Anesthetic Management of Abdominal Surgery

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Additional information is available at the end of the chapter

1. Introduction

General or regional anesthesia can be appropriate for patients undergoing abdominal surgery. In common practice, balanced anesthesia with inhalational anesthetics, opioids and neuromuscular blockers are used in general anesthesia for abdominal surgical procedures. Endotracheal intubation as well as Laryngeal Mask Airway can be used for airway control. Regional anesthesia, mainly central blocks, can be used either as a sole anesthetic technique or combined with general anesthesia. Effective sedation is indicated when regional techniques were used alone. There are few absolute contraindications of spinal and epidural anesthesia including patient refusal and raised intracranial pressure. Relative contraindications are administration of anticoagulants, skin or tissue infections at the proposed site of needle insertion, severe hypovolemia and lack of anesthesiogist's experience. Postoperative headache after spinal may make epidural technique preferred, or, duration of the surgical procedure may be so short that spinal anesthesia may be more practical than epidural, need for prolonged postoperative analgesia makes catheter technique preferred than single-shot technique, etc. (1).

2. Problems associated with abdominal surgery

Pulmonary function is impaired after abdominal surgery more severely than after non-thoracic, non-abdominal surgery. Upper abdominal procedures result in a higher incidence of pulmonary complications. Postoperative pain control improves the pattern and effectiveness of ventilation provided that excessive sedation and depression of ventilation should be avoided. Epidural-subarachnoid administration of opioids or patient-controlled analgesia is recommended for postoperative pain management.

Heat loss via radiation, conduction and evaporation is a particular problem during abdominal surgery. As heat loss causes decreased organ perfusion and metabolic acidosis, and can not be avoided, all fluids including skin preparation, irrigation and intravenous

fluids should be warmed. Heated mattress should be used. Anesthesia circuits should be humidified. Low-flow or closed circuit technique is recommended.

Mechanical bowel preparation, laxatives, ileostomies, preoperative vomiting and/or diarrhoea, when present, cause large fluid loses in patients undergoing abdominal surgery. Intraoperative ascites removal is not associated with hypotension untill translocation of fluids continues or intravascular volume is not maintained (2).

Patients with cancer may have perioperative complications related to the disease or therapy. In patients with colon, pancreas and stomach cancer, hypercoagulability is common. Previous chemotherapy can cause anemia, renal, hepatic and pulmonary toxicity and, cardiomyopaty. Chronic opioid therapy for cancer pain requires greater doses of opioids for postoperative pain management (2).

3. Preoperative evaluation

The purpose of preoperative evaluation is to obtain current and previous medical status. It will give us ability of perioperative patient management. As medical problems can affect anesthesia, anesthesiologist should have knowledge about and manage them perioperatively. Then perioperative comfort can be reached: reduced patient anxiety, decrease of delays of surgery, less postoperative morbidity etc..

Preoperative risk assessment is performed by using ASA risk classification system which was developed in 1941 (Table 1). The system was based on the patients preoperative medical conditions and neither the type of anesthesia nor the type of surgery was considered in this classification. Preoperative physical examination should include, at least, blood pressure, heart rate, respiratory rate, height and weight. BMI can be calculated. The evaluation of the airway includes inspecting the teeth and measuring length and range of motion of the neck, thyromental distance and Mallampati classification which is performed by asking patients open the mouth widely (Table 2). Auscultation of the heart and lungs; observing the patient's effort for walking, can predict the need for further testing. For patients with risk factors for coronary artery disease, or who have symptoms of ischemia, an ECG is indicated.

Morbidly obese patients have higher incidence of difficult tracheal intubation, decreased oxgnenation, increased gastric volume, pulmonary embolism and sudden death. Heart disease, hypertension and Obstructive Sleep Apnea (OSA) are more common in obese patients. Obesity, hypertension and large neck circumference (>60cm) predict OSA. This neck measurement also predicts difficult ventilation and intubation.

Preoperative diagnostic and laboratory evaluation depends on the patient's medical status and history and the surgical procedures. The requirement of complete blood count, liver function, renal function and coagulation testings, urinanalysis, chest radiography in patients undergoing abdominal surgery is similar with other surgical procedures (3).

