Management of common surgical complications

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Abstract
Postoperative complications represent a potentially avoidable cause of morbidity and mortality. Meticulous preoperative assessment and planning is essential and allows for the delivery of preventative measures throughout the peri-operative period.

The importance of recognizing complications early when they do arise is essential, and allows for the timely provision of appropriate and targeted therapies. This article describes common surgical complications and suggests management strategies that can be instituted throughout the surgical care pathway in order to reduce complication rates and decrease unnecessary morbidity and mortality.

Keywords Haemorrhage; pain; patient safety; surgical complications; surgical site infection; venous thromboembolism

Introduction
The incidence rate of major complications following inpatient surgical procedures has been reported as up to 22% with a mortality of up to 0.8%.1,2 It is estimated that 187–281 million surgical procedures are performed globally each year, suggesting that annually, at least 7 million patients will suffer serious complications as a consequence of surgery and that 1 million patients may die as a result. An effective and pro-active approach to the prevention and timely management of complications is therefore mandated in all fields of surgery.

Classification of postoperative complications
All operations carry risk and complications may be classified as being general, as a consequence of undergoing any surgical procedure or as specific to the particular operation being performed.

Complications may be further divided by time of onset; immediate (within the first 24 h of surgery), early (within 30 days or during the inpatient episode) or late (after 30 days).

Table 1 summarizes the chronological onset of some common general postoperative complications.

Managing the risk of complications
The mainstay of management of any surgical complication remains:

• risk assessment and prevention
• early recognition
• immediate and appropriate management.

Risk assessment and prevention
Preoperative assessment of comorbidity and pre-morbid function allows the clinician to predict likely risks for a specific patient undergoing any given surgical procedure. The surgical team may then institute risk-reducing measures to minimize complications. This phase includes the opportunity to optimize comorbid conditions and their management (such as treating hypertension or COPD) along with the instigation of specific prophylactic measures (such as the use of antibiotics or the choice of anaesthetic technique).

A further measure of reducing operative complications is the implementation of the World Health Organization (WHO) Surgical Safety checklist. This has been shown to reduce surgical morbidity by 30% and mortality by almost 50%, by identifying and eliminating avoidable error.4

Early recognition
Early detection and timely intervention are key to reducing the morbidity of postoperative complications and this relies on the vigilance of clinicians, with attention to detail. The majority of hospital trusts advocate Early Warning Scores (EWS) to identify and respond to patients who present with or develop acute illness. Scores reaching certain thresholds will trigger a call for urgent clinician review.

Immediate and appropriate management
Following early recognition, it is essential for appropriate management strategies to be implemented in order to reduce significant morbidity or even mortality. This may involve medical or surgical therapies and may culminate in referral to other specialties or escalation to a higher level of care. The following sections give a summary of common surgical complications and outlines of preventative and management options.

COMMON SURGICAL COMPLICATIONS

Haemorrhage
Perioperative bleeding that results in cardiovascular instability is associated with poor outcomes and has a high incidence of significant morbidity or mortality.5 Hypovolaemia is largely avoidable and therefore prophylactic and early resuscitative measures should be instituted in order to mitigate or avoid physiological upset.

Types of haemorrhage include:
• primary haemorrhage: intra-operative bleeding or a continuation of intra-operative bleeding noticed after surgery; usually occurs as a result of inadequate haemostasis.
• reactionary haemorrhage: bleeding occurring immediately postoperatively (within 24 hours, typically 4–6 hours) as a consequence of patient warming/vasodilation and increasing blood pressure during recovery from anaesthesia.
• secondary haemorrhage: typically 7–14 days following surgery and usually as a consequence of local infection.

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Prevention

Preoperatively, the patient’s risk of bleeding should be carefully assessed, which includes a review of medications such as anti-platelet agents and anticoagulants and their indications. Depending on the specific risks of the planned operation, it is often safe to stop these drugs during the perioperative period, however it is usually best to obtain specialist advice from haematology or cardiology if in doubt.

Some patients may present for surgery with a pre-existing anaemia due either to a comorbidity, dietary insufficiency or indeed, the acute pathology necessitating the operation. Any significant anaemia is best corrected before the planned surgery and preoperative transfusion should occur at least 48–72 hours before an elective procedure, in order to maximize the oxygen carrying capacity of the transfused blood.

