MINI-SYMPOSIUM: SPECIAL CARE PATIENTS

(i) Surgery in elderly patients

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Summary

The important aspects of surgery in elderly patients can be summarised for the preoperative, operative and postoperative period. Preoperative care includes a detailed medical and social history, physical assessment for co-existing medical conditions and appraisal of the present physical state. This will determine which investigations are appropriate. Following this the risk involved with surgery can be estimated, and any medical conditions or co-existing diseases that need to be corrected prior to surgery identified (e.g. hypertension, diabetes control, cardiac arrhythmias, poor nutrition). The type of surgical procedure and anaesthetic should be tailored to each patient.

Optimum operative care includes careful peri-operative monitoring and maintenance of a stable haemodynamic status. Variations in blood pressure, hypoxia and hypothermia should be prevented. Wherever possible, consideration should be given to using local or regional anaesthesia. Postoperative care includes nutritional support, prevention of delirium, thromboembolic prophylaxis and effective pain control. Wherever possible early mobilisation should be encouraged to avoid the adverse effects of recumbency.

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Introduction

In western countries the life expectancy of the population continues to increase such that in the UK the average life expectancy is 75 years for males and 80 for females. Approximately 9.4 million people are aged 65 years and above in the UK and of these, 336,000 are aged 90 years and over. Surgical rates are nearly twice as high for persons aged over 65 years (215 operations per 1000 persons) as for persons less than 65 years (120 operations per 1000 persons). Approximately half of all emergency surgical procedures are performed in the elderly and the proportion is set to increase in future years as more of the population survive into their seventies.

Pre-existing medical conditions such as cardiac or pulmonary disease present in this older population place them at greater risk of an adverse outcome. Elderly patients have the highest postoperative mortality and morbidity rates in the adult surgical population. Postoperative events of particular concern are cardiac, pulmonary and cerebral injury and cognitive dysfunction. When operating on the

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elderly, the surgeon must consider the pre-existing morbidity and life expectancy of the patient, before making a decision regarding the requirement and the type of surgery. In addition the appropriate postoperative rehabilitation regime should be considered. The elderly have diminished physiological reserves and are less able to maintain haemostasis. In this review the special surgical requirements of the elderly will be considered.

Peri-operative mortality

Mortality associated with anaesthesia and surgery is traditionally reported as the death rate within 30 days of surgery. Three quarters of all postoperative deaths occur in the elderly. Since 1996 there has been a slight but steady increase in the mean age of all postoperative deaths from 74 to 76 years, reflecting changes in the healthcare requirements of an increasingly older, frailer population. The most common surgical procedures leading to death are

- Fracture of neck of femur
- Peripheral arterial occlusive disease
- Ruptured abdominal aortic aneurysm
- Acute intestinal vascular insufficiency
- Perforated diverticulum of colon
- Malignant neoplasm of colon

Some reported rates for 30-day mortality are given in Table 1.

Predictive factors

Advanced age alone is a significant predictive factor for mortality as the functional capacity of organs reduces with age, resulting in a diminished physiological reserve. Other risk factors include

- Major and/or emergency surgery
- ASA grades 3–5
- Co-existing medical diseases (hypertension, cardiac disease, diabetes mellitus, renal failure, liver disease, respiratory disease)
- Associated malignant disease
- Poor nutrition
- Low albumin
- Anaemia
- Patient living in institutional care
- Impaired mobility

The ASA grade is the American Society of Anaesthesiologists classification of risk related to current physical status (Table 2). Numerous studies have demonstrated the predictive power of this simple scoring system for mortality and morbidity associated with anaesthesia and surgery. Anaesthetists now use this system routinely. The grade may be prefixed with L for elective, S for scheduled, U for urgent and E for Emergency surgery.