ASA 1	Healthy patient without organic, biochemical, or psychiatric disease.
ASA 2	A patient with mild systemic disease e.g., mild asthma or well controlled hypertension. No significant impact on daily activity. Unlikely to have an impact on anesthesia and surgery.
ASA 3	Significant or severe systemic disease that limits normal activity, e.g., renal failure on dialysis or class II congestive heart failure. Significant impact on daily activity. Probable impact on anesthesia and surgery.
ASA 4	Severe disease that is a constant threat to life or requires intensive therapy, e.g., acute myocardial infarction, respiratory failure requiring mechanical ventilation. Major impact on anesthesia and surgery.
ASA 5	Moribund patient who is equally likely to die in the next 24 hours with or without surgery.
ASA 6	Brain-dead organ donor

'E' added indicates emergency surgery

Table 1. American Society of Anesthesiologists Physical Status Classification

Class I	The soft palate, fauces, entire uvula, and pillars are visualized
Class II	The soft palate, fauces, and a portion of the uvula are visualized
Class III	The soft palate and base of the uvula are visualized
Class IV	The hard palate only is visualized

Table 2. Mallampati Classification

3.1. Preoperative evaluation of patients with cardiovascular disorders

The most common perioperative cardiovascular problem is hypertension which can be defined as blood pressure (BP) greater than 140/90 mmHg. It is recommended to delay elective surgery for Systolic BP>200 mmHg and Diastolic BP>115 mmHg. In the presence of ischemic heart disease, Revised Cardiac Risk Index has been validated as the best to predict perioperative cardiac risk (Table 3). In patients with heart failure, anesthesiologist should focus on minimizing the effects of the disease preoperatively. Decompansated heart failure is a high risk condition and is an indication for delaying elective surgery. Medical therapy of hypertension and other cardiac diseases should be continued preoperatively, and should be administered on the day of surgery. In patients with mitral stenosis, heart rate should be controlled prior to surgery. Beta-blockers are used and continued until the day of surgery to control atrial fibrillation. On the other hand, chronic mitral regurgitation is usually well tolerated perioperatively. In the presence of mitral valve prolapse, it is necessary to diagnose if there is significant valve degeneration. Aortic stenosis increases risk of bleeding and, patients with severe stenosis should be evaluated by cardiologist preoperatively. Aortic insufficiency is generally well tolerated and has low risks of anesthesia. Prophylaxis for

infective endocarditis is no longer recommended in valvular diseases. Some rhythm abnormalities such as isolated right bundle branch block is not a risk factor for anesthesia, but as left bundle branch block is associated with coronary artery disease, it is more important for anesthesiologist. For patients with rapid ventricular rated atrial fibrillation, preoperative rate control-with β-blockers is recommended. If ventricular arrhytmias are benign (isolated ventricular premature beats, VPB) there is no risk perioperatively, but, if VPBs >30/hour, it is potencially lethal.

1. Criteria
1. High Risk Surgery: 1 Point
2. Coronary Artery Disease: 1 Point
3. Congestive Heart Failure: 1 Point
4. Cerebrovascular Disease: 1 Point
5. Diabetes Mellitus on Insulin: 1 Point
6. Serum Creatinine >2 mg/dl: 1 Point
2. Interpretation
1. Scoring
1. Points 0: Class I Very Low (0.4% complications)
2. Points 1: Class II Low (0.9% complications)
3. Points 2: Class III Moderate (6.6% complications)
4. Points 3: Class IV High (>11% complications)
2. Complications predicted by above scoring
1. Myocardial Infarction
2. Pulmonary Embolism
3. Ventricular Fibrillation
4. Cardiac Arrest
5. Complete Heart Block

Table 3. Revised Cardiac Risk Index

3.2. Preoperative evaluation of patients with pulmonary risks

Asthma, if well-controlled, provides less risk for complications. Pulmonary function tests are indicated only in diagnosis or assessment of therapy, and not for risk assessment. Risks for pulmonary complications include smoking, age>70 years, ASA score>2, prolonged surgery (>2 hours), chronic obstructive pulmonary disease (COPD), BMI>30, hypoalbuminemia (<3 g/dL). Alternatives to general anesthesia such as epidural anesthesia may provide less postoperative pulmonary complications.

3.3. Preoperative evaluation of patients with hepatic disorders

In case of history of hepatitis, it is important whether acute episode occured soon after surgery. Elective surgery is contraindicated in patients with acute disease. Severe liver disease cause high perioperative morbidity and mortality. This can be predicted by using the Child-Turcotte-Pugh classification (Table 4). The cause and the degree of hepatic dysfunction are important (3).