Depending on the specific risks of the planned procedure, blood should be drawn for group and save or cross-match. This should be completed with sufficient time to address any potential difficulties that may be created by the detection of unusual antibodies. The planning phase should also include arrangements for the use of cell-salvage where available if a significant blood loss is anticipated. Preoperative dehydration should be avoided by appropriate ordering of the operating list and the use of maintenance intravenous fluids where required.

Intra-operatively, meticulous surgical technique is essential to avoid unnecessary blood loss, and difficulties, when encountered, should be communicated to the theatre and anaesthetic team.

Diagnosis

Primary haemorrhage should be identified at the time of operation and controlled appropriately. Reactiory or secondary haemorrhage may be identified postoperatively in the form of an external bleed (active bleeding, blood in drains) or internal bleed (patient is hypotensive, tachycardic, pallored, confused and oliguric with a low serum haemoglobin).

Management

The control of major haemorrhage is covered elsewhere (SURGERY 2013; 31(11): 574–581), but mandates adequate venous access, with concomitant control of the bleeding source and the administration of appropriate blood products and/or volume replacement.

Surgical site infections

Surgical site infections (SSIs) are defined as infections that occur at the site of an operation within 30 days if no implant or foreign body is left within the patient during surgery, or within 1-year of an operation if an implant or foreign body is left in situ. SSIs account for 15% of hospital-related infections and are associated with significant morbidity and mortality. In the United Kingdom alone each SSI accumulates excess costs of £1594 and can increase hospital length of stay by up to 7 days. Patients with SSIs are also twice as likely to die following a surgical procedure and, if discharged, have a fivefold increased chance of being readmitted.

The incidence of wound infections is related to the type of operation being performed with clean operations (e.g. excision of skin lesion) having an infection rate of <1%, contaminated procedures (e.g. appendicectomy) 15% to 20% and infected procedures (e.g. Hartmann’s procedure for diverticular perforation) approximately 40%. Two-thirds of SSIs are related to the wound and the remaining third are confined to the organ space. Organisms causing such infections usually originate from the patients normal skin or bowel flora. Less commonly, bacterial contamination may occur from an exogenous source, such as from contamination by theatre staff, airborne pathogens, non-sterile instruments or prostheses.

Prevention

Numerous modifiable risk factors exist for avoiding an SSI.

- Preoperative:
  - patient factors:
    - weight loss
    - stop smoking
    - control hyperglycaemia
    - treat existing bacterial colonization (MRSA screening)
    - optimize nutrition
  - surgical factors:
    - hair removal (Clipping not shaving)
    - aseptic technique
    - meticulous surgical technique
    - minimize operating time

<table>
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<tr>
<th>Day</th>
<th>Respiratory</th>
<th>Cardiovascular</th>
<th>Renal</th>
<th>Gastrointestinal</th>
<th>Pain</th>
<th>Infection</th>
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<tr>
<td>1</td>
<td>Basal atelectasis</td>
<td>Haemorrhage / hypovolaemia / electrolyte disturbance / atrial fibrillation / myocardial infarction</td>
<td>Ureteral retention</td>
<td>Nausea and vomiting / ileus / abdominal compartment syndrome</td>
<td>Wound pain</td>
<td>Wound infection</td>
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Table 1
- avoid hypothermia by using patient warming devices
- antibiotic prophylaxis where appropriate
- utilize drains and sutures to avoid fluid collections (haematoma, seroma)
- minimize theatre ‘traffic’

- Postoperative:
  - regular wound inspection
  - infection control and strict hygiene discipline — hand hygiene, isolation of infected patients, clean ward environment
  - early removal of clips, sutures, drains and foreign materials
  - avoid unnecessary antibiotics
  - minimize length of stay.

**Antibiotic prophylaxis**
Administration of prophylactic antibiotics can significantly reduce the incidence of SSI and there is good evidence to support their use for gastrointestinal, oropharyngeal, vascular, open-heart, obstetric and gynaecological procedures, orthopaedic prosthesis placement, spinal operations and craniotomy. Antibiotics should be administered at the time of induction of anaesthesia and a second dose should be given intra-operatively for procedures lasting more than 4 hours. Choice of antibiotic agents will be based on the likely pathogens for each procedure and will be guided by local protocols. The WHO Guidelines for Safe Surgery 2009 lists current recommendations of agents for prophylaxis.4

**Diagnosis**
An established superficial SSI may cause pain, swelling, redness, heat, purulent wound discharge or dehiscence. Deeper infections may be more difficult to diagnose, but may result in pain or irritation of local structures (such as the diaphragm in subphrenic collections) and both can cause systemic clinical signs of sepsis (pyrexia, tachycardia, tachypnoea and malaise). For deeper infections, clinical suspicion is often accompanied by corroborating laboratory or radiological findings.