Cardiovascular disease

The ageing process has a number of effects on the cardiovascular system. Myocardial stiffening

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Table 1: Reported 30-day mortality rates for different patient groups.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Mortality Rate</th>
</tr>
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<tbody>
<tr>
<td>All operations and age</td>
<td>1.2%</td>
</tr>
<tr>
<td>Aged 60–69</td>
<td>2.2%</td>
</tr>
<tr>
<td>Aged 70–79</td>
<td>2.9%</td>
</tr>
<tr>
<td>Aged over 80</td>
<td>6.0%</td>
</tr>
<tr>
<td>Aged over 90</td>
<td>8.4%</td>
</tr>
<tr>
<td>Emergency abdominal surgery aged over 80</td>
<td>9.7%</td>
</tr>
<tr>
<td>Thoracotomy aged over 70 years</td>
<td>17.0%</td>
</tr>
<tr>
<td>Any major surgical procedure aged over 90</td>
<td>19.8%</td>
</tr>
<tr>
<td>Elective primary hip or knee replacement</td>
<td>0.5–1%</td>
</tr>
<tr>
<td>Revision total hip replacement</td>
<td>2%</td>
</tr>
<tr>
<td>All hip fracture surgery</td>
<td>8.3%</td>
</tr>
<tr>
<td>Hip fracture aged &lt; 60</td>
<td>3.3%</td>
</tr>
<tr>
<td>Hip fracture aged 60–69</td>
<td>3.8%</td>
</tr>
<tr>
<td>Hip fracture aged 70–79</td>
<td>4.8%</td>
</tr>
<tr>
<td>Hip fracture aged 80–89</td>
<td>8.8%</td>
</tr>
<tr>
<td>Hip fracture aged 90 and above</td>
<td>14.9%</td>
</tr>
</tbody>
</table>

Table 2: ASA physical status classification system.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>Grade 1</td>
<td>A normal healthy patient</td>
</tr>
<tr>
<td>Grade 2</td>
<td>A patient with mild to moderate systemic disease which is well controlled, e.g. Hypertension, controlled diabetes</td>
</tr>
<tr>
<td>Grade 3</td>
<td>A patient with severe systemic disease that limits activity but is not incapacitating, e.g. moderate chronic obstructive airways disease, angina on exertion, stable asthma</td>
</tr>
<tr>
<td>Grade 4</td>
<td>A patient with severe systemic disease that is incapacitating and is a constant threat to life, e.g. acute asthma, severe, acute exacerbation of chronic airways disease, critical aortic stenosis</td>
</tr>
<tr>
<td>Grade 5</td>
<td>A moribund patient who is not expected to survive without the operation, e.g. ruptured aortic aneurysm</td>
</tr>
</tbody>
</table>
impairs early diastolic filling of the ventricles. There is increased aortic root diameter and stiffening of the large arteries, which increases afterload. This leads to left ventricular hypertrophy. There may be little change in myocardial contractile ability in the resting state, but the response to exercise is significantly reduced with age. Conduction abnormalities are more common in the elderly as are arrhythmias. In addition hypertension is more common, which may contribute to ischaemic heart disease and the risk of sudden death.

**Assessment**

Preoperative cardiac assessment includes a relevant cardiac history and physical examination for signs of cardiac failure and cardiac murmurs. Preoperative investigations that may identify those at increased risk are an ECG, exercise test and echocardiogram. For stable elderly patients having low or intermediate risk surgery the ECG is the only necessary cardiac screening test. ST segment depression or left ventricular hypertrophy, are associated with an increased risk of perioperative myocardial ischaemia. Those patients with second or third degree heart block need to be considered for a pacemaker insertion (either temporary or permanent) before surgery.

Exercise stress testing gives a measure of functional capacity and is a screening test for significant coronary artery insufficiency. It should be considered for those at intermediate risk and scheduled for high-risk surgery such as major vascular surgery. For those unable to undergo exercise stress testing dipyridamole thallium scintigraphy or dopamine stress echocardiography are alternatives.

Echocardiography is indicated before elective surgery for those elderly patients with cardiac murmurs to diagnose aortic or mitral valve disease. These are common in the elderly. Severe aortic stenosis may require aortic valve replacement before major non-cardiac surgery. Lesser degrees of aortic stenosis may effect the anaesthetic management of patients. Spinal anaesthesia is contra-indicated in the presence of aortic stenosis as it causes peripheral vasodilatation, which results in a fall in blood pressure and coronary artery perfusion pressure. More intensive monitoring of the blood pressure with an arterial line or central venous pressure measurement may be indicated. Patients diagnosed with mitral or aortic regurgitation should receive antibiotic prophylaxis at the time of surgery to prevent endocarditis.