Parameter	1	2	3
Ascites	Absent	Slight	Moderate
Bilirubin (mg/dL)	<2	2-3	>3
Albumin (g/dL)	<3.5	2.8-3.5	<2.8
Prothrombin Time (sec)	<4	4-6	>6
Encephalopathy	none	Grade 1-2	Grade 3-4

Table 4. Child-Turcotte-Pugh Classification

3.4. Drugs and alternative therapies

Although there are no official standards or guidelines on the preoperative use of herbal medications, it is suggested that herbals be discontinued at lest 2-3 weeks before surgery. On the other hand, in practice, anesthesiologists cannot evaluate patients 2-3 weeks before surgery. Therefore, anesthesiologists should be familiar with herbals, their complications and treatments (4).

3.5. Preoperative evaluation of morbidly obese patients

Obesity is associated with increased risk of cardiovascular diseases and diabetes mellitus. Obstructive sleep apnea (OSA) and cancer are more common in obese patients. Then, preoperative evaluation should be focused on coexisting diseases as well as on airway, history of snoring, and vital signs. Neck circumference should be measured. Patients with OSA should bring their continuous positive airway pressure devices to the hospital to use postoperatively.

3.6. Preoperative fasting

The main indication of preoperative fasting recommendation is to reduce risk of pulmonary aspiration. The ASA guideline supports a fasting period of 2 hours for clear liquids. A

fasting period of 6 hours after a light meal and 8 hours after a meal that includes fried or fatty foods is recommended (5). Solid food should be prohibited for 6 h before elective surgery in adults and children, although patients should not have their operation cancelled or delayed just because they are chewing gum, sucking a boiled sweet or smoking immediately prior to induction of anaesthesia. These recommendations also apply to patients with obesity and gastro-oesophageal reflux (6). Preoperatively administered carbohydrate-rich drink can reduce discomfort during the period of waiting before elective surgery compared with preoperative oral intake of water or overnight fasting (7).

4. Hepatic function and anesthesia

Anesthetics and surgical procedure can induce hepatic function; on the other hand, hepatic dysfunction can impair the response to anesthesia and surgery. Influence of volatile anesthetics on hepatic blood flow and function is related not only tothe anesthetic itself but also to the severity of hepatic dysfunction and abdominal surgical manipilation. Volatile anesthetics affect hepatic blood flow. Some other conditions may influence hepatic blood flow including age, volemia, intraoperative position, surgical procedure, blood pressure changes, local anesthetics, vasopressors, hemoglobin level and arterial oxygen concentrations. Anesthetics decrease cardiac output and then decrease portal blood flow; but they may increase hepatic arterial blood flow. Total hepatic flow can be restored, but often normal values can not be reached. Volatile anesthetics alter portal venous and hepatic arterial vascular resistance. Sevoflurane maintains hepatic arterial blood flow and hepatic O_2 delivery. Compound A does not alter hepatic function. No clinical hepatotoxicity has been found by using low and high flow sevoflurane and isoflurane anesthesia. In patients with chronic liver disease, isoflurane and desflurane have not changed liver function tests. Indeed, xenon seems to be the ideal anesthetic gas as it appears to be having no effect on organ perfusion; no changes on hepatic arterial blood flow. Intravenous anesthetics can affect hepatic function; thiopental and etomidate decrease hepatic blood flow, propofol increases portal and hepatic arterial blood flow. But intravenous anesthetics have not demonstrated significant effect on postoperative liver function. The effect of central neuroaxial blocks on liver function is still unclear.

Abdominal surgery reduces total hepatic blood flow. Pneumoperitoneum can increase hepatic perfusion during CO_2 insuflation. Surgical operations of biliary tract, colon, stomach and, hepatic resection for HCC are risk factors for perioperative hepatic failure. Perioperative hemorrhage is common in patients with preoperative hepatic dysfunction.

5. Anesthetic management of hepatic resection

It is important to diagnose the presence of esophageal varices. In case of thrombocytopenia, those large esophageal varices are major perioperative risk factors. Coagulopathy and anemia should be corrected prior to surgery. There is a significant risk of bleeding intraoperatively. Invasive monitoring and ability of rapid transfusion i.e. venous access- is essential. Intravenous fluids should be supplemented with sodium and potassium. The

severity of liver failure and majority of hepatic resection affect the choice and dosing of anesthetic drugs as well as postoperative pain treatment (8).

