ERAS Protocol Steps

Creating and implementing an ERAS protocol involves many steps. The first step is to form a multidisciplinary team consisting of disciplines that will be involved in the patient's care. This allows for all disciplines to function as a team in order to provide the best patient care. The next step is for the team to define the patient population or medical/nursing treatment that will be served (Bakker, Cakir, Doodemen, & Houdijk, 2015). Once the population has been identified, a systematic literature search is conducted (Hain & Kear, 2015). Enhanced recovery after surgery protocols have been documented in several populations since 2000. After the literature review, clinical pathways and process maps are designed using evidence-based practice and best standards of care. The next step is to create standardized order sets, which ensures that all necessary documentation becomes the standard of care. (See Table 3 for a sample of order sets.) The final step is to identify individuals responsible for monitoring patient outcomes and collecting data in order to revise and improve the clinical pathways and patient care.

CONCLUSION

The development of ERAS protocols using current evidence provides standardized care that improves patient outcomes. The literature has shown that institutions that have developed ERAS protocols have reported decreased costs associated with hospitalization and decreased length of stay. By using current evidence to develop these protocols, institutions can do further research through adequately powered multi-institutional studies. ●

Disclosure

The authors have no conflicts of interest to disclose.

Table 2. Enhanced Recovery After Surgery Perioperative Pathway

Preoperative	<ul style="list-style-type: none"> • Preadmission counseling • Fluid and carbohydrate loading • No prolonged fasting • No or selective bowel preparation • Antibiotic prophylaxis • Thromboprophylaxis • Premedication
Intraoperative	<ul style="list-style-type: none"> • Short-acting anesthetic agents • Midthoracic epidural • Avoidance of salt and water overload • Maintenance of normothermia
Postoperative	<ul style="list-style-type: none"> • Midthoracic epidural • No NG tube • Prevention of PONV • Avoidance of salt and water overload • Early removal of Foley catheter • Early oral nutrition • Use of nonopioid pain medication with NSAIDs and acetaminophen • Early mobilization • Stimulation of gut motility

Note. NG = nasogastric; PONV = postoperative nausea and vomiting; NSAID = nonsteroidal anti-inflammatory drug.

Table 3. Postoperation Orders for Pancreaticoduodenectomy

General	<ul style="list-style-type: none"> • VS q4h • I&O q4h • O₂ saturation q4h • Accu-Chek bid if nondiabetic • SSI q6h if diabetic until eating, then ac and hs • Endocrine consult if BG > 180 x 2 or if type 1 DM • CBC, CMP POD 1-3 • CBC, BMP POD 4-5 • Drain amylase POD 1, 3, 5 • No labs POD 6 unless indicated
POD 0	<ul style="list-style-type: none"> • NG tube • npo • Foley catheter • LR or 0.9% NS at 125 mL/hr • Epidural or hydromorphone hydrochloride PCA • 500 mg acetaminophen elixir via NG tube x 1
POD 1	<ul style="list-style-type: none"> • Remove NG tube; if patient experiences nausea, distention of > 400 mL/8 hr output, attending surgeon preference • Start clear liquid diet • Remove Foley catheter • Change to D5.45% NS at 75 mL/h • Continue epidural or hydromorphone hydrochloride PCA • Enoxaparin sodium at 40 mg SC qd • Ondansetron at 4 mg IV q6h • Omeprazole at 20 mg IV qd • Promethazine at 12.5 mg IV q6h prn • OOB to chair > 2 times • PCRM and SW consult
POD 2	<ul style="list-style-type: none"> • D5.45% NS at 50 mL/h • Clear liquid diet • Epidural or hydromorphone hydrochloride PCA • Schedule acetaminophen at 500 mg q6h • Oxycodone at 5-10 mg q3h prn • Omeprazole at 20 mg po qd • Docusate sodium at 100 mg po bid • Ondansetron at 4 mg po q6h prn • Promethazine at 12.5 mg po q6h • Ambulate bid (PT/OT consult for weakness)
POD 3	<ul style="list-style-type: none"> • Solid food (ADA, cardiac, renal) • Saline well IV fluid • Remove epidural or PCA and transition to oral narcotics • Ambulate bid
POD 4-5	<ul style="list-style-type: none"> • POD 3 orders if kept from advancement
POD 6-7	<ul style="list-style-type: none"> • Evaluate for discharge
Discharge instructions	<ul style="list-style-type: none"> • 1-week follow-up appointment with surgeon • Follow-up with endocrine, cardiology, etc., based on postoperation course • Oxycodone at 5-10 mg q6h prn (90 tabs) • Omeprazole at 20 mg bid (60 tabs) • Docusate sodium at 100 mg bid (60 tabs) • Insulin (if started in hospital) • Any new drugs started in hospital

Note. VS = vital signs; I&O = intake and output; bid = twice daily; SSI = sliding scale insulin; ac = before meals; hs = at bedtime; BG = blood glucose; DM = diabetes mellitus; CBC = complete blood count; CMP = comprehensive metabolic panel; BMP = basic metabolic panel; POD = postoperative day; npo = nothing by mouth; LR = lactated Ringer's solution; NS = normal saline; PCA = patient-controlled analgesia; SC = subcutaneous; IV = intravenous; prn = as needed; OOB = out of bed; PCRM = Physicians Committee for Responsible Medicine; SW = social worker; po = orally; bid = twice daily; PT = physical therapy; OT = occupational therapy; ADA = American Diabetes Association; tabs = tablets.

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