Resuscitation and anaesthesia for penetrating trauma

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Purpose of review

The worldwide burden of trauma is increasing, but is unequal between nations. Trauma targets the young and productive in society and imposes a major burden on the health infrastructure. This review provides a distillation of practice in a busy urban trauma centre dealing with large volumes of penetrating trauma.

Recent findings

The anaesthetist holds a pivotal role in the management of penetrating injury; the requirements of prompt airway control, early delivery to theatre and control of a physiologically brittle patient can be challenging. Recognition that attempts at definitive surgery in exsanguinating patients may do more harm than good has made surgery a tool of resuscitation rather than an end in itself.

Summary

Depending on where they practice, clinicians are more or less likely to encounter patients with gunshot wounds. However, adherence to basic principles and attention to the details of temperature control, invasive haemodynamic monitoring, blood product therapy and effective communication should translate to improved outcomes for patients after penetrating trauma.

Keywords

penetrating trauma, anaesthesia, review

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Abbreviations

ERT	emergency room thoracotomy
rFVIIa	recombinant activated human clotting factor VII

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Introduction

In 1990, about five million people died worldwide as a result of injury [1] and it is estimated that by the year 2020, 8.4 million people will die every year from trauma [2]. However, volumes and patterns of injury vary considerably around the world; overall homicide rates range from 1.0 per 100 000 in established market economies to 44.8 per 100 000 in sub-Saharan Africa [3•]. While the United States saw a nationwide decrease in the annual non-fatal firearm-related injury rate of 40.3% between 1993 and 1997, with a 21% decline in the annual firearm-related death rate during the same period [4], South Africa is battling with what has been described as 'a malignant epidemic of trauma' [5]. Penetrating trauma in South Africa in the 1980s was predominantly from stab wounds; however, in recent years gunshot wounds have become much more common (Fig. 1). The total number of deaths that occur in South Africa due to unnatural causes is estimated to range from 65 000 to 80 000 per annum (accounting for between 12% and 15% of the more than 500 000 deaths that occur annually from all causes) [6•]. Most of the deaths from injuries in South Africa occur among non-white males in the economically active age range of 15–44 years and the leading cause of these deaths for males is homicide; more than half of all the homicides are inflicted by firearms and one-third by sharp instruments [6•]. In our trauma unit near the centre of urban Johannesburg, approximately 160 priority-one patients undergo resuscitation per month, with 55% of cases being due to penetrating injury [7•].

Airway

Penetrating injuries to the neck are a common feature in our emergency departments. On arrival, patients are evaluated using established advanced trauma life-support (ATLS®), principles [8] and classified as either requiring immediate operation or to be managed with careful observation supported by selective application of investigations. Patients are resuscitated in the Trendelenburg position, to prevent air embolism, an uncommon but avoidable cause of death after major cervicomediastinal venous injury [9]. The principle clinical features mandating early tracheal intubation are acute or worsening respiratory distress, airway compromise from blood and secretions, extensive surgical emphysema, tracheal deviation by haematoma, and decreasing level of consciousness [10]. Intubation can be challenging, as pre-oxygention may be less effective than usual and if mask ventilation is attempted, air may be forced into the subcutaneous tissue causing further distortion of the anatomy [11•]. Although rapid sequence induction has

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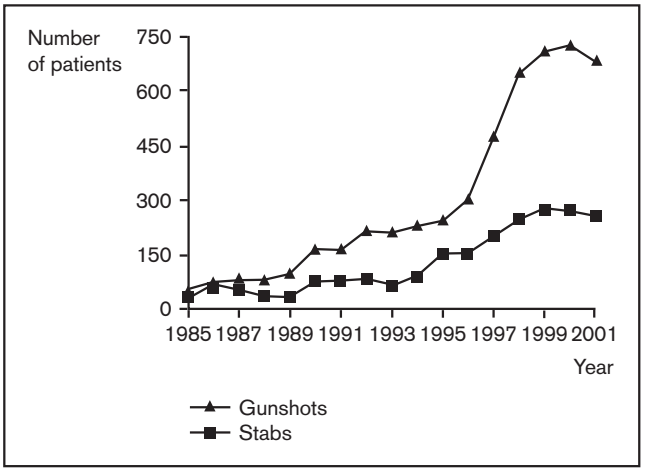
Figure 1. Priority-one resuscitations



Penetrating trauma at the Johannesburg Hospital between 1985 and 2001.

Figure 2. Foley catheter used to tamponade bleeding in gunshot neck

reported success rates of between 65% and 98% [9,10], the use of neuromuscular blocking agents in the presence of a haematoma in the neck may result in total obstruction of the airway as loss of muscle tone may lead to a 'can't intubate, can't ventilate' scenario [9]. Also, the drugs used in rapid sequence induction may have undesirable effects on cardiac output and blood pressure. In Johannesburg, a combination of morphine and midazolam is used to allow pre-oxygenation and facilitate intubation when possible, with selective use of suxamethonium by doctors only. If the clinical setting is more urgent, we advocate the use of etomidate or ketamine as induction agents, because of their favourable haemodynamic properties. Neuromuscular blockers are not used in penetrating injuries where it is suspected that the airway is injured or may be difficult.

Patients with penetrating neck injury taken directly to the operating room are those with severe external haemorrhage, expanding or pulsatile haematomas, patients who are haemodynamically unstable despite resuscitation or patients with stridor, haemoptysis or air bubbling through a neck wound, particularly in the absence of a pneumothorax [9,12]. Severe bleeding is controlled by external pressure or by inserting a Foley catheter into the wound and inflating the balloon (Fig. 2) [13]. If use of a Foley catheter is attempted, intubation must be carried out as a priority, as tamponade of bleeding is never absolute and distortion of the airway is inevitable.

Approximately 7–10% of cases of penetrating neck injury will involve the respiratory tract [12,14] and those with airway trauma have a mortality of up to 33% [15]. Direct airway injury may be controlled by intubation through the wound (Fig. 3).

Viral pathogens are common in trauma patients [16•] and full barrier precautions must be universal; patients with penetrating injuries to the airway are often uncooperative due to a combination of hypoxia, hypotension and intoxication and can spray and aerosolize blood all over the resuscitation bay.

Gunshot wounds to the face may result in airway compromise due to the presence of blood and saliva in the airway and/or haematoma and oedema of the upper airway; approximately 20% of these patients require an emergency airway and up to 10% of patients with a gunshot to the face will have an associated cervical spine injury [17]. If the patient is conscious then we turn them on their side or sit them up and allow blood and secretions to drain away. The patient is given a hand-held sucker and instructed in its use to clear the oropharynx. Significant soft tissue swelling is inevitable if the projectile has crossed the floor of the mouth or the

Figure 3. Direct intubation through a stabbed neck

Figure 4. Gunshot to the right side of the face requiring an emergency surgical airway

tongue and airway protection is almost always required (Fig. 4). If emergency airway protection is not required, the patient is closely observed and will often be stable enough for oropharyngeal intubation with tracheostomy performed in theatre with the first maxillofacial surgical intervention.

Intubation facilitated by fibre optic bronchoscopy is the gold standard for any patient in whom the airway is suspected to be difficult: direct airway injury can be definitively diagnosed and it allows for placement of an endotracheal tube into one of the bronchi if there is a major injury to the opposite side [18•,19]. The patient should be allowed to breathe spontaneously for as long as possible and ideally should undergo a gas induction of anaesthesia followed by bronchoscopy; a rigid scope may be useful if there is blood or copious secretions in the pharynx.

Figure 5. Gross haematoma after a stabbed neck

Elective intubation by the most experienced anaesthetist available is undertaken by a variety of means: awake fibreoptic intubation in the sitting position being our method of choice. However, nasotracheal intubation is not attempted in the presence of midface gunshot fractures. Expertise in this technique is vital, as false extratracheal placement has been reported in a patient with a tracheal injury despite use of a fibre optic scope and mistakes can lead to fatal airway compromise [20].

Surgical cricothyroidotomy remains a life saving intervention [17,21]; if, however, there is significant haematoma in the neck then this intervention may become more complicated (Fig. 5). The teeth are always carefully inspected and cervical and chest radiographs

examined if there is a chance of aspiration of broken or avulsed teeth.

Cervical spine injury

Unstable cervical spine injury without neurological injury is very rare in penetrating neck injury [22]. The majority of patients with gunshot wounds to the neck either have obvious neurological fallout or have no neurological injury. In a series of 346 patients with penetrating neck injuries from our institution, 9% had cervical spine injury [12]. Although laryngoscopy is known to cause cervical spine movement at a point of injury irrespective of in-line immobilization or traction, strenuous efforts are made to immobilize the cervical spine during all emergency airway manoeuvres [23]. The focus must be for timely control of the airway, but this should not be achieved at the expense of cervical spine immobilization [24••].

Emergency room thoracotomy

Even in level-1 centres in the USA, emergency room thoracotomy can have dismal results. A review of 160 consecutive patients undergoing emergency room thoracotomy (ERT) documented a survival rate of 2.7% [25]. Experience in Johannesburg has confirmed the futility of ERT in patients after blunt trauma, but those patients with penetrating chest injuries may have a survival rate of up to 20% [26]. The survival rate for patients with penetrating abdominal trauma who require ERT is approximately 7% in our setting [26]. ERT is a maximally invasive procedure, undertaken in a rush and without full facilities; in an environment of high prevalence of HIV, liberal use of the technique is not warranted.

