Post-operative Care and Complications

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Surgical complications are a considerable cause of death and disability around the world, and are devastating, not only to patients but also costly to health care systems, particularly in low-resource regions. The poorest third of the world's population is estimated to receive only 3.5% of the 234 million surgical procedures undertaken annually. Despite being such a small proportion of global surgical output, the undertaking of these procedures and management of post-operative complications represent a substantial challenge for healthcare providers in low-resource regions.

Surgical complications occur for a variety of reasons, and emergency surgery by its nature is associated with a higher rate of complications compared to elective procedures due to an interplay between patient, disease and surgical factors.

Ideally, prevention of complications starts from careful patient selection and meticulous preoperative preparation of the patient, a luxury which is often not afforded in the emergent setting. Many acutely ill patients with surgical disease in low-resource regions are unable to access the definitive life-saving surgery that they need, and of those who do access surgical care, most present late in the course of their disease process. They may also experience considerable delays waiting for time-sensitive surgical intervention due to lack of staff or facilities. All these sources of delay contribute to the development of post-operative complications, compounding the inherent risk of emergency surgery.

Preoperatively, the use of the 19-item World Health Organisation (WHO) Surgical Safety Checklist has been shown to reduce surgery-related deaths and complications by more than one-third. By advocating for and adhering to the safety checklist before the start of the operation, surgeons in low-resource regions can reduce the burden of human error and the rate of avoidable complications.

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During the operation, the surgeon can also do much to influence the post-operative outcome by adhering to the fundamental principles of proper surgical technique, which involve:

1. Careful handling of tissues
2. Meticulous dissection, haemostasis and debridement of devitalised tissue
3. Compulsive control of all intraluminal contents to minimise contamination
4. Preservation of blood supply to tissues
5. Elimination of any foreign body from the wound
6. Maintenance of strict asepsis
7. Thorough drainage and irrigation of any pockets of purulence in the wound
8. Ensuring the patient is kept euthermic and fluid resuscitated during the procedure
9. Careful selection of method for skin closure or packing depending on the level of contamination

After the operation is completed, there needs to be close surveillance for any deviation from normal post-operative course so that swift action can be taken. This chapter will detail the goals of post-operative care as well as the presentation and management of common surgical complications that follow emergency surgery.

7.1 Post-operative Care

7.1.1 General Approach

Vigilance is the key to excellent post-operative care for the acute surgical patient. This involves regular examination of the patient to identify post-operative complications at an early stage when they can be most effectively addressed. On the round, the surgeon needs to be compulsive in checking all wounds, input and output charts, vital signs, nutritional status, pain and activity levels, and act on any complication promptly and appropriately. In this way, a brief inconvenient complication can be dealt with before it becomes a devastating and disabling one.

The key ingredients to the management of every post-operative patient are ensuring adequate analgesia, fluids and electrolytes, nutrition, prevention of thromboembolism and control of potential sources of infection. The specifics of each of these aspects of management have already been covered in previous chapters. However, the importance of integrating these into the post-operative care of acute surgical patients cannot be overstated. Developing a systematic approach to ensuring that all of these aspects of care are addressed for each and every patient seen on the post-operative round will go a long way to preventing surgical complications.

7.1.2 Analgesia

All operations will result in some level of pain for the patient, and adequate analgesia is vital for their post-operative recovery. Not only does uncontrolled pain contribute to suffering, but it also increases sympathetic outflow resulting in increases in heart rate, vasoconstriction and increased oxygen demand, which can contribute to myocardial ischaemia. Inadequately controlled pain also impairs pulmonary function, especially following abdominal and thoracic procedures, where pain induced by movement inhibits effective coughing and diaphragmatic function leading to atelectasis and pneumonia. When pain is under control, patients are able to mobilise which reduces their incidence of venous thromboembolism, improves pulmonary function, and prevents deconditioning. It also contributes to their overall psychological well-being and avoids setting up the neural circuits for the development of chronic pain. As soon as practicable, parenteral routes of analgesia should be changed to oral routes to facilitate removal of intravenous access devices.