A cardiac risk index has been devised as shown in Table 3.

**Myocardial infarction**

Myocardial infarction is one of the main causes of postoperative death and the risk is markedly increased in the presence of pre-existing cardiovascular disease (Table 4). Infarction usually occurs within three days of surgery with the first day being the highest risk. Infarction is more likely to be ‘silent’ (painless) in the elderly and in the presence of diabetes. This may be partly due to the postoperative pain control, residual effects of the anaesthetics and impaired conscious level of the patient. ECG changes include S–T segment elevation and Q wave development. Traditional cardiac enzymes tests are unreliable, as the effect of surgery will elevate creatine kinase. Creatine kinase cardiac isoenzyme or troponin T and I are

<table>
<thead>
<tr>
<th>Table 3</th>
<th>A scoring system for predicting the risk of cardiac complications and mortality after non-cardiac surgery.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points</td>
<td></td>
</tr>
<tr>
<td>Congestive cardiac failure</td>
<td>11</td>
</tr>
<tr>
<td>Myocardial infarction within 6 months</td>
<td>10</td>
</tr>
<tr>
<td>Rhythm not sinus or premature atrial contraction</td>
<td>7</td>
</tr>
<tr>
<td>More than 5 ventricular extrasystoles per minute</td>
<td>7</td>
</tr>
<tr>
<td>Age more than 70 years</td>
<td>5</td>
</tr>
<tr>
<td>Emergency surgery</td>
<td>4</td>
</tr>
<tr>
<td>Significant valvular stenosis</td>
<td>3</td>
</tr>
<tr>
<td>Poor general medical condition</td>
<td>3</td>
</tr>
<tr>
<td>Abdominal or thoracic aorta surgery</td>
<td>3</td>
</tr>
</tbody>
</table>

| Score 0–5 | Risk complications—0.7% | Mortality—0.2% |
| Score 6–12 | Risk complications—5%   | Mortality—2%   |
| Score 13–25 | Risk complications—11%  | Mortality—2%   |
| Score > 26 | Risk complications—22%  | Mortality—56%  |
therefore more useful. Peak levels of troponin occur at 12–24 h after myocardial damage and they may remain raised for 14 days. Raised levels indicate myocardial injury that may be associated with pulmonary embolism, congestive cardiac failure, myocarditis, renal failure or after stroke. A diagnosis of myocardial infarction after surgery should therefore only be made in conjunction with positive ECG changes.

Ideally surgery should be delayed by at least three to six months following a myocardial infarction. Patients should then be assessed using echocardiography to measure left ventricular function and an exercise test. Coronary artery surgery or percutaneous transluminal coronary angioplasty should be considered before elective surgery, for those considered at high risk, with limited cardiac function or unstable angina. Consideration should also be given to using peri-operative beta-blockers, which are the only class of drugs which have been shown to reduce the risk of perioperative myocardial ischaemia.

The American college of cardiology has classified patient risk into major, intermediate and minor.4

<table>
<thead>
<tr>
<th>Major (&gt;5%)</th>
<th>Intermediate (1–5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial infarction within 30 days</td>
<td>Mild angina</td>
</tr>
<tr>
<td>Unstable or severe angina</td>
<td>Previous myocardial infarction</td>
</tr>
<tr>
<td>Congestive cardiac failure</td>
<td>Previous or corrected congestive cardiac failure</td>
</tr>
<tr>
<td>High grade atrio-ventricular block</td>
<td>Diabetes mellitus</td>
</tr>
<tr>
<td>Symptomatic ventricular arrhythmia</td>
<td>Renal insufficiency</td>
</tr>
<tr>
<td>Supra-ventricular arrhythmia with uncontrolled ventricular rate</td>
<td>Congestive cardiac failure</td>
</tr>
<tr>
<td>Severe valvular disease</td>
<td>Minor (&lt;1%)</td>
</tr>
<tr>
<td>Advanced age</td>
<td>Left ventricular hypertrophy on ECG</td>
</tr>
<tr>
<td>Left bundle branch block on ECG</td>
<td>ST segment or T wave abnormality on ECG</td>
</tr>
<tr>
<td>Atrial fibrillation or any rhythm other than sinus</td>
<td>Low functional capacity (e.g. inability to go up stairs)</td>
</tr>
<tr>
<td>Previous stroke</td>
<td>Uncontrolled hypertension</td>
</tr>
</tbody>
</table>