A physiological classification has been suggested to guide clinicians (Table 1) [27]. Ladd and colleagues [28••] recently validated this approach and recommend that ERT should be withheld for patients of class I or II at scene, or class I on arrival at hospital (see Table 1). There remain some enthusiasts for emergency thoracotomy in the pre-hospital setting but we are reluctant to support this approach in an urban setting [29•].

Fluid resuscitation

The debate over which fluid to use for resuscitation is ongoing. In a systematic review of randomized controlled trials comparing colloid and crystalloid resuscitation in critically ill trauma patients, the relative risk of death with colloid was 1.3 (95% CI 0.95–1.77) [30]. The results of a second similar review were even more discouraging with a relative risk of death with colloid of 2.6 (1.1–5.9) [31]. Several reasons have been advanced to explain these findings, but they are consistent with the hypothesis that expansion of the circulating volume in trauma patients with ongoing bleeding is harmful.

An awareness of the experimental and clinical evidence that fluid administration before surgical control of haemorrhage may actually worsen bleeding and increase mortality after penetrating injury has led members of the Cochrane Injuries Group to describe current resuscitation practice as 'potentially harmful and at best experimental' [32•]. Intravenous fluids have been shown to inhibit platelet aggregation, dilute clotting factors, modulate the physical properties of thrombus and cause increases in blood pressure that can mechanically disrupt clot [32•]. Animal models have demonstrated reductions in mortality with resuscitation to a mean arterial pressure (MAP) of 40 mmHg versus more normal pressures (80 mmHg) [33]. In a study of hypotensive patients with penetrating injuries in Houston, significantly more patients survived when they were randomized to a policy of fluid resuscitation delayed until haemorrhage had been controlled than with immediate fluid administration [34]. The methodology of this study has been criticized [32•] and the concept of delayed administration of fluids may not be universally applicable. The recent Fluid Restriction in Trauma study described a trial including 110 patients who where hypotensive at least once in the first hour after injury [35•]. Patients were randomized into two groups: the first underwent resuscitation to a conventional systolic blood pressure of above 100 mmHg and the second to a lower systolic blood pressure of 70 mmHg. Patients with both blunt and penetrating injuries were included and while there was a significant difference in recorded systolic blood pressure between the groups (114 mmHg versus 100 mmHg) the mortality was the same. These results highlight the difficulties in clinical research in this area and the weakness of using an isolated recording of low blood pressure as a marker for haemorrhagic shock. The study groups were homogeneous and included 13% of

Table 1. Classification of physiological status

Class I No signs of life	Class II Agonal	Class III Profound shock	Class IV Mild shock
Full cardiorespiratory arrest: No electrical activity, asystole, absent corneal, pupillary and gag reflexes	Electromechanical dissociation: Any electrical activity on ECG with no palpable pulse or blood pressure	Blood pressure <60 mmHg	Blood pressure between 60 and 90 mmHg

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patients who stopped bleeding spontaneously after non-operative management.

In a well-designed study from Philadelphia, Clarke and colleagues [36••] found a strong correlation between delay in the resuscitation area and increased mortality in hypotensive patients with major abdominal injuries requiring laparotomy. The probability of death showed a relationship with both the extent of hypotension and the length of time in the emergency department for patients who were in the emergency room for 90 min or less. The probability of death increased as much as 1% for each 3 min delay in the emergency room. Information about volumes of pre-surgery fluids was not available in this study but it may be that delay to surgery also implies greater infusion of fluid. South African experience supports this premise and patients with penetrating torso injury should be given minimal emergency room interventions with the goal of speedy surgical arrest of bleeding [37]. The priority is for securing of the airway, placement of a large bore central catheter and blood analysis for arterial gases and cross-match. We are always mindful of haemo-pneumothorax and place chest drainage tubes without waiting for radiographic confirmation. Imaging can be helpful, but more often slows the resuscitation and is not helpful in an exsanguinating patient.

Intraoperative decision making

Up to 35% of deaths after civilian trauma result from massive haemorrhage into the torso [38•] and in modern warfare, death from exsanguination occurs in approximately half of all deaths [39]. After major trauma with exsanguination, a vicious cycle of metabolic derangement characterized by acidosis and hypothermia leads to a severe coagulopathy, which, when clinically evident, is often difficult to treat and leads inexorably to the patient's demise [40]. This has been described as the 'exsanguination syndrome' and intraoperative appearance of coagulopathy is very highly predictive of death [41••]. Prevention of onset of this syndrome by a rapid surgical procedure where the minimum is done to stop haemorrhage and limit or contain contamination is referred to as damage control surgery [42]. Following this 'incomplete' surgery vigorous attempts are made to restore normal physiology in an intensive-care unit setting and when stable, the patient is returned to theatre for anatomical reconstruction.

In these situations, the anaesthetist is the critical decision-maker. All too often the surgeon can become focused on his or her attempts to gain control of a difficult surgical situation and then may want to proceed to provide definitive surgical treatment. Signs of impending physiological decompensation must be recognized before the limit of the patient is exceeded and the vicious cycle becomes irreversible. Communication is vital to ensure that the surgeon is aware of the degree of physiological compromise, as the decision to perform damage control surgery should be made as early as possible.

Temperature control is critical in patients with major penetrating injury; high volume fluid warmers are used as routine and a heated air blanket should be placed over the head, shoulders and upper extremities, with a second blanket over the lower limbs. The upper body air blanket may be in the way of attempts to achieve appropriate vascular access, or sternotomy, but if it can be positioned once lines are placed it is extremely useful. Irrespective of the urgency of the situation, the patient's head must be covered to prevent heat loss. Raising the ambient temperature of the operating room and use of warmed anaesthetic gases is also helpful (Fig. 6).

The recognition of patients who need damage control can be learned [43••]. Trajectory of projectiles, physiological compromise on presentation and intraoperative parameters predict the onset of the exsanguination syndrome and the need for damage control [41,43••,44•]. Indications to abort surgery include an arterial pH below 7.2 or temperature under 34°C, estimated blood loss of 5 l or massive transfusion requirements [41]. The degree of surgical expertise, critical care availability and the volume of other cases pending should also be taken into consideration and an honest dialogue between surgeon and anaesthetist is vital. Early institution of damage control is thought to confer improved results [43••].

Blood transfusion

Although the availability of blood for transfusion is known to be a major determinant of outcome after injury [45], packed red blood cell transfusions have been shown

Figure 6. Damage control patient

Temperature control is not easy with this exposure. The patient had a gunshot wound to the liver.

to have significant immunosuppressive potential, and transmission of fatal diseases through blood supply has been extensively documented. Packed red blood cell transfusions are an independent risk factor for post-injury infection and multiple organ failure [46]. Initially, transfusion was felt to be a surrogate for injury severity, but it has been found to be a robust and independent predictor of postoperative complications. Attitudes to transfusion have changed substantially since the early 1990s and at least one large trial found that using a restrictive blood transfusion protocol in place of a more traditional one improved survival [47]. These findings have led to a paradigm shift with respect to blood transfusion: whereas the traditional view was that anaemia by itself was a sufficient indication for transfusion, the current consensus is that a second indication must be present in addition to a decreased haemoglobin concentration.

Diverse clinical experience has substantiated the feasibility of autotransfusion in trauma [48]. Autotransfusion eliminates the infectious, allergic, and incompatibility problems of stored blood, an important concern because of the HIV/AIDS pandemic. However, when large amounts of collected blood are reinfused, a consumptive coagulopathy and platelet dysfunction may occur [49]. These risks may outweigh the benefits of autotransfusion in the critically injured patient who has multiple potential bleeding sites. In Johannesburg, we use commercially available chest drains, which allow us to collect and reinfuse blood after it has been filtered [50].

Novel adjuncts

Intravenous administration of recombinant activated human clotting factor VII (rFVIIa) has an established place in prevention of bleeding in haemophiliac patients undergoing surgery. In a hypothermic, coagulopathic animal model, rFVIIa reduced blood loss and restored abnormal coagulation function when used as an adjunct to damage control surgery techniques [51•]. Seven massively bleeding, multi-transfused, coagulopathic trauma patients have also been treated with rFVIIa after failure to achieve haemostasis with conventional means. The coagulopathic bleeding resolved in all patients, coagulation parameters improved dramatically and four of seven patients survived [52••]. Decreasing haemorrhage by inducing hypercoagulability at the bleeding site holds great potential and randomized, multinational trials have commenced. RFVIIa is also being considered as a pre-hospital adjunct as, in an animal model, when given early after injury it is thought to cause temporary cessation of bleeding and improve haemodynamics [38•].

Conclusion

Depending on where they practice, clinicians are more or less likely to encounter patients with gunshot wounds. Experience in high-volume centres has led to the recognition of exsanguination as the initiator of a syndrome that may lead to an irreversible cycle of hypothermia, acidosis, coagulopathy with resulting physiological derangement and death. The anaesthetist is a key figure in the chain of survival and the most precious resource that a major trauma patient possesses is time. The anaesthetist should recognize his or her responsibilities in early control of the airway, limited pre-surgical infusion of crystalloid and temperature preservation. Dialogue between anaesthetist and surgeon and early institution of damage control techniques should translate to improved outcomes for this most brittle sub-group of trauma patients.