7.1.3 Fluids and Electrolytes

It is important to recognise that acute surgical patients are easily fluid depleted. They are kept nil by mouth prior to the procedure, subjected to long operations with insensible losses and typically have limited oral intake after the procedure. The disease process often contributes to this volume depletion, especially gastrointestinal pathology resulting in increased losses from fevers, vomiting, diarrhoea and third-space sequestration of fluid, such as seen in bowel obstruction. Hypovolaemia needs to be avoided due to its detrimental effects on cardiac output, organ perfusion and resultant oxygen delivery to tissues, with the potential development of multi organ dysfunction. Adequate fluid resuscitation on presentation and thoughtful management of maintenance fluid requirements are vital to ensuring patients remain euvolaemic. Clinical signs such as dry mucous membranes and reduced skin turgor can provide indications of a patient's fluid status; however, the most sensitive indicator of hypovolaemia is the urine output. Strict fluid balance monitoring particularly in the immediate post-operative period is essential to guide fluid management, with the aim to maintain urine output of greater than 0.5 mL/kg/h. Fluid requirements can be met by using 30–35 mL/kg per day as a guideline, with additional fluid to compensate for pyrexia, and increased drain, fistulae or stoma losses.

Depletion of electrolytes such as potassium, magnesium and phosphate are common in the perioperative period and attention to their appropriate replacement will facilitate wound healing and reduce the risk of complications associated with electrolyte deficiencies. The daily requirement of the major electrolytes is summarised

Table 7.1 Daily electrolyte requirement

Sodium	1–2 mmol/kg/day
Potassium	0.5–1 mmol/kg/day
Magnesium	0.1 mmol/kg/day
Phosphate	0.1 mmol/kg/day

in Table 7.1. These should be added to intravenous maintenance fluids, with additional supplementation provided for deficiencies. Once the oral intake is established, patients should receive adequate amounts in a well-balanced diet. Supplementation should be considered if the diet is of poor micronutrient quality, which is often the case in low-resource regions.

7.1.4 Nutrition

Surgery causes significant physiological stress on the human body, related to the severity of the underlying disease and complexity of the procedure, resulting in increased energy expenditure and protein mobilisation moderated through the release of pro-inflammatory cytokines. Wound healing requires an adequate supply of macro- and micronutrients, and this is particularly at risk when patients are in a hypercatabolic state in the perioperative period. Adequate nutrition support during this time is known to enhance wound healing, reduce post-operative complications, shorten the period of convalescence and help prevent further deterioration of the nutritional state. Due to food insecurity, undernutrition is a major problem in many low-resource regions. This chronic undernutrition of macro- and micronutrients puts the acute surgical patient at particular risk of post-operative complications. This is compounded by the practice of keeping patients 'nil by mouth' for the procedure, sometimes for a protracted period due to delays in surgery, followed by the slow progression of diet post-operatively whilst gut function is being re-established.

Early enteral feeding, within 6–12 h post-procedure, if clinically appropriate, is associated with a significant reduction in post-operative complications. Consideration should be given to the level of nutritional intake whenever a post-operative patient's progress is being reviewed, and consider the need for more intensive nutritional support if any deficiencies are identified. A good starting point to determining a patient's daily requirement is 30–35 kcal/kg/day total energy and 0.8–1.5 mg protein/kg/day. The critically ill patient will require more nitrogen in the form of protein and more energy.

Refeeding syndrome can occur when a patient is refed after a period of starvation. The details of which are discussed in a separate chapter. Patients at risk are those who have had little to no food intake for more than 5 days, especially if already undernourished and particularly those who have low levels of potassium, magnesium or phosphate prior to feeding. These patients should have feeding introduced at maximum of 50% of total energy requirements for the first 2 days with full requirement for fluid, electrolytes, vitamins and minerals met from day 1. They

should be supplemented with thiamine and multivitamins. Potassium, magnesium and phosphate need to be closely monitored and replaced accordingly.

7.1.5 Prevention of Thromboembolism

Every surgical patient requires prophylaxis against venous thromboembolism. The perioperative period is a high-risk period for thromboembolism due to all three factors involved in the Virchow's triad—venous stasis from immobility during the operation and relative immobility during recovery; endothelial dysfunction due to inflammatory cytokines released and hypercoagulability from hypovolaemia and fluid shifts. Use of thromboembolic deterrent stockings (TEDS) during the whole hospital admission, with sequential compression devices intraoperatively is important. Patients need to be encouraged to mobilise from post-operative day 1 and chemical prophylaxis using unfractionated heparin or low molecular weight heparins is essential throughout the hospital admission. The intricacies of thromboprophylaxis are discussed elsewhere. This is well covered in another dedicated chapter.

7.1.6 Control of Potential Sources of Infection

The patient often emerges from the operating theatre with a number of lines and drains, all of which are potential sources for external pathogens to enter the body. On the post-operative round, consideration should be given to early removal of intravenous access devices, indwelling catheters and surgical drains as soon as they are no longer required.