6. Anesthetic management of abdominal organ transplantation

Except living donor recipients, these cases are accepted as emergency cases. Patients undergoing liver transplantation should be evaluated by multiple medical specialists. Medical and physical examinations should be done carefully. But, as the patients wait long time for transplantation, changes could have occurred since the last evaluation. The patient may have pulmonary hypertension, then pulmonary artery catheterisation is needed and can be performed preoperatively, i.e, in the ICU. The prevalence of cardiac disease is greater in liver transplant patients than in the general public. Complications of cardiac disease play a large role in early mortality and graft loss in the postoperative period. While the presence of risk factors seems to predict coronary disease in renal disease, these factors do not perform as well in liver disease. Intraoperative monitoring may include transesophageal echocardiography also. In the preoperative period, red blood cells, fresh frozen plasma (10 U each) must be ready and 4 Units of platelets available (9,10).

General anesthesia induction and maintenance is nearly similar with any other surgery. Atracurium or cisatracurium is preferred to vecuronium, because atracurium is independent of liver for clerance. If neuromuscular monitoring is performed, any muscle relaxant can be used. An arterial line and central venous line are necessary and, ultrasound can be used to facilitate the access. As these patients are hypovolemic and have low peripheral resistance, induction of anesthesia can cause severe hypotension. After induction, an orogastric or nasogastric tube should be placed for gastric decompression. As patients have coagulopathy, placement of nasogastric tube can cause severe bleeding. Optimal anesthetic technique has not been defined for maintenance of anesthesia. Volatile anesthetics are suitable for liver transplantation, except halothane. Balanced technique using volatile agent and opioids, or total intravenous anesthesia using benzodiazepines and opioids can be used, with oxgen in air and without Nitrous oxyde for liver transplantation.

Peroperative hypothermia should be treated by blankets and warm intravenous fluids. Some tests are necessary during intraoperative period; arterial blood gase analysis, hematocrit, blood glucose and electrolytes.

There are three phases of liver transplantation; dissection, anhepatic and neo-hepatic phases. During dissection, hypotension frequently develops and adequate fluid replacement and management of diuresis are crucial.

Acidosis and hypocalemia frequently occur during the anhepatic stage. During early reperfusion phase, severe hemodynamic changes and cardiac arrest can ocur when the vascular clamps are removed. Coagulopathy or bleeding can develop in the reperfusion phase. Hypertension may occur during abdominal closure.

After liver transplantation, patients can be extubated in the operating room (11-14). On the other hand, close monitoring and laboratory tests have to be continued in the ICU. Patients

undergoing liver transplantation have decreased analgesic requirements when compared with other major abdominal surgery; it was concluded that orthotopic liver transplant patients experienced less pain and used less morphine postoperatively than did liver resection patients (15).

7. Anesthetic management of laparoscopic surgery

Laparoscopy was used for gynecologic diagnostic procedures in 1970s. Then, in 1980s, laparoscopic cholecystectomies were started (16). Although physiologic changes during this procedure can complicate anesthetic management, absolute contraindications are rare.

The routine pneumoperitoneum technique for laparoscopy is insufflation of CO_2. CO_2 is more soluble in blood than air, O_2 and N_2O. Pneumoperitoneum results in ventilatory and respiratory changes. First, pneumoperitoneum decreases thoracopulmonary compliance and, elevation of diaphragm can cause atelectasis, ventilation-perfusion changes can occur. $PaCO_2$ increases from the beginning of insufflation and, reaches maximum at 15-30th minute in patients undergoing laparoscopic cholecystectomy under head up position. After this period, increase in $PaCO_2$ requires a search for another cause. $PaCO_2$ increases more in ASA class II and III patients than in ASA I patients. The main cause of increased $PaCO_2$ is absorption of CO_2 from peritoneum, and the second, hypoventilation caused by abdominal distension, position, or volume-controlled mechanical ventilation. Increased $PaCO_2$ can be corrected by a %10-25 increase in alveolar ventilation. During pneumoperitoneum, endotracheal tube can move into bronchi because of cephalad displacement of diaphragm. Anesthesiologist should be aware of increased plateau airway pressure to notice endobronchial intubation (17).