Congestive cardiac failure

The presence of congestive cardiac failure is a major risk factor for an adverse cardiac event after surgery. Treatment of cardiac failure with diuretics and vasodilators preoperatively is recommended. Intensive monitoring during surgery is essential and this should include a urinary catheter. For more extensive surgery a pulmonary artery catheter or trans-oesophageal doppler to measure left ventricular filling pressures and cardiac output may be indicated. Dehydration and diuretic medication may deplete intravascular volume. A pulmonary artery catheter will help monitor and correct this. This can be particularly useful with regional anaesthesia, in which the expansion of the intravascular volume from the anaesthesia will result in hypotension unless controlled by fluids or vasopressor drugs. For those with cardiac failure, excessive fluids cannot be given so the use of vasopressors is preferable. There will need to be a titration of fluids and medications against the monitored cardiac parameters.

Patients considered to be at high risk of a cardiac event should ideally be monitored for three days postoperatively for ST segment depression. This is a specific marker of ischaemia. Troponin levels are a more sensitive indicator of myocardial damage than creatine kinase or ST segment changes. Pain control should be aggressive to reduce the physiological stress response to surgery. The use of peri-operative beta-blockers should be considered. Two small randomised trials have demonstrated a halving of the incidence of myocardial ischaemia with a regime of intravenous then oral atenolol for seven days. Continuous epidural analgesia postoperatively may also be advantageous.

Hypertension

The prevalence of hypertension increases with increasing age, such that it is very common in the
Diabetes mellitus

There is an increased prevalence of diabetes with increasing age. Diabetes is a significant risk factor for cardiovascular disease and diabetic patients have more extensive atherosclerosis. In addition they may have silent myocardial ischaemia and poorer outcomes than non-diabetics. Diabetes also leads to impaired wound healing due to decreased leukocyte response, impaired phagocytosis and altered capillary permeability. Diabetic wounds are also more susceptible to infection. It is not therefore surprising that diabetes is associated with increased postoperative morbidity and mortality.

Complications may be reduced by optimisation of diabetic control preoperatively and using intravenous insulin with the dose adjusted as required over the peri-operative period. The blood sugar should be maintained between 5 and 10 mmol/L perioperatively. The surgeon may need to consider less invasive surgical methods to reduce the risk of wound sepsis or delayed wound healing.

Pulmonary disease

Ageing affects ventilation, gas exchange, compliance, muscle power and other parameters of lung function as well as the defence mechanisms of the lungs. In addition elderly people are at a higher risk of chronic obstructive pulmonary disease (COPD). The most important risk factor for this is smoking. Pure age-related changes do not lead to clinically significant airway obstruction or dyspnoea in the non-smoker, although, in smokers and ex-smokers with emphysema, dyspnoea worsens with age. Pulmonary disease is associated with increased postoperative morbidity (pneumonia, hypoxia, atelectasis) and mortality.

Risk factors for pulmonary complications include endotracheal intubation, prolonged surgery, general anaesthesia as opposed to regional, thoracoabdominal surgery, chronic obstructive pulmonary disease, asthma, smoking and chest deformation. For spirometry a forced expiratory volume of less than 75% or a maximal ventilatory volume of less than 50% of predicted values when corrected for age and sex, indicate a significant risk of pulmonary complications. Smoking results in a six-fold increase in the incidence of postoperative respiratory complications and should therefore be stopped at least eight weeks before elective surgery.