7.2 Complications

7.2.1 Wound Complications

7.2.1.1 Seroma

A seroma is a collection of liquefied fat, serum and lymphatic fluid that builds up in the subcutaneous layer under the incision. This most commonly occurs after large skin flaps are developed in the course of the operation such as in the repair of large hernias due to the dead space that remains. This will usually present as a localised, well-circumscribed swelling, and may be associated with clear discharge from the immature wound. Placement of a suction drain in the potential space may help reduce seroma formation. A large symptomatic seroma may be aspirated under aseptic conditions. If it continues to re-accumulate after at least two aspirations, the incision may be opened and packed with gauze to allow healing by secondary intention. An infected seroma should also be treated with open drainage.

7.2.1.2 Haematoma

A haematoma is an abnormal collection of blood that collects in the subcutaneous layer under an incision or in a potential space in the abdominal cavity. Haematomas are at higher risk of becoming secondarily infected compared to seromas, therefore are more worrisome. They are related to inadequate haemostasis, depletion of clotting factors and coagulopathy. Clinical signs depend on its size and location. Under the surgical wound, it may present as a painful, expanding swelling and dark red fluid may drain out of the fresh wound; in the neck, it can cause airway compromise; in the abdomen, it can present as anaemia, abdominal pain and paralytic ileus that fails to improve post abdominal surgery. Preoperatively any clotting factor abnormality should be corrected and anticoagulation medications discontinued. During surgery, adequate haemostasis with ligature and electrocautery must be achieved before closure. Management of haematomas again depend on their size and location in the body. Small wound haematomas may not require any intervention as they mostly will resorb over time. On the other hand, a haematoma in the neck may need to be evacuated in the operating theatre, as will an expanding haematoma under a skin flap detected soon after surgery or one that has become secondarily infected.

7.2.2 Wound Infection

Surgical site infections occur due to bacterial contamination of the surgical site and continues to be a significant problem. Several factors contribute to the risk of developing a wound infection, outlined in Table 7.2, one of which is emergency surgery. Emergency surgical wounds are more likely to be contaminated than those in elective procedures, and the rate of infection is up to 40% for dirty wounds (Table 7.3).

Table 7.2 Risk factors for post-operative wound infection

Patient factors	Environmental factors	Treatment factors
Ascites Chronic inflammation Undernutrition Obesity Diabetes Extremes of age Hypercholesterolaemia Hypoxaemia Peripheral vascular disease Post-operative anaemia Previous site of irradiation Recent operation Remote infection Skin carriage of staphylococci Skin disease in the area of infection Immunosuppression	Contaminated medications Inadequate disinfection/ sterilisation Inadequate skin antisepsis Inadequate ventilation Presence of foreign body	Drains Emergency procedure Inadequate antibiotic coverage Preoperative hospitalisation Prolonged operation

Table 7.3 Classification of surgical wounds

Category	Criteria	Infection rate
Clean	No hollow viscus entered Primary wound closure No inflammation No breaks in aseptic technique Elective procedure	1–3%
Clean-contaminated	Hollow viscus entered but controlled – Small bowel Low-velocity traumatic incisions, e.g. – Kitchen knife injury, clean glass cut Primary wound closure Minor breaks in aseptic technique Mechanical drain used	5–8%
Contaminated	Uncontrolled spillage from viscus – Large bowel Low-velocity lacerating, tearing or bursting wounds High-velocity injuries – Crush injuries, garden tools Inflammation apparent Open, traumatic wound Major break in aseptic technique	20–25%
Dirty	Untreated, uncontrolled spillage from viscus Pus in operative wound Open suppurative wound Severe inflammation More than 12 h after injury Severe tissue damage and excessive ischaemic tissue – Severe crush injuries – Penetrating abdominal trauma with hollow viscus perforation – Wounds sustained in warfare – Cloth, shrapnel, faeces in wound	30–40%

Infections occur most commonly 5–6 days post-operatively, but may be sooner or later than that. Up to 90% of all post-operative infections occur within 30 days post-operatively. Superficial and deep wound infections present with tenderness, erythema, oedema, and there may be drainage of purulent fluid from the wound. The patient may also have leukocytosis and fever. Preoperative antibiotics should be given for prophylaxis in clean-contaminated procedures, and for therapeutic intentions in contaminated and dirty procedures. Clean-contaminated wounds can be closed primarily after a wound wash. Contaminated and dirty wounds may be converted to a clean-contaminated one after wide debridement and copious wound irrigation and be considered for primary closure. However, because of the high risk of wound infection, often delayed primary closure or healing by secondary intention is recommended. A wound infection deeper than superficial cellulitis should be opened to allow drainage and managed as a dirty wound. Negative pressure dressings, if available, can expedite the process of healing by secondary intention.