**Management**
Targeted therapy is the key to management, with source control, drainage of collections (surgical or radiological) and the administration of appropriate empiric antibiotics as early as possible following collection of relevant culture samples.

**Venous thromboembolism**
In 2005, there were 25,000 UK deaths from hospital-acquired thromboembolic disorders and as a consequence national guidelines now exist for its prevention and treatment.11,12 Venous thrombosis occurs as a consequence of three factors described by Virchow’s Triad: endothelial damage (e.g. smoking), reduced venous flow/stasis (e.g. immobility) and hypercoagulability (e.g. heritable coagulopathies, malignancy).

Thrombus usually develops within deep venous systems of the leg (DVT) but can migrate proximally or dislodge and travel within the venous system (embolism) and potentially cause occlusion of pulmonary vessels (pulmonary embolism). Prophylactic measures should be universally adopted in surgical patients and are aimed at reducing venous stasis, promoting early mobilization and using prophylactic doses of anticoagulant agents.

Risk factors for thromboembolism are summarized in Table 2, alongside risk scoring for the probability of acquiring a DVT.11,12

**Prevention**
The NICE guidelines for surgical patients are summarized as follows:

- stop oestrogen-containing oral contraception or hormonal replacement therapy 4 weeks prior to elective surgery
- use regional anaesthesia above general anaesthesia where possible
- ensure adequate hydration
- promote early mobilization
- all patients should undergo formal risk assessment at admission and pharmacological venous thromboembolism (VTE) prophylaxis administered where indicated
- patients’ risk of developing VTE and their risk of bleeding should be further reassessed after 24 h
- start mechanical VTE prophylaxis in patients without contraindication;
  - graduated elastic compression stockings
  - foot impulse devices/intermittent pneumatic calf compression
- extended pharmacological VTE prophylaxis should be prescribed for 28 days postoperatively for patients who have had major cancer surgery in the abdomen or pelvis
- orthopaedic joint replacements also require extended VTE prophylaxis (28–35 days for elective hip replacement, 14 days for elective knee replacements).

**Diagnosis**

- **DVT (Lower limb):**
  - unilateral calf swelling/tenderness
  - dilatation of superficial veins
  - erythema
  - mild pyrexia
  - investigation:
    - duplex ultrasound
    - venography
- **PE:**
  - tachypnoea and decreased oxygen saturations
  - tachycardia
  - pleuritic-type chest pain
  - haemoptysis
  - circulatory collapse or cardiac arrest
  - investigation:
    - ECG: Sinus tachycardia, right heart strain (S1Q3T3 pattern)
    - type 1 respiratory failure on arterial blood gas
    - chest radiograph: wedge-infarct
    - CT pulmonary angiogram (CTPA) is gold standard

**Management**
The patient should continue with mechanical compression devices and be given oxygen, analgesia and prescribed therapeutic-dose heparin if safe to do so. If clinical suspicion is high, the first dose of anticoagulant should be given while further investigations are arranged.
For extensive DVT or life-threatening PE, fibrinolytic agents can be considered, but are contraindicated by recent surgery. Alternatively, a surgical or radiological thrombectomy or embolectomy may be required. To reduce the risk of a major PE in the presence of an extensive DVT or when there have been multiple embolic episodes, a filter may be placed radiologically in the inferior vena cava. Following the acute episode, the cause of the DVT/PE should be thoroughly investigated and a risk/benefit evaluation should be performed for the prescription of prolonged oral anticoagulation. A first thromboembolic event occurring in the setting of reversible risk factors, such as immobilization, surgery or trauma, should receive warfarin therapy for at least 3 months. Patients who have recurrent VTE or pre-existing irreversible risk factors, such as known thromophilia, should be placed on long-term anticoagulation; however, this decision should be made in conjunction with a haematologist.

Preoperative pain

Postoperative pain is a serious cause of morbidity, with around 40% of patients experiencing moderate-to-severe pain on the day of surgery. Pain may be acute, being related immediately to the surgical period, or may become chronic if extending beyond the expected healing time (typically greater than 3 months).

Untreated pain can result in tachycardia and hypertension, respiratory compromise (diaphragmatic splinting, atelectasis, sputum retention, infection), paralytic ileus, urinary retention, immobility and low-mood. Pain is subjectively reported by the patient, though the use of a verbal scale or visual analogue score may aid quantification.