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Review Article

Perioperative Management of the Geriatric Patient

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Introduction

Large number of elderly individuals are undergoing surgery because of the advances in surgical and anesthetic techniques combined with sophisticated perioperative monitoring.[1,2] Preoperative assessment is useful to identify risk factors and to recommend a management plan that minimizes the risks. Each person should be assessed individually and judgments should be based on an individual's problem and physiological status, not on age alone. Older persons often have overlapping comorbid conditions that limit their functional capacity, recovery and increase the risk of death. Advanced age, poor functional status, impaired cognition, and limited home support are risk factors for adverse outcomes.[3-8] In one study, the mortality rate for patients older than 70 years undergoing elective cholecystectomy was nearly 10 times that for younger patients. In a study of abdominal operations, the mortality rate for patients aged 80-84 years was 3%; the rate was 9% for patients aged 85-89 years and 25% for those older than 90 years.[9] However, when age and severity of illness are directly compared, severity of illness is a much better predictor of outcome compared to age.[7] Emergency operations are an independent predictor of adverse postoperative outcomes in elderly persons.[10,11]

Preoperative Assessment

A complete history with full medication list, physical examination, laboratory examinations, and an assessment of the surgical risks should be included for a preoperative evaluation of an elective surgery.

Informed consent

The patient, consenting family member(s) or legal guardian(s) should be told about the procedure and regarding any potential complications or disabilities. Decision capacity is a prerequisite for providing legally and morally sufficient informed consent or refusal.[12]

Nutritional status

Nutritional status should be determined, as those who are malnourished have increased morbidity and mortality.[13,14] The laboratory assessment of malnutrition generally includes a complete blood cell count, albumin level, and transferrin levels. Albumin levels of less than 3.2 g/dl in a frail elderly person is a risk factor for increased mortality. A body mass index of less than 20 kg/m^2 also suggests a high risk.

Physical examination

A complete and careful physical examination is necessary. The important points to be noted are hydration, nutritional status, the neck (lymph nodes, thyroid masses, carotid pulsations and bruits), blood pressure, the abdominal examination for lesions such as hernia, aortic aneurysm and incidental masses. Rectal examination is a prerequiste, as is pelvic examination in women. Any evidence of peripheral vascular disease should be identified.

Investigations

Current data shows that routine testing based on age alone is not indicated. Significant predictors of adverse outcome after surgery in the elderly are not the laboratory abnormalities but rather American Society of Anaesthetist status and surgical risk.[15]

System oriented perioperative care

Cardiovascular diseases

Cardiac complications are among the most common and the most serious postoperative problems. The strongest predictors of adverse cardiac outcomes are recent myocardial infarction (MI), uncompensated congestive heart failure (CHF), unstable ischemic heart disease, and certain cardiac rhythm disorders.[16] The major clinical predictors are unstable coronary

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syndromes, decompensated CHF, significant arrhythmias, and severe valvular diseases. Intermediate clinical predictors are mild angina pectoris, prior MI, compensated or prior CHF, and diabetes mellitus. Minor clinical predictors are advanced age, abnormal ECG findings, rhythm other than sinus, low functional capacity, history of stroke, and uncontrolled systemic hypertension. [17] The assessment of functional capacity is based on energy expenditure measured in terms of metabolic equivalents (METs).

If an emergency surgery is needed, the patient's risk stratification and management is assessed afterwards. If the surgery is urgent or elective and if the patient has had coronary revascularization within five years and has had no recurrent symptoms or signs, patient can be considered for surgery. If the patient has recurrent symptoms or signs but has had a recent coronary evaluation, such as angiogram or stress test, with a favorable result, then surgery is considered with calculated risk. If coronary evaluation results are unfavorable or if change in symptoms occurs, then American College of Cardiology / American Heart Association Task Force's Practice Guidelines on perioperative cardiovascular evaluation for noncardiac surgery is to be followed.[16,17]

Perioperative betablocker therapy has been shown to reduce long term (six months) mortality rates, with few adverse effects.[17,18] Thus, the perioperative use of atenolol is recommended in patients with coronary artery disease or in those individuals with risk factors for coronary artery disease unless the patient has significant contraindications, such as asthma. Due to lack of controlled evidence, no recommendations can be made either for or against the use of other medical therapies such as digitalis, nitrates, or calcium channel antagonists. Therapy with these drugs should be continued or started based on the same criteria that would apply in the non operative setting.

If the initial evaluation indicates mild or moderate hypertension and no associated metabolic or cardiovascular abnormalities, no reason exists to delay the surgery. Anti hypertensive medications should be continued during the perioperative period; a diastolic blood pressure of 110 mm Hg or higher requires control before undergoing surgery. If patient is on beta blockers or clonidine, they should be continued because of potential heart rate and blood pressure rebound. In the postoperative period, acute elevations in blood pressure, labile blood pressure, sometimes significant hypotension can occur. Occasionally, uncontrolled pain, ischemia, fluid overload, excitement, electrolyte abnormalities, anxiety or a distended bladder can cause hypertension. As much as 30% of postoperative hypertension is idiopathic and resolves within three hours. When secondary causes are not responsible for the rise in the blood pressure, treatment with calcium channel antagonists, beta blockers and drugs that block both alpha and beta adrenergic receptors should be considered.

CHF is a significant risk factor associated with poorer outcomes.[19] In patients aged sixty five years and above, heart failure patients undergoing major noncardiac surgery experience substantial morbidity and mortality despite advances in perioperative care, whereas those with coronary artery disease without heart failure have similar mortality compared with a more general population. Identifying heart failure based on findings from a careful history and physical examination is important. If possible, the cause should be identified and treated accordingly.

Pulmonary diseases

Pulmonary diseases increase the risk of postoperative complications, accounting for 40% of postoperative complications and 20% of deaths.[20,21] Age related changes such as increased closing volumes, decreased expiratory flow rates, increased dead space and decreased diffusing capacity predispose older persons to pulmonary complications. Ventilatory responses to hypoxia, hypercarbia and mechanical stress are impaired secondary to reduced central nervous system activity. [20] There is also an exaggerated respiratory depression to benzodiazepines, opioids, and volatile anaesthetics.[20,21] The additive effect of supine position, general anesthesia and abdominal incisions leads to a significant reduction in functional residual capacity and an associated increase in airway resistance. The combination of these effects predisposes patients to atelectasis, with the risks of hypoxemia and infection. Additionally, postoperative pain and use of analgesics contribute to a reduced tidal volume and impaired clearing of secretions dependent on adequate coughing and deep breathing.

The preoperative functional level has been shown to be a reliable predictor of pulmonary complications. Preoperative smoking cessation, antimicrobial therapy for bronchitis, perioperative bronchodilator therapy,

optimization of therapy for uncompensated right heart failure, inhalation of humidified gas, postural drainage, and chest physiotherapy can reduce pulmonary complications, lower mortality and shorten hospital stay. Pulmonary function testing is indicated in patients considered for lung resection. Abnormalities suggesting an increased risk of postoperative pulmonary complications include a vital capacity of less than 50% of predicted, a forced expiratory volume in one second (FEV 1) of less then 2 L or less than 50% predicted or the presence of substantial hypoxemia or hypercapnia. Hypoxic pulmonary vasoconstriction is blunted in elderly and can cause difficulty with one lung ventilation.[22]

Renal diseases

Preoperative renal status is the best universal predictor of postoperative renal failure. Serum creatinine is a poor predictor of renal function in older patients with renal disease. Paying close attention to volume status, aggressively treating infections and avoiding the use of nephrotoxic drugs are critical to minimize postoperative renal deterioration in older adults.

Diabetes mellitus

Diabetes mellitus is associated with increased incidence of perioperative complications including ketoacidosis, stroke, renal failure and sepsis. Recommendations for the control of blood sugar levels are made based on the extent of surgery and time of resumption of a normal diet. The glucose level should be less than 300 mg/dl preoperatively (preferably <200 mg/dl). Prevention of hyperglycemia during the perioperative period has been shown to improve wound healing, reduce the risk of infection and reduce cerebral damage in the presence of a hypoxic event. Diabetic patients undergoing major noncardiac surgery appear to have a high mortality rate, often because of cardiovascular death.[23]

Thromboembolic disease

An estimated 20-30% of patients undergoing general surgery without prophylaxis develop deep vein thrombosis and the incidence rate is as high as 40% in those undergoing hip and knee surgery, gynecologic cancer operations, open prostatectomies and major neurosurgical procedures. Fatal pulmonary embolism is a major cause of operative deaths in elderly persons. The Fifth American College of Chest Physicians Consensus Conference on Antithrombotic Therapy recommendations can be followed for risk assessment, prophylaxis, intraoperative and postoperative anti-thrombotic therapy.[24]

Neuropsychiatric disorders

Neuropsychiatric problems are common among older patients. Delirium, dementia and depression are common important conditions to be considered. 15% of all patients admitted for repair of hip fractures have dementia. Depression is also common among older patients and can be exacerbated by any acute illness or hospitalization.[25] An abrupt change in cognition and consciousness is the major manifestation of delirium. New onset visual hallucinations in elderly patients are more suggestive of delirium than of a new psychiatric disorder. Delirium develops in at least 15% of elderly surgical patients and studies show that hospitalized patients with delirium have higher rates of morbidity compared to hospitalized patients in control groups and that delirium is a predictor of poor outcome.[26,27] The length of stay in hospital for a patient with delirium is increased by 60%, and their rate for nursing home placement is five times higher. Independent, specific factors that preoperatively predicted postoperative delirium in elderly patients are age, poor cognitive function, poor physical function, self reported alcohol abuse, aortic aneurysm surgery, noncardiac thoracic surgery and abnormal preoperative sodium, potassium, or glucose level. Independent precipitating factors for delirium are use of physical restraints, malnutrition, respiratory insufficiency, dehydration, addition of more than three medications and nosocomial infection.[28-34]

Intraoperative risk factors for delirium include the type of surgery, hypoperfusion and anesthetic drugs. Delirium occurs after general surgery in 10-15% of patients, after orthopedic surgery in 28-61% of patients, and after cataract surgery in 1-3% of patients. After surgery for femoral neck fractures or bilateral knee replacements, delirium occurs in up to 61% of elderly patients. Several studies have found no difference in the effects of general, epidural, or spinal anesthesia on postoperative delirium rates if medications are controlled for in the analysis.[27]

Postoperative factors associated with delirium include hypoxia and hypocapnia. The rate of postoperative delirium decreases from 61.3% to 47.6% when geriatric assessment is performed both preoperatively and postoperatively and when appropriate interventions are implemented. Perioperative donepezil decreases postoperative confusion and delirium.