Table 7.4 Factors associated with wound dehiscence

Technical error in fascial closure
Emergency surgery
Intra-abdominal infection
Malnutrition
Wound infection, haematoma and seroma
Previous wound dehiscence
Elevated intra-abdominal pressure
Advanced age
Chronic corticosteroid use
Obesity
Radiation therapy and chemotherapy
Systemic disease (uraemia, diabetes mellitus)

7.2.3 Wound Dehiscence

Wound dehiscence or acute wound failure is the post-operative separation of any or all abdominal musculoaponeurotic layers. It is of great concern to surgeons due to the risk of evisceration, need for immediate intervention, possibility of repeat wound failure, surgical site infection and formation of incisional hernia. Dehiscence develops most commonly 5–10 days post-operatively when the wound is at its weakest but can occur any time after surgery. The factors that contribute to wound dehiscence are summarised in Table 7.4. Deep wound infection is one of the most common reasons for local wound separation. Acute wound failure may present without warning, or patients may have felt a popping sensation during straining or coughing. Evisceration makes this an obvious diagnosis. A discharge of a large amount of clear, haemoserous fluid heralds wound dehiscence in around 25% of patients. It may also be detected by probing the wound with a gloved finger. Once diagnosed, the degree of fascial separation and presence of evisceration or intra-abdominal contamination will determine the subsequent treatment. A small dehiscence in the proximal aspect of the wound may be treated by packing with saline-soaked gauze and using an abdominal binder. In the event of evisceration, the intestines should be covered with moist towels and arrangements made for return to the operating theatre for exploration of the abdominal cavity. Any intra-abdominal sepsis should be addressed then attention turned to the closure of the wound. Necrotic or infected fascia should be debrided. If the fascia cannot be brought together without undue tension, a mesh, either non-absorbable or biologic should be used to bridge the fascia. In some patients, the wound may be left open with a negative pressure dressing to allow healing by secondary intention.

7.3 Gastrointestinal

7.3.1 Ileus

An ileus is a functional obstruction that occurs due to inhibition of bowel peristalsis. A primary or post-operative ileus occurs without any precipitating factors and tends

to resolve within 2–4 days. A paralytic ileus is one that is associated with a precipitating factor and may have a delayed return to bowel function. Altered bowel motility in the post-operative period is likely an interplay between surgical stress, manipulation of the bowel, restricted oral intake and use of narcotic analgesia. In paralytic ileus, the precipitating factor may be a manifestation of intra-abdominal infection, electrolyte abnormalities, prolonged exposure of abdominal contents during a lengthy surgical procedure or systemic illness. This should be differentiated from a mechanical obstruction to guide management. The patient usually has a distended abdomen, nausea with or without vomiting and a quiet abdomen with few bowel sounds. An abdominal X-ray may show diffusely dilated small and large bowel with air in the colon and rectum, with or without air-fluid levels. This is in contrast to mechanical small bowel obstruction, where there is small bowel dilatation, air-fluid levels and prominent valvulae conniventes proximal to the transition point, with the absence of gas in the distal bowel. A CT if available, is more accurate at differentiating functional from mechanical obstruction. Steps should be taken to correct the common causes of paralytic ileus, such as replacement of electrolytes. The patient should be placed on bowel rest and a nasogastric tube may be placed to decompress the stomach and small bowel if the patient is vomiting. Prompt management of the ileus is important following bowel surgery as increased intraluminal pressure can predispose to rupture of anastomoses. In certain cases where there is closed-loop bowel obstruction or intra-abdominal sepsis precipitating the functional obstruction, emergency re-laparotomy may be required.

7.4 Post-operative Collections and Anastomotic Leaks

Emergency bowel surgery is associated with high morbidity and mortality, in part due to sepsis and anastomotic leakage. This is related to the poor nutritional status, immunocompromised state and presence of intra-abdominal contamination or sepsis to begin with. Adequate microcirculation at the resection margins is crucial for the healing of an anastomosis and colorectal anastomoses are considered at higher risk for leaks compared to those involving the small bowel.