Intraoperative standard monitoring should include arterial blood pressure, heart rate, electrocardiograpy, pulse oximetry, capnometry, and, in case of severe heart disease, transeosephageal echocardiography in laparoscopic procedures. Endotracheal intubation and controlled ventilation is the safest anesthetic technique. The laryngeal mask airway (LMA) has been used as an alternative to tracheal intubation but, aspiration of gastric contens may occur. The Proseal LMA is a more effective ventilatory device for laparoscopic cholecystectomy than LMA and the use of LMA for laparoscopic cholecystectomy is not recommended (18). Use of NO_2 is not contrindicated for laparoscopic cholecystectomy, but would be better to use air instead of NO_2 during intestinal or colonic procedures (19,20). Deep muscle relaxation is desirable, but is not clear that it is obliged. The choice of anesthetic drug does not play a direct role in patient outcome. As mask ventilation inflates the stomach during induction, an orogastric /nasogastric tube placement and aspiration before trochar placement is necessary. During pneumoperitoneum, $PETCO_2$ must be maintained between 35-40 mmHg. Intraoperative patient tilt should not exceed 15-20 degrees and positioning must be slow to avoid hemodynamic changes. Inflation and deflation should be done slowly. Peritoneal insufflation induces hemodynamic changes such as decreases in cardiac output independent of head-down or head-tilt position of patient, elevated arterial and systemic/pulmonary vascular resistances. Heart rate may

increase slightly but, reflex increases of vagal tone can cause bradycardia or, even asystole. Then, atropine should be available. Intracranial pressure rises during pneumoperitoneum. These hemodynamic changes seem to be similar in high-risk cardiac patients and healthy patients qualitatively, but not quantitatively. Severe heart failure and terminal valvular insufficiency are more important than ischemic heart disease in being prone to cardiac complications during laparoscopic procedures. Vasodilators, α-2 agonists and remifentanil infusions are preferred to reduce the hemodynamic changes, especially in cardiac patients. In patients with chronic obstructive pulmonary disease (COPD), increased respiratory rate is a beter choice than increased tidal volume (17).

Postoperatively, O_2 should be administered after laparoscopic surgery. Nausea and vomiting is one of important postoperative morbidity after laparoscopic surgery and should be prevented and/or treated by using antiemetics (21,22).

Although general anesthesia with endotracheal intubation and controlled ventilation is the most frequently used anesthetic technique, regional anesthesia can be used safely for laparoscopic procedures. Epidural technique reduces opioid use, provides better muscular relaxation, shorter duration in recovery room, but, on the other hand, discomfort or shoulder pain caused by abdominal distention cannot be completely alleviated with epidural anesthesia and/or analgesia (23-25). Spinal anesthesia has been used only contemplated in patients where general anesthesia is contraindicated for laparoscopic cholecystectomy, however, a study in 3492 patients has found a number of advantages of spinal anesthesia, and it was concluded that spinal anesthesia should be the anesthesia of choice (26). This result was supported by recent studies, moreover the cost of spinal anesthesia has been found lower than that of general anesthesia (27). Regional anesthesia provides decreased PONV and hemodynamic changes and quicker recovery, it also requires gentle surgical manipulation, otherwise may cause anxiety and discomfort.

The most dangerous complication of laparoscopic procedures is gas embolism. It occurs mainly during the induction of insufflation. Intravascular injection of gas or, insufflation into an abdominal organ cause gas embolism. In addition to gas in vena cava and right atrium which causes a sudden fall in cardiac output, foramen ovale can open and a paradoxal embolism may ocur. Clinical findings depend on the volume of the embolus. If the volume is less than 0.5 ml/kg of air, embolism can be detected by invasive monitors without clinical signs; pulmonary artery pressure increases and doppler sounds changes. If the volume is 2 mL/kg of air, typical clinical symptom and signs appear; hypotension, tachycardia, cyanosis, arrhythmias, increased central venous pressure, and auscultation of millwheel murmur, decreased $PETCO_2$ and increased gradient between $PaCO_2$ and $PETCO_2$ (Δa-$PETCO_2$). When diagnosed, first insufflation should be stopped and pneumoperitoneum should be released for treatment of gas embolism. Patient should immediately be placed into head-down + left lateral decubitus position and hyperventilation with %100 O_2 should be reached. Aspiration of gas from central venous catheter is both diagnostic and therapeutic. In prevention of gas embolism, volume preload can be effective.

7.1. Postoperative pain management

Laparoscopy provides reduction in postoperative pain and analgesic consumption when compared with laparotomy. The nature of pain is also different; pain after laparotomy is parietal, mainly in the abdominal wall, on the other hand, pain after laparoscopic cholecystectomy is multifactorial. Visceral pain is common, but, port site local anesthetic infiltration provides analgesia. Non-steroidal antiinflammatory drugs (NSAID) are effective for pain relief after laparoscopic procedures (17).