Perioperative interventions should focus on

thrombosis prophylaxis, oxygen therapy, prevention and treatment of perioperative hypotension, prompt identification and treatment of postoperative complications. Improving orientation by placing clocks, calendars, appropriate lighting, decreasing sensory overload, providing reassurance and using personal hearing aids and eyeglasses are some of the non pharmacologic interventions for delirium. Intubated patients should have access to communication via word boards, paper and pencil. Physical restraints have not been shown to be safe or effective in the management of delirium. Observation by the nursing staff or family members provides better patient care than physical restraints.

Patients with Parkinson disease require special attention during the perioperative period. These include withholding medications in patients who are advised nothing by mouth, can cause significant worsening of symptoms. Patients may experience hypoxia from stiffening of chest wall muscles, dysphagia and worsened tremor (which can cause increased pain at the operative site). If possible, a feeding tube can be used to administer the medications at appropriate times.
Patients who take levodopa may develop orthostatic hypotension, nightmares, hallucinations and occasionally delirium, all of which may worsen with the addition of surgery and anesthesia. Anticholinergic drugs such as trihexyphenidyl are used alone in the early stages of treatment and later to supplement levodopa. Adverse effects may include dry mouth, urinary retention, constipation, confusion, delirium and impaired thermoregulation due to decreased sweating. Meperidine and propoxyphene should be avoided in elderly persons because of the accumulation of toxic metabolites and the potential severe reaction.

Intraoperative care

Regional versus general anaesthesia

Most evidences show little difference between regional and general anaesthesia in elderly.[35] However regional anaesthesia may show some benefits like affecting coagulation system by preventing postoperative inhibition of fibrinolysis, thereby decreasing deep vein thrombosis and pulmonary embolism. There may be deceased blood loss in pelvic and lower limb surgeries in regional anaesthesia. Patient in regional anaesthesia do not undergo airway instrumentation, hence have lower risk of hypoxia.[36]

Hypothermia

Maintaining body temperature is important because hypothermia is associated with myocardial ischemia and hypoxia in early postoperative period.[37] Advanced age and general anesthesia are associated with hypothermia. Spinal anaethesia with high blockade can also lead to decreased core temperature.

Postoperative pain management and care

Hypoxemia is more common during transportation of elderly patient and in early postoperative period. So supplementary oxygenation and oxygen saturation monitoring is mandatory during this period. Pain management is a crucial aspect of perioperative care.[38] There is age related decrease in pain perception.[39,40] Depression, anxiety, fear, fatigue and cognitive impairment can affect the perception of pain. The treatment plan should anticipate the need for pain control which should be individualized, it should be assessed and modified frequently based on the patient's response. Both medical and nonpharmacologic approaches, such as physical agents and cognitive behavioral approaches, should be used.[41,42] The risk of addiction to opioids is small when used for acute pain syndromes.[43] To avoid the risk of acetaminophen toxicity, the dose should not exceed 4 g/day in older patients with normal liver function. Older persons, who are hospitalized for acute illnesses including surgical interventions, often lose their independence and are discharged to institutions for long term care. Specific changes in the provision of acute hospital care can reduce the frequency of discharge to institutions for long term care. Individualized care, consultation with specialists in multiple disciplines such as nurses, social service counselors, pharmacists, physical and occupational therapist whenever possible promote an optimal patient outcome.[44]

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DAY CASE SURGERY

The Anaesthetist's Role in Promoting High Quality Care

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Introduction

The provision of day case surgery demands meticulous pre-operative preparation of patients, close liaison with general practitioners and all community services, specialised peri-operative care by staff trained in day surgery and extension of that care back into the community. Day case surgery is performed in a wide variety of styles in Great Britain and Ireland today. Ideally, the pre-operative care should take place in purpose built premises which are closely linked to existing hospitals but remain self-contained and autonomous. Often however, patients are admitted to a day ward and have their surgery in the main theatre on a dedicated day surgery list. This can still provide a high quality of care. The practice of admitting day cases onto in-patient wards and that of scheduling both day stay cases and in-patients on the same operating list does not achieve the same high quality of care. It is important to remember that anaesthetic care does not end when the patient leaves the recovery area nor does it finish when the patient leaves the Day Surgery Unit (DSU) and goes home.

All aspect of patient care must receive input from a variety of both hospital and community staff and from the patients themselves. There is a need for a co-ordinated approach, from selection to discharge, and on to late recovery.

Day surgery must be audited and the results reported to all those involved. This audit should not be solely hospital-based but must include community aspects. The success of any DSU should include measures of patient satisfaction as well as types of cases performed and the numbers of patients treated.

It is of paramount importance that the process of selecting patients and the liaison between hospital and community services for day case surgery, achieves what has been termed “seamless care”.

Recent Reports

Over the last few years, several reports have been published for those who wish to extend or improve the manner in which they practise day surgery. The Audit Commission, the Royal College of Surgeons of England, Caring for Children in the Hospital Service and the Value for Money Unit of the Department of Health Management Executive (DHME) have all produced papers in this field and these are helpful background reading (See Further Reading).

The Department of Health Estates published Volume I of a Health Building Note, HBN 52, in 1993, that describes the standards to which new DSUs should be built. It is a very useful document for all those who are faced with the need to increase day surgery, and has taken into consideration many of the North American experiences of this type of practice. In the same year, the DHME published the report of a Task Force in day surgery which contains a 'tool kit' to assist those trying to start or improve day care in their hospitals. This document stresses the importance of total quality management and how DSUs can provide the best care for a wide variety of procedures. It suggests how those who work in a DSU can collect and collate data relating to their practice and how these data should reflect the nature of the procedures performed rather than just numbers of cases. The authors of this report hope that the use of various items within the 'tool kit' will enable existing centres to widen the scope and improve the quality of their work. At the same time, it will indicate to others how they can develop effective day care practice. It is reasonable to believe that half of all elective surgery may be performed as day cases by the year 2000.

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Selection of Patients

There are various routes for referral to day surgery: from hospital out-patient clinics, from accident and emergency departments, from Professionals Allied to Medicine and direct from general practice. The exact mode of referral is unimportant as long as all adhere to agreed protocols of patient assessment. There are no absolute criteria of fitness for day surgery.

Assessment falls into four main categories;

(i) social

(ii) medical

(iii) facility

(iv) personnel.

All of these are equally important. However, some of these factors are not always easy to assess by the hospital doctor who has to rely on health care professionals in the community to alert him/her to potential problems.

(i) Social Factors:

(a) The patient must be willing to undergo day surgery.

(b) There must be a responsible adult, able and willing to care for the patient at home for at least the first 24 hours post-operatively.

(c) Patients or their carers should have easy access to a telephone.

(d) The patient's home situation should be compatible with postoperative care, with satisfactory standards of heating and lighting, together with adequate kitchen, bathroom and toilet facilities.

(ii) Medical Factors:

(a) The patient or his/her immediate carer should be able to understand the planned procedure and subsequent postoperative care.

(b) The patient should be either fully fit, or any chronic disease such as diabetes, asthma, hypertension or epilepsy, should be well controlled.

(c) The patient should ideally have a Quetelet ratio (defined as the weight in kilograms divided by the height in metres squared) of less than 30. This will facilitate both anaesthesia and surgery.

(d) Patients should be assessed fully before admission for the procedure, all appropriate investigations performed, consent forms signed, and the likely events of their day explained. Many patients do not require any 'routine' pre-operative investigations.

(e) Patients should be selected according to their physiological status not their age.

(iii) Facility Factors:

(a) Care should be provided in a facility which is set aside for day surgery. Ideally this should be purpose-built. Alternatively day surgery should be practised in a dedicated area within the hospital.

(b) Simple, rapid and effective exchange of information between hospital and community personnel must be possible.

(c) Information technology must be provided so that adequate audit of all aspects of patient care can take place.

(d) Many hospitals will be providing care for day patients, who need anaesthesia, in specialised units eg. ophthalmology, dentistry, psychiatry, accident and emergency. It may not be appropriate to centralise these services into one DSU but all such patients must receive the same high standards of selection, preparation, perioperative care, discharge and follow-up.

(iv) Personnel Factors:

(a) Care should be provided by experienced medical staff who are enthusiastic and skilled in day surgery. This must be a consultant-led service.

(b) Nurses and other health care professionals should be specially trained and specifically allocated to DSU.

(c) General practitioners (GPs) and community liaison staff must agree that their patients can receive this type of care, and help in the decision-making process. They should have the opportunity to visit their local DSU so that new developments in anaesthesia and surgery can be discussed and appreciated.

Documentation

Every DSU does not need to design their own assessment forms. There are large numbers of these forms in existence in Great Britain and Ireland and throughout the rest of the world Those about to start, or to update their practice, should try to obtain as many of these forms as possible to benefit from the experience of others. A specimen form is shown in Appendix 1 and further examples are available from the British Association of Day Surgery (BADS)* .