Preoperative assessment of the respiratory system includes taking a history of dyspnoea and cough. The ability to climb several flights of stairs has similar predictive value to spirometry, however factors other than chest disease may limit stair climbing in the elderly. Appropriate preoperative investigations are chest radiography and blood gases. Pulmonary function tests are indicated for those with chest symptoms undergoing thoracic and upper abdominal surgery. Preoperative preparation for those at risk should include training in cough and lung expansion techniques in conjunction with chest physiotherapy. Bronchodilating and mucolytic therapy is appropriate for those with COPD and asthma. Sedative medicines should be kept to a minimum. Bronchospasm should be treated with bronchodilators and steroids. If infection is considered, antibiotics should be administered as appropriate.

General anaesthesia has marked effects upon pulmonary function. As discussed later, regional anaesthesia has advantages over general anaesthesia and results in a lower incidence of postoperative hypoxaemia and respiratory depression. Contributing factors to this are the effects of anaesthetic drugs, particularly those used for muscular paralysis and analgesics. For the elderly shorter and intermediate acting neuromuscular blocking drugs are preferable to longer acting drugs with antagonists given to reverse their effects at the end of surgery. Supplementary oxygen should be used to prevent hypoxia for several days postoperatively.
Renal impairment and fluid balance

Renal function decreases with age. There is a reduction in renal plasma flow, glomerular filtration rate, reduced renal tubular function and decreased renin and aldosterone levels. In addition the thirst mechanism is impaired. These factors along with an altered renin—angiotensin system, lead to an increased tendency to develop dehydration and electrolyte imbalance. A normal serum creatinine may be due to decreased muscle mass rather than normal renal function. Moderate increase in serum creatinine levels are associated with increased postoperative morbidity.

Urine output monitoring is an essential part of postoperative care of the elderly patient. This may be best achieved using a urinary catheter. Some orthopaedic surgeons cite an increased risk of sepsis of orthopaedic implants after bladder catheterisation. This fear is not supported by clinical studies and therefore unjustified. Other aspects of fluid balance include monitoring of fluid intake and if necessary central venous pressure or pulmonary artery pressures.

Renal impairment associated with cardiovascular disease can make fluid management very difficult. Cardiac failure and pulmonary oedema are more prevalent in the elderly. Judicious use of intravenous fluids is necessary to reduce the occurrence of this complication. Elderly patients will take twice the time of a younger patient to excrete excess extracellular water (ten versus five days). In the presence of renal impairment and respiratory disease, intravenous fluids should therefore be given cautiously, to provide for only maintenance, with additional correction for fluid loss. If hypotension occurs this should be controlled by vasoconstrictors, inotropic drugs and cautious colloid infusions.

Cerebrovascular complications

With age there is a loss of grey matter and a reduction in brain volume. Cognitive function and co-ordination are reduced, along with the vision, hearing, taste and touch. In addition the processes controlling temperature are impaired. Homeostasis and baroreceptor and laryngeal reflexes are all reduced.

Stroke

Stroke is one of the most devastating of complications that may occur after surgery in the elderly. It is defined as a focal neurological deficit lasting more than 24h. The peri-operative period is the time of greatest risk due the physiological stresses imposed. Possible aetiological factors are changes in adrenergic activity, tachycardia, hypertension, hypotension and hypoxia. Patient factors that are associated with an increase risk of a stroke occurring are previous stroke, cardiovascular or cerebrovascular disease, hypertension, diabetes mellitus or COPD. Prevention is by maintaining cardiovascular stability with avoidance of large variations of blood pressure and adequate pain control.

Delirium

Delirium or postoperative cognitive dysfunction, refers to a fluctuating state of disorientation, impaired memory, and incoherent speech. After surgery it has been termed postoperative cognitive dysfunction. This has to be differentiated from dementia where there is a global cognitive impairment without any effect on consciousness. Some degree of delirium occurs in between 5% and 60% of elderly patients after surgery, with hip fracture patients having one of the highest incidences. The large differences in reported incidence reflect differing definitions of delirium and that related to different surgical procedures. Clinical signs include disturbed attention and cognition and a reduced ability to maintain attention to external stimuli. Consciousness may be diminished. In addition there may be disorganised thinking, hallucinations, insomnia and impaired memory. A scoring system of standardised questions such as the Abbreviated Mental Test score (Table 5) should be used.