In a recent study, bilateral ultrasound-guided TAP block has been found equivalent to local anesthetic infiltration of trocar insertion sites for overall postoperative pain in 80 patients undergoing laparoscopic cholecystectomy (28).

8. Anesthetic management of bariatric surgery

Obese patients have co-morbidities as hypertension, obstructive sleep apnoea, obesity-hypoventilation syndrome, non-alcoholic fatty liver disease and diabetes mellitus. Thus, these patients frequently need ICU after surgery. Airway management can be difficult in obese patients caused by short neck, pharyngeal soft tissue, large tongue; although BMI was not found to be associated with intubation difficulties in a study (29). Obese patients can have decreased lung capacities and are prone to undergo rapid oxygen desaturation. Morbid obesity is associated with a reduction in time to desaturate during apnoea following standard pre-oxygenation and induction of anaesthesia (30). During induction of general anesthesia, CPAP can be added to preoxygenation to prevent atelectasis. The volume of distribution of lipophilic drugs is changed in obese patients, except remifentanil. Induction dose of propofol, and, rocuronium, vecuronium and remifentanil should be dosed by using ideal body weight (IBW); thiopental, benzodiazepines, maintenance dose of propofol, atracurium, succinylcholine, fentanyl and sufentanyl can be dosed by using total body weight (TBW) (31,32). Reverse Trendelenburg position is an appropriate intraoperative position for obese patients because it causes minimal arterial blood pressure changes and improves oxygenation (33). As obese patients seem to be having more frequent complications caused by intraoperative positions, further care is needed during positioning. During pneumoperitoneum pulmonary resistance increases. Alveolar recruitment by repeated lung inflation to 50 mmHg or with vital capacity maneuver followed mechanical ventilation with PEEP 10-12 cmH$_2$O, and beach chair position has been effective at preventing lung atelectasis and is associated with better oxygenation in obese patients undergoing laparoscopic bariatric surgery (34-37). In addition to pneumoperitoneum, body mass is an important determinant of respiratory function during anaesthesia in obese patients. The recruitment maneuver should always be performed when a volemic and hemodynamic stabilisation is reached after induction of anaesthesia.

In the postoperative period, beach chair position, aggressive physiotherapy, noninvasive respiratory support and short-term recovery in critical care units with care of fluid management and pain may reduce pulmonary complications. Postoperative analgesia can be provided by intravenous or thoracic epidural Patient Controlled Analgesia. Non-opioids reduce opioid consumption and side effects (29).

9. Enhanced recovery after surgery

Enhanced Recovery After Surgery (ERAS) is a multimodal perioperative care pathway designed to achieve early recovery for patients undergoing major surgery. Initiated by Professor Henrik Kehlet in the 1990s, ERAS or "fast-track" programs have become an important focus of perioperative management after colorectal surgery (38,39).

The factors which delay going home after major GI surgery are; pain, lack of gastrointestinal function and immobility. Therefore postoperative management should include pain control, to promote gastrointestinal function and mobility as soon as possible (40,41).

ERAS is associated with more rapid recovery and shortened length of stay more than 30% and appears to be associated with reduced post-operative complications up to 50% (40).

Anesthesiologist has a role in ERAS as well as surgeon. Patients should not receive sedative premedication, long-acting opioids should be avoided, mid-thoracic epidural anaesthesia can be preferred. Avoidance of fluid overload and the use of body warmers for maintenance of normothermia intraoperatively are recommended. Prevention of postoperative nausea and vomiting should be induced (42).

Postoperative care should include continuous epidural mid-thoracic low-dose local anaesthetic and opioid combinations for approximately 48 hours following elective colonic surgery and approximately 96 hours following pelvic surgery. Acetaminophen (paracetamol) should be used as a baseline analgesic (4 g/day) throughout the post-operative course. For breakthrough pain, epidural boluses should be given while the epidural is running. Nonsteroidal anti-inflammatory drugs should be started at removal of the epidural catheter. Nasogastric tubes should not be used routinely in the postoperative period, and, oral nutritional supplements should be prescribed from the day of surgery until normal food intake is achieved.

A care plan that facilitates patients being out of bed for 2 hours on the day of surgery - followed by 6 hours - is recommended as early mobilisation. Stimulation of gut motility is also recommended.

In summary, the core principles of ERAS are to minimise invasive surgery and optimise pain control, and gastrointestinal function; less intravenous fluids, taking solid foods and fluids, and early mobilisation. And the goal of ERAS is not to decrease hospital stay but to enhance recovery, perioperative organ dysfunction and morbidity (43).

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