An information booklet should also be provided which clearly explains the mechanics of the day care process. This booklet should outline the pre-operative preparation, what patients should wear and bring to the hospital on the day, what to expect postoperatively and how to communicate with those involved in their care. Protocols should be available for the patient to postpone and re-book their procedure for medical or valid social reasons. Specific information sheets, relating to the individual planned procedure, should also be available for the patient to take home and read at leisure. Again, examples of this type of information are available from the BADS*.

The information in such packages should be agreed by all involved in the patient's care.

* The British Association of Day Surgery can be contacted through its Honorary Secretary, Miss Sarah Penn, c/o Day Surgery Unit, Addenbrookes Hospital, Hills Road, Cambridge, CB2 2QQ.

Staffing

Each DSU should have a medical director who has a specific interest in day case surgery. A consultant anaesthetist with management experience is ideally suited to such a post. The medical director should have adequate time allocated in their contract for this responsibility.

Each DSU will also require adequate staffing led by a senior nurse who provides the day-to-day administration of the unit in liaison with the medical director. The staffing levels of each DSU will depend on the design of the facility and the work undertaken, as well as local preferences. The DSU must have reception staff of high quality as well as nursing and ODP personnel. Several published documents (e.g. A Short Cut to Better Services by the Audit Commission and Guidelines for Day Case Surgery by the Royal College of Surgeons - see Further Reading) have attempted to quantify the staff required. We recommend that each DSU formulates its own staffing structure which takes into consideration their local needs.

Each unit should have a management group which represents the interests of those who work there. This will include representatives from anaesthesia, surgery, hospital nursing, community nursing, general practice, management, finance, audit, and ancillary care. This management group should write an operational policy, define a timetable and organise marketing and audit strategies. They should meet on a regular basis.

Anaesthetic Management

Once a patient has been selected and fully prepared for day surgery, decisions must be made for their anaesthetic management. Each anaesthetist should develop techniques which permit the patient to undergo the surgical procedure with the minimum of stress and the maximum of comfort. Analgesia is paramount and must be long lasting. Morbidity, such as nausea and vomiting, must be minimised. The Association of Anaesthetists has published standards of patient monitoring and assistance for the anaesthetist which apply just as much to day surgery as to in-patient work (see Further Reading).

Recovery

Modern anaesthetic techniques for day surgery should ensure rapid recovery. Supervision of the patient in the postoperative period must be of the same high standard as that provided for in-patients. Recommendations for the standards of recovery facilities and monitoring during recovery have been described in previous Association of Anaesthetists booklets (see Further Reading).

Transfer from the immediate recovery area should occur when the patient is awake, in control of his/her airway, orientated, comfortable and without continuing haemorrhage or other complications. In the later stages of recovery, observation remains essential and staffing levels must reflect this.

Discharge

Patients must fulfil established discharge criteria before they leave the DSU. Every patient must be seen following the operation by the anaesthetist and surgeon involved in his/her care. Assessment of "street fitness" can be made by nursing staff who can take the responsibility for discharging the patient, provided that they follow the unit's written policy. If there is any doubt as to the patient's fitness for discharge, the anaesthetist concerned or a deputy must be contacted for a medical assessment.

Each DSU will establish its own discharge policy and an example is provided in Appendix 2.

There must be access to in-patient beds for patients with perioperative complications. If a patient requires admission then an in-patient bed must be found. If day surgery is being performed in an isolated site then protocols for transport and admission to hospital must be defined.

Discharge following Regional Anaesthesia

Special attention should be paid to the recovery of patients who have received regional anaesthetic blocks. Residual neural blockade after spinal or epidural (caudal) blocks may cause postural hypotension and urinary retention despite return of adequate motor and sensory function. Pflug et al (1978) have suggested four clinical criteria which must be met before ambulation can be permitted:

i) return of sensation in the perianal area (S4-5)

ii) plantar flexion of the foot (while supine) at the same strength as that prior to anaesthesia

iii) return of proprioception in the big toe

iv) patient is not sedated or hypovolaemic.

It has been suggested that the ability to evert the foot demonstrates the return of S1 motor function and indicates that the patient will be able to walk safely. The need to elicit perianal sensory levels, can thus be avoided.

Peripheral nerve blocks and intravenous regional anaesthesia can provide excellent conditions for day case surgery. Patients may be discharged home with residual sensory or motor blockade. The duration of the blockade must be explained and the patient must receive written instructions as to their conduct until normal sensation returns.

Postoperative Instructions

All patients should receive verbal and written instructions on discharge. They should be warned of any symptoms that they might experience during the first 24 postoperative hours. They should be discharged home with a supply of appropriate analgesics and advised not to drive, drink alcohol, operate machinery or cook until the following day. Guidance should be given as to when sutures should be removed, together with any specific instructions relating to their surgical procedure.

In the event of a problem the patient must know where help or advice can be found A list of contact telephone numbers should be supplied. These instructions should be given in the presence of the responsible person who is to escort and care for the patient.

Discharge Summary

It is essential to inform the patient's GP, by facsimile or telephone call, of the nature of the anaesthetic and surgical procedure performed and of the patient's discharge. Ideally this should occur before the patient leaves the DSU. The practitioner should have been alerted to the date of their patient's proposed treatment by a pre-operative request for medical and social information. The GP is thus able to plan appropriate post operative care for the patient based on up-to-date information in conjunction with their own knowledge of the patient's health and social background.

Until the patient next attends for out-patient review, care is provided by their own GP, the community nursing service or the immediate family. DSUs should also provide support postoperatively, if requested.

Audit

The Audit Commission has published an audit questionnaire for patients to complete once they have gone home. This offers guidance for each DSU to develop its own audit. Discharge of the patient from the DSU to the home is not the only adequate measure of success for day surgery. Unless it can be demonstrated that a patient is comfortable at home, with minimum morbidity, no conclusions can be made.

Contractual Arrangements

The duration of a day case theatre list should be assessed in notional half days and should be designated as a fixed commitment in the anaesthetist's job plan.

There is no doubt that sessions occasionally overrun though, equally, they can be shorter. Such variations should be considered as part of the normal variation in clinical work.

Time required to assess the patients pre and postoperatively should be considered part of the flexible sessions that are included in each anaesthetist's job plan.

The Future

Day surgery will increase in the future. Many aspects will change and develop. Surgeons will increase the complexity and duration of their day case operations as newer techniques involving "minimal access surgery" increase the number of potential day case patients. Anaesthetists will continue to reduce postoperative morbidity by utilising new agents and techniques. Epidural and subarachnoid analgesia techniques will be used more frequently. Hotel facilities will be built close to DSUs. Community and domiciliary nursing will develop further expertise in this field.

Many new types of DSUs will evolve over the coming decade. All involved in this type of work must be prepared to adopt a flexible approach and to re-evaluate their practice in the light of new developments. Quality care, reflecting the patient's needs, should be the goal of all involved with day surgery. The anaesthetist has a pivotal role in this development.

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Appendix 1

An example of a preoperative screening assessment for patients who are being considered for day case surgery as used by the Churchill/John Radcliffe Hospital, Oxford.

Day Surgery Unit

TO BE HANDED TO PATIENTS ATTENDING OUT-PATIENTS **BEFORE** SEEING DOCTOR.

Assessment Questionnaire

Name: **Date:**

Record No:

It is possible that you may need to come into hospital for an operation. It would be greatly appreciated if you could help by answering the following questions.

1. Do you suffer or have you suffered from any of the following:

	Yes	**No**
i) Heart disease	☐	☐
ii) Palpitations	☐	☐
iii) High blood pressure	☐	☐
iv) Chest pains	☐	☐
v) Swelling of ankles	☐	☐
vi) Shortness of breath	☐	☐

		Yes	No
vii)	Asthma	☐	☐
viii)	Chronic cough	☐	☐
ix)	Diabetes	☐	☐
x)	Epilepsy	☐	☐
xii)	Jaundice	☐	☐

Other diseases (please list) ..... .

2. Are you taking any tablets, pills, inhalers, oral contraceptive or medicine - for any reason? ☐ ☐

   If yes, please list.....

3. Have you any allergies? ☐ ☐

   If yes, please list.....

4. Do you smoke ☐ ☐

   If yes, please list.....

5. Have you had any operations or anaesthetics before? ☐ ☐

   If yes, please list.....

6. Do you have false, capped or loose teeth? ☐ ☐

7. Is there anything about yourself or your family's medical history you think we should know? ☐ ☐

   If yes, please give details .....

It is possible you may be suitable for day case surgery which would mean you would not have to spend the night in hospital. This will normally only be the case if you can answer "yes" to the following.

		Yes	**No**
1.	Would you like the opportunity to have your surgery done and be sent home all on the same day?	☐	☐
2.	Would it be acceptable to you to have no premedication (premed) before surgery?	☐	☐
	This is a drug that is used to make patients sleepy before they go down to the operating theatre. We feel that it has considerable disadvantage when the patient wishes to go home on the same day as many patients will remain sufficiently drowsy from it to be unable to leave hospital. As the type of surgery that is performed in the day case unit usually takes a short while only, many patients are happy not to have a pre-medication and would rather go fully awake to the theatre where they are anaesthetised fully, quickly and completely with an anaesthetic injection.	☐	☐
3.	Can you make your own way to the Churchill Hospital?	☐	☐☐ ☐
4.	Can someone collect you from the Churchill Hospital between 4 p.m. and 5 p.m. on a weekday?	☐	☐
5.	Will there be a responsible and physically fit person available to look after you for the first night?	☐	☐

Thank you for your help.