Diagnosis

Pain is subjectively reported by the patient, though the use of a verbal scale or visual analogue score may aid quantification.

Management

Acute pain should be managed in accordance with the WHO analgesic ladder, commencing with simple analgesia and then escalating to include compound preparations (e.g. co-codamol), NSAIDS and opioids. Several routes of administration may be utilized in order to achieve a satisfactory level of pain-relief and the provision of patient-controlled analgesia (PCA) should be considered. Multimodal therapy is the best means of achieving satisfactory outcomes and when available, an acute pain team/service should be consulted in supporting management decisions and guiding patient care.

Respiratory complications

Respiratory complications are common and are often related to pre-existing lung disease (such as COPD), inadequate postoperative analgesia, or a combination of both of these modifiable factors. Basal atelectasis is the most common cause of fever and low oxygen saturations in the first 12–24 hours after surgery and this is the crucial window in which targeted interventions can prevent infective complications.

Prevention

Optimization of pre-existing lung disease is important, and patients with severe concurrent respiratory problems are best managed in conjunction with a respiratory specialist. An active chest infection is a contraindication to elective procedures. Preoperative physiotherapy is invaluable for patients undergoing major chest or abdominal surgery. Patients should be taught deep breathing exercises as well as techniques for effective expectoration of secretions that may be aided by the routine use of saline or bronchodilator nebulizers and incentive spirometry devices in high-risk patient groups. Effective analgesia is essential and patients should be taught strategies to minimize the

### Table 2

**Risk factors predisposing to venous thromboembolism**

<table>
<thead>
<tr>
<th><strong>Patient factors</strong></th>
<th><strong>Surgical factors</strong></th>
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<tr>
<td>Age</td>
<td>Trauma or surgery, especially if involving the lower limb or pelvis</td>
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<tr>
<td>Personal history or first-degree relative with a history of DVT</td>
<td>Prolonged anaesthetic and surgical time &gt;90 min, or &gt;60 min if involving the pelvis or lower limb</td>
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<td>Reduced mobility</td>
<td>Surgery with a significant reduction in patient mobility</td>
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<td>Obesity</td>
<td>Dehydration</td>
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<td>Pregnancy or &lt; 6 weeks post-partum</td>
<td>Critical care admission</td>
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<td>Thrombophilia e.g. Protein C and S deficiency, Factor V Leiden, Prothrombin gene mutation, Antithrombin deficiency, Homocysteinaemia</td>
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<td>Use of hormonal replacement therapy or oral contraceptive pill</td>
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<tr>
<td>One or more medical comorbidities, especially cardiac disease; metabolic, endocrine or respiratory disorders; infectious disease; inflammatory conditions</td>
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<tr>
<td>Varicose veins with phlebitis</td>
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<tr>
<td>Malignancy, especially pelvic and abdominal</td>
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Preventing the development of pain is more effective than treating established pain. Perioperative plans for analgesia should take account of the nature and length of the procedure performed along with the planned incision. Patient factors such as age, pre-existing pain and anxiety have all been shown to be predictors of postoperative symptoms. Pre-emptive analgesia should be multimodal and oral or parenteral analgesics may be augmented by local anaesthetic, delivered as either a local or regional block.
impact of their incision on respiratory function by applying additional support or postural manoeuvres.

**Diagnosis**
Patients may exhibit tachypnoea or productive cough and this can be accompanied by the clinical signs of reduced air entry on auscultation and dullness to percussion. Review of the observation chart may confirm an increased respiratory rate and reduced oxygen saturations. Blood tests can show increased inflammatory markers. Imaging of the chest can help differentiate collapse, consolidation or effusions.

**Management**
Analgesia should be optimized and chest physiotherapy instituted, along with the use of supplemental oxygen. Alveolar collapse will respond to deep breathing, though positive pressure ventilation (invasive or non-invasive) may be required for refractory cases. Infections (consolidation on imaging with raised inflammatory markers) should be treated with broad spectrum antibiotics and sputum and blood cultures sent to guide ongoing treatment. Significant effusions may require percutaneous drainage and most patients with respiratory complications will benefit from nebulized saline and bronchodilators. A low threshold of suspicion should be maintained for pulmonary emboli and CTPA arranged if this diagnosis is considered.

Despite best efforts, a number of patients will deteriorate rapidly due to respiratory complications. Early involvement of critical care specialists in this group is essential.

**REFERENCES**