Some of the contributing factors include

- Unfamiliar surroundings
- Prolonged surgery
- Hypoxia

<table>
<thead>
<tr>
<th>Table 5 Questions used for the abbreviated mental test score.</th>
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</thead>
<tbody>
<tr>
<td>Patients age.</td>
</tr>
<tr>
<td>Give time to the nearest hour.</td>
</tr>
<tr>
<td>Recall an address to be repeated at the end of the test (e.g. 26 church road).</td>
</tr>
<tr>
<td>Present year.</td>
</tr>
<tr>
<td>Name of institution presently in.</td>
</tr>
<tr>
<td>Recognition of two people (e.g. doctor, nurse).</td>
</tr>
<tr>
<td>Date of birth.</td>
</tr>
<tr>
<td>Year of start of second or first world war.</td>
</tr>
<tr>
<td>Name of current monarch or head of state.</td>
</tr>
<tr>
<td>Count backwards from 20 to 1.</td>
</tr>
</tbody>
</table>
Excessive intra-operative blood loss
Impaired vision and hearing,
Pre-existing dementia
Malignant disease
Psychoactive drugs
Polypharmacy
Drug withdrawal (e.g. hypnotics and alcohol)
Infection (urine, chest, wound, septicaemia)
Urine retention
Respiratory infection
Water and electrolyte imbalance
Renal impairment.

Typically delirium occurs on the second post-operative day with symptoms worst at night. Delirium is associated with increased hospital stay and morbidity, but is reversible for the vast majority of patients. Only about 1% of cases have persistently increased impairment of cognitive function. The following factors have been cited as appropriate methods for reducing the occurrence of postoperative delirium.8

**Before surgery**

Assessment of sensory impairment, e.g. hearing, sight
- Baseline assessment of mental state
- Medical assessment
- Assessment of drugs that may cause delirium (anticholinergics, antidepressants)
- Explanation of process of care before surgery
- Orientation of the patient by staff

**Intra-operative measures**

- Ensure oxygenation and perfusion
- Avoid hypoxia and hypotension
- Correct electrolyte imbalance
- Reduce dose of drugs as appropriate for the elderly
- Avoid atropine, benzodiazepines, scopolamine, anticholinergics
- Avoid prolonged or extensive surgery
- Minimise hospital stay or use day surgery
- Use regional anaesthesia

**Postoperative measures**

- Appropriate pain control
- Avoid dehydration and electrolyte imbalance
- Quite well lit room
- Minimise changes of staff or rooms
- Continue to keep the patient orientated
- Visits from friends and family
- Early mobilisation
- Use normal hearing aids, glasses etc.
- Ensure patient has adequate undisturbed sleep

Should delirium occur infections such as those of the chest, wound or urinary system should be excluded, as should urine retention. Fluid and electrolyte imbalance should also be corrected. Alcohol or other drug withdrawal will require appropriate treatment. Regular reassurance should be provided with features of care as listed above. If sedation is deemed necessary small doses of an oral tranquiliser such as haloperidol should be used. This drug has less cardiovascular side effects that other sedatives. Regional anaesthesia may have a marginally lower risk of delirium in comparison to general anaesthesia, however there are conflicting views on this.9

**Thromboembolic complications**

The elderly are at increased risk of thromboembolic complications. Other risk factors that may be present are

- History of previous thromboembolism
- Surgery of the abdomen or lower limbs
- Prolonged surgery
- Dehydration
- Polycythaemia
- Obesity
- Smoking
- Malignancy
- Recumbency.

The incidence of thromboembolic complications varies greatly between studies, reflecting different degrees of diagnostic diligence, use of thromboprophylaxis and whether routine screening for these complications is undertaken. For hip fracture patients some degree of deep venous thrombosis will occur in over half of the patients, although it will be symptomatic in only a small proportion of these. Pulmonary embolism occurs in about 1–3% of cases, of which about half will be fatal.