Appendix 2

An example of discharge criteria following day case surgery as used by the Day Surgery Centre, St Bartholomew's Hospital, London.

PRIOR TO DISCHARGE

	Yes	No
1. Has stable B/P and pulse - [Results:- B/P . . . . . Pulse . . . . .]	☐	☐
2. Can swallow and cough	☐	☐
3. Can walk without feeling faint	☐	☐
4. Has minimal nausea and is not being sick	☐	☐
5. Can breath comfortably and looks a normal colour	☐	☐
6. Is wide awake and knows what is going on	☐	☐
7. Has passed urine	☐	☐
8. Has had something to drink	☐	☐
9. Has had the operation site checked	☐	☐
10. Postoperative instructions explained to patient or relative	☐	☐
11. Has had their postoperative medications	☐	☐
12. Has their doctor's letter been faxed to GP? Date . . . . Time	☐	☐
13. Has the GP been telephoned? Date . . . . Time	☐	☐
14. Knows when to come back to outpatients (follow up if necessary)	☐	☐
15. Has someone to stay with them tonight/up to 24 hrs post-surgery	☐	☐
16. Has their audit check questionnaire.	☐	☐

I confirm that these discharge criteria have been met and the patient can go home at . . . . . and I believe that this patient will/will not benefit from a visit from the community care group and this has/has not been arranged.
(Delete as required)

Signed . . . . . (Day Ward Nurse)

Principles of anaesthesia in urological surgery

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Anaesthesia for urological surgery poses particular challenges for the anaesthetist related to the patient population and procedure type. The aim of this article is to cover the general principles of anaesthesia, with dedicated sections relevant to practising urological surgeons. This represents vast amounts of knowledge that cannot be covered in one article. We will focus upon preoperative preparation for surgery and anaesthesia, perioperative management including monitoring and analgesia, and postoperative management including fluid balance, critical care and recovery.

Significant proportions of urological surgical patients have some degree of renal failure and this may be related to the surgery required. Anaesthetic care of patients with chronic renal impairment and transplant surgery will be covered in a future review.

INTRODUCTION

A large proportion of urology patients are very young or elderly. These patients can undergo multiple minor procedures or major reconstructive surgery with marked physiological disturbance. The role of the anaesthetist is to manage perioperative physiology in addition to the provision of anaesthesia and analgesia.

PREOPERATIVE PREPARATION FOR SURGERY AND ANAESTHESIA

ASSESSMENT

The objective of preoperative assessment is to identify and optimize any disease state. It is important to differentiate between chronic stable disease and deteriorating clinical states which need further specialist input. Concurrent medical therapy can be checked and optimized for the surgical period with appropriate tests arranged at this stage [1,2].

PRE-ASSESSMENT CLINICS

In this surgical group, young patients may have complex histories, i.e. cerebral palsy, and elderly patients may have multisystem disorders. Both groups represent challenges to the anaesthetist if reviewed on the day of surgery. The introduction of 'pre-assessment' clinics has streamlined surgical admissions and reduced cancellation rates. These clinics are usually led by a specialist nurse with anaesthetic consultant input and support. They provide an excellent environment for informing and obtaining the consent of the patients.

Pre-operative assessment can be considered under the following headings:

- Airway
- Breathing
- Circulation
- Drugs, anaemia, diabetes and patient positioning.

AIRWAY

The anaesthetist makes the choice of technique used for airway management after a full assessment. The following factors are taken into consideration:

Patient factors

- Full stomach/risk of soiling of airway
- Postoperative ventilation requirement
- Poor respiratory function/reserve
- Neuromuscular disorders.

Surgical factors

- Intra-thoracic/abdominal surgery requiring muscular relaxation
- Patient positioning
- Prolonged surgery
- Laparoscopy/pneumoperitoneum.

The following patients should be referred for anaesthetic opinion:

Patient characteristics suggestive of a difficult airway:

- Large overbite
- Mouth opening <2 cm
- Immobile cervical spine e.g. ankylosing spondylitis
- Short neck
- Obesity with or without short stature
- Unstable cervical spine
- Previous difficult intubation
- Congenital facial abnormalities
- Previous head and neck surgery/ radiotherapy
- Previous tracheostomy
- Thyroid surgery/goitre

BREATHING

A functional assessment is often as revealing as sending patients for pulmonary function tests and a careful respiratory history may be adequate. Patients who cannot show adequate exercise tolerance due to pathology or immobility require a formal assessment of respiratory function [3].

An arterial $PaO_2 < 8$ kPa and shortness of breath at rest are strong indicators that postoperative ventilation may be required. Patients with poor lung function often benefit from regional anaesthetic techniques, although this evidence is not universal [4]. Patients unable to lie flat are unsuitable for regional anaesthesia.

CIRCULATION

Significant cardiovascular morbidity is a common factor in elderly patients. The stress response to surgery and anaesthesia can precipitate cardiac events in poorly optimized patients. Perioperative cardiac events, e.g. myocardial infarction (MI) or arrhythmia, carry a higher mortality and morbidity than if they occurred outside the perioperative period.

Factors that should be discussed with a cardiologist and the anaesthetist are:

- Angina pain at rest or minimal exertion;
- Symptoms of syncope, cardiac failure and shortness of breath on exercise;
- Recent history of an unstable coronary syndrome or MI.
- Rheumatic fever with cardiac involvement;
- Previous cardiac surgery;
- Presence of an implanted pacemaker;
- Uncontrolled hypertension.

The American College of Cardiology and American Heart Association published guidelines for assessing patients with cardiac disease undergoing noncardiac surgery. Patients able to walk a flight of stairs without breathlessness have a reasonable functional reserve and are unlikely to have significant disease. Specific tests are unwarranted unless a major procedure is scheduled. Patients who cannot exercise enough to assess left ventricular function require further tests, such as a stress echocardiogram or exercise tolerance tests [5].

Hypertension is widespread and stable control is necessary to reduce the risk of perioperative cerebrovascular accident or cardiac event. Uncontrolled or newly diagnosed hypertension in surgical patients is managed jointly by anaesthetists and cardiologists.

DRUGS

Polypharmacy is common in elderly patients; most drugs have little bearing on anaesthesia and should be continued throughout the perioperative period. The following drug groups are particularly relevant to urology:

- Angiotensin-converting enzyme inhibitors are prescribed for heart failure and hypertension. They should be omitted on the day of surgery as they can lead to persistent hypotension under anaesthesia. Serum electrolytes may be disturbed and should be checked before surgery.
- Warfarin is prescribed for various reasons. Surgery should not be undertaken with an International normalized ratio (INR) of >2 unless in an emergency, when fresh frozen plasma can be given to normalize clotting. Vitamin K is of limited use in acute situations as it has a slow onset and leads to difficulty re-establishing effective control of INR.
- Anti-platelet drugs are prescribed for patients with ischaemic heart disease. Aspirin irreversibly inhibits platelet function for up to 7 days. Thienopyridines such as clopidogrel are newer antiplatelet drugs acting via suppression of platelet ADP. They should be discontinued for 7 days before surgery unless a continued antiplatelet effect is required (in exceptional circumstances).
- β-blockers act upon the heart to reduce chronicity and inotropy. They have been shown to reduce adverse cardiac events, specifically acute MI, when prescribed from 1 week before to 1 month after surgery [6,7].
- α-blockers used for hypertension or symptomatic control in prostatic enlargement lead to marked hypotension during regional anaesthesia, and that may be difficult to reverse.
- Diuretics are prescribed for hypertension, cardiac, renal and hepatic impairment. It is important to establish the reason for prescription and check for common side-effects of the drug, e.g. frusemide may cause hypokalaemia.

ANAEMIA

The optimum delivery of oxygenated haemoglobin to end organs and peripheries is essential. It is important that preoperative anaemia is investigated and appropriately managed before elective surgery. Preoperative transfusion is controversial and should be discussed with the anaesthetist involved (see below).

INSULIN AND DIABETIC CONTROL

Diabetes is a common multisystem disease and often affects the renal system via microcirculatory changes or direct effects. Many urological patients will consequently be diabetic. Preoperative assessment is directed at establishing the impact on other organ systems and planning diabetic control through the perioperative period. Oral hypoglycaemics and insulin may be used alone or in combination for all types of diabetes.

Patients undergoing minor procedures may omit oral hypoglycaemic drugs and resume medication and diet after surgery. Patients undergoing major surgery or who are insulin-dependent should have an insulin and dextrose regimen titrated to effect. This should be instituted before surgery and maintained throughout the recovery period. This can speed recovery and reduce the hospital stay. Reductions in wound infection rates by increasing diabetic control are now widely accepted.

In the critical-care setting tighter control of blood glucose levels has led to a reduction in mortality, morbidity and length of stay. Outside of critical care accidental hypoglycaemia remains a safety issue and this has led to doctors permitting higher blood glucose levels than with traditional sliding scales. In the light of this new critical care evidence, practice may change [8].

PATIENT POSITIONING

It is important to assess before surgery the ability of the patient to safely tolerate the surgical position. Examples are: hip replacement and lithotomy position, or ankylosing spondylitis and the lateral table-break position for nephrectomy. Procedures such as laparoscopic radical prostatectomy use a Trendelenburg tilt in conjunction with insufflation of the peritoneal cavity for prolonged periods. This may lead to marked physiological disturbance. Patients scheduled for such procedures with an exercise tolerance of <4 metabolic equivalents (unable to climb a flight of stairs without stopping) as a result of cardiorespiratory disease should be discussed with an anaesthetic colleague.