All surgeons dread the anastomotic leak due to its potentially catastrophic sequelae. It results in sepsis and can lead to enteric fistula formation, need for reoperation, possibility for permanent stoma and potentially death. In the early stages, an anastomotic leak may manifest as malaise, fever, abdominal pain, ileus, localised erythema around the wound and leukocytosis. As it progresses, it can form fistulae to the skin or any contiguous structure such as the bladder or vagina. In emergency surgery, particularly in haemodynamically unstable, immunocompromised and nutritionally depleted patients, and in the presence of faecal peritonitis, significant bowel dilatation and oedema, an anastomosis is best avoided as a leak may prove to be fatal. In these situations, defunctioning stomas are advisable until the primary pathology has resolved, at which time a stoma reversal may be considered. Once an anastomotic leak is suspected or diagnosed, the patient needs to be adequately resuscitated and given broad-spectrum antibiotics. Bowel rest needs to be instituted

and an NG placed to reduce intraluminal pressure. Any infected surgical wounds should be opened. Reoperation is required if there is diffuse peritonitis, intra-abdominal haemorrhage, suspected bowel ischaemia, major wound disruption or evisceration. In the critically ill and unstable patient, damage control surgery may be required in the first instance. The compromised segment of bowel is resected, both ends left stapled off, peritoneal lavage performed and abdomen left open. A re-look laparotomy with the formation of stoma in 24–48 h is then performed when the patient is more stable. In the otherwise stable patient, a new small bowel anastomosis or stoma with or without distal mucus fistula may be formed.

A single intra-abdominal abscess may be drained percutaneously under image guidance; however, presence of multiple abscesses probably requires open or laparoscopic drainage.

7.5 Intestinal Fistula

A fistula is an abnormal connection between two epithelialised structures, one of which is a hollow organ. Gastrointestinal fistulas are most commonly iatrogenic, occurring as a result of anastomotic breakdown or unrecognised bowel injury. They may also develop after instrumentation or drainage of intra-abdominal collections. The risk factors that increase the likelihood of developing a fistula are the same as those predisposing to anastomotic leakage. The diagnosis is obvious when there is enteric or colonic content discharging to the structure with which it has fistulated, such as discharge of enteric content through the abdominal wound in an enterocutaneous fistula or faecaluria in a colovesical fistula. Fistulas can be classified based on the volume of output, which is influenced by whether it originates proximal or distal in the intestine. A low output fistula drains less than 200 mL/day, moderate output 200–500 mL/day and high output more than 500 mL/day. Sepsis tends to be a prominent feature and presents in up to 75% of cases. Patients can develop hypovolaemia, dehydration, electrolyte and acid-base imbalance, loss of protein and trace elements with resultant malnutrition, especially in high output fistulas. The skin surrounding an enterocutaneous fistula is at risk of excoriation and breakdown due to the corrosive effects of GI effluent. The principles of management can be remembered using the mnemonic ‘SNAP’, which stands for control of Sepsis and Skincare, optimising Nutrition with fluid and electrolytes, defining the Anatomy with imaging and Planning for definitive repair.

7.6 Respiratory

7.6.1 Atelectasis and Pneumonia

The most common post-operative respiratory complication is atelectasis, which is the combined result of the anaesthetic, splinting from abdominal wound, immobility and post-operative narcotics. The patient may have a low-grade fever, malaise

and reduced breath sounds at the lung bases. Adequate analgesia and strict instructions to mobilise, deep-breathe and cough, together with chest physiotherapy, will help re-open collapsed alveoli and prevent the development of pneumonia. Pneumonia if it develops, should be treated with appropriate antibiotics and aggressive chest physiotherapy.

7.6.2 Thromboembolic

Venous thromboembolism encompasses deep vein thrombosis (DVT) and pulmonary embolism (PE), and as previously stated, patients hospitalised for surgery are at particularly high risk. Patients who develop a DVT may present with calf pain, swelling, warmth, redness and congested veins; however, most will show no physical signs and PE may be the first manifestation of the disease. Most signs and symptoms of PE are non-specific such as sudden dyspnea, chest pain, haemoptysis and tachycardia. Massive PE resulting in haemodynamic instability and death occurs in 5–10% of patients. The diagnosis of PE is best achieved using a CT pulmonary angiogram (CTPA) or V/Q scan; however, these may not be available in the low-resource setting. Bedside echocardiography can provide a rapid, non-invasive method for diagnosis in the hemodynamically unstable patient. The value of a 12-lead ECG should not be discounted. In some instances, a 'S1Q3T3' pattern of acute cor pulmonale is classic of a PE. A provisional diagnosis of PE in patients with the above symptoms may be made with the following criteria:

1. Chest X-ray showing no abnormality
2. ECG showing no features of acute myocardial infarction
3. Doppler ultrasound of lower limbs showing deep vein thrombosis
4. Echocardiogram showing right atrium/ventricular dilatation, right ventricular dysfunction or pulmonary hypertension in a patient with no previous findings
5. No previous cardiopulmonary disease.

In these patients, it may be appropriate to initiate treatment with a low molecular weight heparin, such as 1.5 mg/kg/day of enoxaparin. The patient can then be referred to a centre where CTPA is available for definitive diagnosis.