Measures that may be taken to reduce the incidence of thromboembolic complications are

- Avoidance of prolonged immobility/bed rest
- Avoidance of over-transfusion
- Avoidance of dehydration
- Use of regional anaesthesia
- Pharmacological (heparin, warfarin, low-dose aspirin)
Mechanical pumps (foot or calf intermittent compression)
Thromboembolic stockings

Pharmacological methods are associated with an increased risk of adverse events in the elderly. These include wound haematomas, intracranial haemorrhage or gastrointestinal bleeding. Therefore the benefit of each method should be balanced against the risk and related to the individual patient and the proposed surgical procedure.

Nutrition

Poor nutritional status is common in the elderly. Approximately 7% of those aged 70 years and over are anaemic and 11% of elderly men and 17% of women have a serum albumin below 35 g/L. Other risk factors for malnutrition are physical restrictions, psychosocial factors, depression, monetary factors, cultural factors, social isolation, dental problems, change in taste perception, impaired gastrointestinal function, diarrhoea, constipation, early satiety, excess alcohol intake, and chronic disease. The consequences of malnutrition are wound infection and delayed wound healing, sepsis, prolonged hospital stay and increased mortality.

A nutritional assessment should form part of the preoperative assessment. This includes history, for which a nutrition assessment score may be used, physical findings and laboratory tests. Indicators of a poor nutritional status are

- Significant weight loss over time
- Weight lower that 20% of expected after correction for height
- BMI (body mass index, weight/square of height) < 18 kg/m²
- Serum albumin less than 35 g/L
- Significant change in functional status
- Inadequate food intake
- Presence of other nutrition related disorders

The optimum BMI is 20–25 kg/m². Wherever possible, before elective surgery malnutrition should be corrected using oral, enteral or even intravenous feeding and corrections should continue after surgery.

Pressure sores

Surgical intervention is one of the important risk factors for developing pressure sores, with increased age, immobility, prolonged surgery, operative hypotension and poor nutrition as aetiologic factors. Steps should be taken before and during surgery to prevent the development of pressure sores. These include nutritional support, moving the patient or their limbs during surgery and special mattresses. For prolonged surgery appropriate pressure relieving devices to prevent skin damage during surgery should be used. Immediately after surgery is completed the patient should be transferred to a pressure-relieving mattress.

Hypothermia

The elderly have impaired thermoregulatory control. Hypothermia will increase peripheral vasoconstriction, myocardial ischaemia, blood pressure and the risk of cardiac arrhythmias. Blood coagulation is also affected. In addition hypothermia will increase the risk of wound healing complications, increase operative blood loss and prolong hospital stay. Hypothermia is equally likely during both general and regional anaesthesia. To prevent operative hypothermia intra- and postoperative core body temperature should be maintained at or above 36.7 °C, using a warming blanket, mattresses, warmed intravenous fluids and humidified inhaled gases.

Surgery

The surgeon needs to consider what is the most appropriate treatment for an elderly patient whilst considering the estimated operative and anaesthetic risks. What is considered the correct treatment for a young, fit patient may be totally inappropriate in a frail elderly patient who is unable to tolerate a major surgical procedure. For example, the orthopaedic surgeon may have to accept a lesser degree of fracture reduction, rather than undertake a complex reconstructive procedure. Other examples where surgery may be altered are treating a displaced intracapsular fracture by closed reduction and percutaneous internal fixation rather that a replacement arthroplasty, accepting the alignment of a distal radial fracture rather than undertaking a reduction procedure, treating a displaced ankle fracture with reduction and plaster rather than internal fixation and accepting that the risks of a revision hip arthroplasty outweigh the possible benefits.

Each patient has therefore to be assessed on an individual basis. Many decisions regarding
treatment options can only be made after a full and careful assessment of the patient. In current orthopaedic practice this is often deficient, with treatment decisions being made on the basis of the X-rays and only altered if the anaesthetist indicates the patient is at high operative risk for the procedure proposed. Early anaesthetic assessment at the time of surgical decision making can reduce the risk of the patients having to be cancelled for the scheduled surgery.