PERIOPERATIVE MANAGEMENT

The main choice is whether to use a local, regional, general or a combined anaesthetic technique. Sedation is used as an adjunct to local or regional anaesthesia. Patient and surgical factors affect the anaesthetic choice. These include the patient's comorbidity and the wide range of surgical procedures. Individual cases should be considered on their merits, as the anaesthetic risk depends upon these. Regional anaesthesia is not intrinsically safer than general anaesthesia.

Perioperative management can be considered under these subheadings:

- Local anaesthesia
- Central neural blockade
- General anaesthesia.

LOCAL ANAESTHESIA

Many areas of the body are amenable to local anaesthetic infiltration to provide analgesia. Surgeons are aware that many operations can be done under local anaesthesia alone. Knowledge of the following is essential for safe practice.

Signs and symptoms of local anaesthetic toxicity:

- CNS; dizziness, circumoral tingling, confusion, convulsion, coma.
- Cardiovascular system: tachycardia, hypertension with adrenaline; bradycardia and hypotension with no adrenaline. Both may be followed by severe or fatal arrhythmia.

Maximum safe doses of local anaesthetic: (with adrenaline dose)

- Bupivacaine 2 mg/kg (2 mg/kg)
- Lidocaine 3 mg/kg (7 mg/kg)
- Prilocaine 6 mg/kg (8 mg/kg).

All these drugs are toxic in overdose and can be lethal if given intravenously. Where permitted adrenaline may be added to increase the length of analgesia but does not reduce the toxicity of accidental intravenous injection.

How to calculate dose/volume of drug that can be given:

Note that a 1% solution contains 10 mg/mL of drug, e.g. a 75-kg man allowed 150 mg bupivacaine = a maximum of 30 mL 0.5% solution

The components of a safe environment for local anaesthesia:

If large amounts of local anaesthetic are to be used intravenous access should be established and patient monitoring instigated with resuscitation facilities immediately available.

NEURAL BLOCKADE

Peripheral nerve blocks:

Both surgeons and anaesthetists can use the following nerve blocks [9,10].

- Penile block: the dorsal nerves of the penis (S2–4 pudendal) may be blocked on either side of the penile vessels at the caudal edge of the symphysis pubis. This is suitable for circumcision and similar surgery. The genital branch of the genitofemoral nerve needs to be blocked for surgery on the skin at the base of the penis.
- Ilioinguinal (L1) and iliohypogastric (L1) may be blocked below the external oblique aponeurosis medial and caudal to anterior superior iliac spine. This is suitable for scrotal, testicular, and hydrocele surgery.
- Genitofemoral (L1,2) may be blocked at the deep ring above the midpoint of the inguinal ligament, deep to external oblique aponeurosis. This allows surgery on the scrotum and labia majora.
- A paravertebral block is made by anaesthetists, at the appropriate level to surgery, deep to the transverse process of the thoracic or lumbar spine. This provides long-lasting unilateral analgesia over 3–5 nerve rami for renal, ureteric and low abdominal surgery. A catheter may be sited for postoperative drug delivery.

Central nerve blockade (CNB)

A conscious patient permits the rapid assessment of neurological change and there may be minimal disturbance of respiratory function. After surgery there is a quicker return to oral intake. Postoperative cognitive dysfunction may occur less frequently with conscious elderly patients and CNB than with general anaesthesia [11]. Three types of CNB are encountered by urologists:

Spinal anaesthesia

Small doses of bupivacaine (10–30 mg) with or without opioid (opioids act synergistically) are injected intrathecally resulting in sensory, motor and sympathetic block. The position of the patient may be manipulated to influence the degree of spread of local anaesthetic. For example, the lithotomy position causes the cephalad spread of anaesthetic. The advantages are a rapid, reliable onset of surgical anaesthesia of predictable, effective duration (60–90 min). The failure rate is 5–10%, requiring either a second attempt or conversion to general anaesthesia.

Epidural anaesthesia

Larger volumes (5–20 mL) of local anaesthetic with or without opioid are delivered into the peri-dural space. The drugs diffuse to exert an effect on the spinal cord and nerve roots. Advantages over spinal anaesthesia are that incremental doses can be given and use may be continued into the postoperative period for analgesia.

Caudal epidural anaesthesia

Large volumes (10–40 mL) of local anaesthetic are delivered to the caudal space, via the sacral hiatus, which is a continuation of the epidural space. In adults it only contains sacral and lumbar nerve roots with the dura mater ending at the level of S2. Caudal epidural injection provides supplementary anaesthesia to the saddle area for perineal surgery. The space may be difficult to locate reliably and the sacral hiatus is absent in ≈10% of the population. It is relatively easy to perform in children. Caudal anaesthesia has an association with prolonged femoral nerve block, slower mobilization and urinary retention.

CNB is not to be undertaken lightly; the very rare adverse effects can be fatal or debilitating, especially those affecting the spinal canal. Previous specific informed consent must be obtained for this type of anaesthesia.

There are contraindications, side-effects and predictable effects common to all types of CNB

- Absolute: local and systemic sepsis; coagulopathy.
- Relative: pre-existent neurological disease; cardiovascular pathology; lack of consent.

Side-effects caused by:

Physical processes:

- Direct nerve trauma.
- Cord compression due to vertebral canal haematoma.
- Abscess.
- Stroke.
- Meningism/meningitis.
- Post-dural puncture headache.

Drugs:

- Intravascular injection of opioids, local anaesthetic or adrenaline.
- Local anaesthetic toxicity.
- Opioid itching and respiratory depression.

Predictable physiological responses:

- Motor and sensory nerve blockade.
- Sympathetic blockade with unopposed vagal effects.
- Urinary retention.

Because of the significant effects on the cardiovascular, respiratory and CNS it is

essential to use regular cardiovascular, respiratory and neurological observations, including distribution of motor and sensory block, as well as analgesic effectiveness.

A common misconception is that regional anaesthesia requires less preoperative assessment and is easier than general anaesthesia. All patients need to be prepared to the same standard for both techniques. There is no evidence to suggest that regional anaesthesia has reduced long-term morbidity and mortality for urological surgery [4].

GENERAL ANAESTHESIA

General anaesthesia is the technique of choice for a wide range of patient or surgical factors, e.g. intra-abdominal or thoracic procedures, cardiovascular instability or long procedures. It involves the induction, maintenance and emergence from anaesthesia by pharmacological agents. It is beyond the scope of this article to discuss the individual pharmacokinetics and pharmacodynamics of drugs used in anaesthesia. Induction may be carried out either by inhalation of halogenated hydrocarbons such as sevoflurane or intravenous injection of the phenol propofol or barbiturate thiopentone.

Areas of special interest are:

- Management of the airway.
- Simple and complex patient monitoring.
- Temperature control.
- Physiological effects of pneumoperitoneum.

AIRWAY

The airway may be supported by a facemask, the laryngeal mask airway or by intubation of the trachea. The laryngeal mask airway is seated over the larynx and allows spontaneous or controlled ventilation.

Indications for tracheal intubation are:

- To protect the airway from soiling.
- To facilitate mechanical ventilation.

Muscle relaxation may be required to facilitate surgery and is achieved by neuromuscular blocking drugs. Neuromuscular blockade cannot be reversed for up to 20 min after giving the last dose and therefore further doses to aid closure of the wound lead to prolonged anaesthesia.

MONITORING

The reasons for monitoring patients throughout the perioperative period are:

- Anaesthetic agents reduce respiratory drive and lying supine leads to a reduction in the functional residual capacity of the lungs.
- Anaesthetic agents reduce myocardial contractility and inotropy, and this combined with peripheral vasodilatation results in hypotension.
- Surgery causes blood loss and fluids shifts, depleting the intravascular volume.
- Measuring expired concentrations of carbon dioxide and anaesthetic agents helps to ensure effective ventilation and depth of anaesthesia.

Monitoring is undertaken before induction and continues until recovery. It consists of:

- Clinical observations; colour, respiratory rate, pulse.
- Simple monitoring; electrocardiogram, pulse oximetry, capnography and noninvasive blood pressure.
- Advanced monitoring; central venous and arterial pressures, blood gas analysis.
- Other; temperature measurement, urine output, respiratory volume and pressure measurements.

A commonly used noninvasive monitoring technique is the oesophageal Doppler probe. This device measures the velocity of red blood cells in the descending aorta and then derives blood flow rates. Further analysis allows assumptions about cardiac output and intravascular volume status. This can be viewed in real-time, guiding fluid and inotrope therapy by dynamic change.

TEMPERATURE CONTROL

During surgery patients may become hypothermic. Increased heat loss is due to impaired thermoregulatory control during anaesthesia. In the elderly, autoregulation is already impaired and children have a relatively large surface-area to body-mass ratio. Core temperature correlates well with temperature measurements from the nose, ear and rectum. Factors predisposing to heat loss are the cool dry atmosphere of the operating room, leading to heat loss via conduction, convection and evaporation [12].

The clinical effects of hypothermia are:

- Shivering which increases metabolic demands;
- Increased pain and anxiety;
- Increased wound infection rates;
- Coagulation abnormalities;
- Cardiac arrhythmia;
- Delays in extubation;
- Prolonged hospital stay.

Useful techniques to reduce heat loss:

- Insulation by air trapping blankets/sterile cotton wool;
- Use of heat reflective materials in hats and leggings;
- Warming of both intravenous fluids and operative fluids;
- Warm air blowers/blankets;
- The humidity and temperature of the operating room may be increased;
- Avoid wet drapes.

PNEUMOPERITONEUM

Laparoscopic surgery requires insufflation of carbon dioxide gas into the peritoneal cavity, allowing surgery and visualization of the viscera. Intra-abdominal pressures up to 20 cmH_2O are used with the following anaesthetic implications:

- Diaphragmatic splinting;
- Increased intragastric pressure;
- Initially increased venous return leading to relative hypertension. Further increases in pressure reduce venous return and cause hypotension;
- Diffusion and possible embolization of carbon dioxide into the bloodstream;
- Trendelenburg and lithotomy positions will exacerbate these effects of the pneumoperitoneum [13].

POSTOPERATIVE

After anaesthesia the patient is transferred to the recovery room to ensure maintenance of the airway, stabilization of respiratory and cardiovascular function, effective analgesia and observations relating to surgical complications. Postoperative care can be subdivided into the requirements for critical

TABLE 1 The strategies to reduce blood transfusion

Factors		
Patient	Surgical	Anaesthetic
Preoperative iron therapy	Efficient coagulation	Hypotensive anaesthesia
Erythropoietin	Choice of technique	Cell salvage
Preoperative autologous donation of blood		Acute normovolaemic haemodilution
		Anti-fibrinolytic drugs

care, fluid management, analgesia and specific urological situations.

CRITICAL CARE

The care of complex surgical cases and high-risk patients requires more monitoring, nursing interventions and expert medical care than can be provided on the open surgical ward. In the UK, this critical care is delivered in an intensive care unit (ICU), high-dependency unit (HDU), and monitored ward beds. The decision to admit a patient to a critical-care environment should be discussed between the surgeon and the anaesthetist.

The Intensive Care Society (UK) has agreed on levels of care for different patient groups, which are listed below. Most urology patients require level 0 and 1 care on the surgical ward. However, given the comorbidity and age of some patients, combined with major surgery, a proportion will require level 2 care for 24–36 h in an HDU/ITU setting. In our current practice it is rare that urology cases require level 3 care in an ITU [14].

Level 0: Patients needs can be met through normal ward care in an acute hospital.

Level 1: Patients at risk of their condition deteriorating, or those recently relocated from higher levels of care whose needs can be met on an acute ward with additional advice and support from the critical care team.

Level 2: Patients requiring more detailed observation or intervention including support for a single failing organ system or postoperative care and those stepping down from higher levels of care.

Level 3: Patients requiring advanced respiratory support alone or basic respiratory support, together with support of at least two organ systems. This level includes all complex patients requiring support for multiorgan failure.

PERIOPERATIVE FLUID MANAGEMENT

This involves the dynamic assessment and treatment of rapid shifts in fluid balance, with regular assessment and correction of haematological and biochemical markers. The aim is to maintain normovolaemia with adequate haemoglobin concentration to ensure oxygen delivery to the tissues, whilst keeping electrolytes within the normal range.

When considering fluid management of an individual patient, factors that should be considered include:

Preoperative

- Reduced fluid intake from starvation or to the disease process, i.e. acute abdomen.
- Increased fluid losses from vomiting, ileostomy output, bowel preparation.

Intraoperative

- Evaporative loss from open abdomen 10-30 mL/kg/h.
- Third space loss to bowel, omentum and retroperitoneum.
- Bleeding.
- Nasogastric losses.
- Normal insensible losses and maintenance.

Postoperative

- Ongoing third space losses.
- Paralytic ileus.
- Nasogastric losses.
- Bleeding.
- Maintenance.

In the presence of normal renal function and haemodynamic variables, a maintenance fluid rate of 40 mL/kg/day (1.6 mL/kg/h) should maintain a urine output 0.5–1.0 mL/kg/h. This allows for normal insensible losses whilst maintaining intravascular volume.

For example, an 80-kg man should receive 3000 mL and pass 1000–2000 mL of urine in 24 h. Preoperative fasting with no intravenous fluids for 8 h deprives this patient of 1000 mL. This needs to be replaced early during surgery.

Postoperative fluid balance in cases with complex or ongoing losses should be closely monitored both clinically and with hourly input and output charts. Should the hourly urine volume reduce, prompt and appropriate correction of intravascular depletion may prevent postoperative renal insults. In some urological procedures, accurate assessment of urine output may be difficult, e.g. bladder irrigation.

Fluid replacement ideally replaces 'like for like', i.e. colloid and packed red blood cells for haemorrhage, and crystalloid for maintenance and third-space losses. The fluid choice should also be guided by an appreciation of the electrolyte demands of the patient; 24 h electrolyte requirements for an adult are Na^+ 1–2 mmol/kg, K^+ 1 mmol/kg and maintenance of normal range for magnesium and phosphate. To reduce the incidence of hyperchloraemic acidosis the current practice is to use fluids with lower chloride ion content than 0.9% saline, e.g. Hartmanns or Gelofusine.

Electrolyte abnormalities specific to urology occur in those patients who have neobladder formation, ileal conduits and Mitrofanoff constructions. Where urine flows over or through intestinal conduits a metabolic acidosis occurs, with hyperchloraemia and low serum bicarbonate levels [15]. TURP syndrome becomes symptomatic from the hyponatraemia caused by absorption of irrigating fluid. If these patients need active management this should occur in a critical-care environment [16].

BLOOD TRANSFUSION

When to transfuse red blood cells has become topical in recent years, with increasing costs and fears of prion and viral transmission. In the critical-care setting, haemoglobin levels of ≥80 g/L are satisfactory. However, a minimum haemoglobin level of ≥100 g/L may be more commonly used on the surgical ward. Preoperative anaemia should be thoroughly investigated and managed before elective surgery [17]. Table 1 shows the strategies to reduce transfusion [18–20].

ANALGESIA

Analgesia throughout the operative period can be provided systemically or by neural blockade, or combined techniques. It is important to provide effective and consistent levels of analgesia as the patient moves through the perioperative period.

Good analgesia that allows effective coughing and earlier mobilization of patients is essential to reduce postoperative respiratory complications. NSAIDS act by inhibiting the enzyme cyclooxygenase, to inhibit the formation of prostaglandins, prostacyclins and thromboxane, that sensitise pain receptors to stimulation. Gastric mucosal blood flow can be reduced and this leads to gastric erosions. A single dose of NSAID may precipitate acute renal failure, particularly in the dehydrated and elderly. Platelet adhesiveness is reduced, leading to increases in blood loss during and after surgery. Bronchial smooth muscle relaxation may be reduced and in 10–20% of asthmatics bronchospasm may occur.

Paracetamol is an extremely safe analgesic and antipyretic drug that is used for treating mild to moderate postoperative pain. It does not have the same anti-inflammatory effects as NSAIDs, but neither does it cause gastrointestinal, respiratory or renal adverse effects. In overdose paracetamol can cause fulminant hepatic failure. Paracetamol can be given orally, rectally and more recently an intravenous preparation has been made available in the UK.

The WHO suggests using an 'analgesic ladder' to provide effective pain management.

Step 1: Mild discomfort can be treated with regular paracetamol.

Step 2: Moderate pain can be treated with addition of codeine or DF118.

Step 3: Severe pain should be treated by use of strong opioid drugs such as morphine.

NSAIDs may be administered at any level. Examples are ibuprofen and diclofenac.

Patient controlled analgesia (PCA) is a technique that allows patients to titrate their own analgesia. This is a controlled infusion device that is pre-programmed to allow set doses of drug to be given in set periods, and that is triggered by the patient. Normal regimens allow the administration of 1 mg of morphine every 5 min. Compared to nurse-delivered intramuscular injection with opioids, PCA offers a more rapid analgesic delivery. PCA is safe and effective when used appropriately, but patient suitability is an important factor, as an understanding of how to use the device is required. The system is rarely applicable to paediatric surgery, although nurse-controlled devices may be used [21].

Continuous epidural analgesia can be used to control pain for up to 5 days after surgery. A combination of local anaesthetic and opioid are continuously infused into the epidural space via an indwelling catheter. Low concentrations of local anaesthetic provide analgesia with minimal motor blockade. Patients need to be nursed in an appropriate environment for the reasons previously described [22].

CONCLUSION

The role of the anaesthetist begins with preoperative assessment and extends throughout the inpatient stay. The principles guiding the anaesthetic management have been discussed, but the true art of anaesthesia is to tailor the plan for each individual.

The preoperative assessment and stabilization of chronic health conditions improves outcomes, reduces cancellation rates and increases health service efficiency. The common techniques of neural blockade that can be used for analgesia and anaesthesia have been described. General and regional anaesthesia have merits but the ultimate choice of technique is a compromise between the patient, anaesthetist and surgeon. Patient safety should be paramount in decision-making processes.

From admission through to discharge, the physiology of the patient must be monitored and supported, to reduce complications and promote rapid healing. These measures can be as simple as a correct dynamic fluid balance reducing renal insults, or maintaining good blood glucose control.

In this era of patient-led care, effective analgesia is a basic humanitarian right (WHO) which promotes rapid healing and well-being. In response to this, more acute-pain services are being created. The current world of technology and Internet access has seen a shift in patient awareness of anaesthetic and surgical options. It is right that both surgeons and anaesthetists are able to answer the questions posed as patients are encouraged to question medical decisions.

The new plan for surgical training proposed by the Royal College of Surgeons (UK) has increased the amount of training time spent in anaesthesia and critical care, recognizing that essential skills can be learnt. Not only will this improve continuity of care during the peri-operative period, but it allows for improved consent for patients at all stages.

Advances in training, supervision, pharmaceuticals and medical devices, combined with the use of national guidelines, have dramatically improved patient safety in the operating department in the last 20 years. A multidisciplinary approach to care delivered throughout the peri-operative period will improve patient care and continue this trend.

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