Other aspects of surgical management will also be altered with ageing. For example, an elderly patient may be unable to comply with postoperative restrictions such as non-weight bearing. A hip fracture fixation must therefore be sufficiently stable to enable full weight bearing. The holding power of screws is reduced in osteoporotic bone. When fixing a fracture in a younger patient incorrect screw placement may be altered, whilst in osteoporotic bone this may not be possible.

**Bone cement**

Methylmethacrylate bone cement is often used for orthopaedic procedures but is not without its risks. Major adverse cardiac events may occur on insertion of the cement including cardiac arrest, hypotension and bradycardia. This is caused partly by the cement monomer which has a cardiotoxic effect. In addition there are systemic emboli of cement, fat, and bone marrow elements during insertion of the prosthesis. These emboli lodge in the pulmonary vessels and may cross the heart through a patent foramen and lodge in the brain and other organs.

The incidence of cardiac arrest from cement insertion is about 1–2% for frail hip fracture patients, but less for the fitter patients who undergo elective arthroplasty. The risk of these adverse events is increased with age, cardiac disease, electrolyte imbalance and use of a long-stem prosthesis. Prevention includes supplementary inspired oxygen at the time of cement insertion, ensuring the bone to receive the cement is irrigated to remove excessive marrow elements and retrograde insertion of cement with a cement gun. For those who are considered to be at a high risk of a cement reaction, consideration should be given to using an uncemented implant.

**Wound healing**

The main factor determining wound healing is the level of tissue oxygen. This is influenced by factors such as the cardiovascular status and anaemia. Other factors which will influence the ability of a surgical wound to heal are listed below.

- Congestive cardiac failure
- Hypovolaemia
- Anaemia
- Nutrition (protein, glucose, minerals, vitamins A and C)
- Diabetes
- Peripheral vascular disease
- Malignancy
- Rheumatoid arthritis
- Hypothyroidism
- Renal failure
- Hepatic failure.

**Timing of surgery**

For elective surgery this is not an issue once appropriate preoperative assessments have been undertaken and any action taken depending on their findings. For emergency surgery there is controversy. The primary factor is the urgency of surgery. Immediate life-threatening conditions requiring surgery, dictate that surgery is undertaken without delay, however for conditions of lesser urgency such as hip fracture surgery, the timing of surgery is more contentious. A compromise needs to be made between allowing some time for correction of dehydration and physiological stabilisation and excessive delays, which may lead to an increase in the complications of recumbency. Published studies are conflicting, but in general surgery for hip fractures is recommended within two days of admission after initial correction of any hypovolaemia. Delays of more than two days increases morbidity from complications such as pressure sores, pneumonia, urinary tract infection and thromboembolism.

Acceptable reasons for delaying surgery are

- Anaemia (haemoglobin below 9 g/L)
- Dehydration or acute uraemia
- Severe electrolyte imbalance
- Uncontrolled diabetes
- Uncontrolled heart failure
- Correctable cardiac arrhythmia or tachycardia (e.g. atrial fibrillation rate > 100/min)
- Acute chest infection
- Exacerbation of chronic chest condition
- Correctable bleeding disorder.

Delaying surgery for lesser reasons should be resisted, as should delaying surgery for chronic conditions that cannot be improved.
Regional versus general anaesthesia

For many procedures anaesthesia may be achieved using one of two methods. General anaesthesia uses gaseous and intravenous drugs to achieve central neurological depression. The main alternative is regional anaesthesia in which drugs are injected into either the subarachnoid space (spinal anaesthesia), epidural space or around peripheral nerves. Other alternatives are a Biers block or direct injection of local anaesthetics at the operative site. Because of the potentially increased risk of adverse events with both general and regional anaesthesia in the elderly, the surgeon should always consider if the desired surgical procedure can be undertaken using a local block.

Most major orthopaedic procedures require either regional or general anaesthesia. Debate continues as to which method has the lowest risk of adverse events. A systematic review of randomised trials that have compared general with regional anaesthesia for all types of surgical procedures concluded that regional anaesthesia resulted in a lower operative mortality (2.1% versus 3.1%), reduced the risk of deep venous thrombosis (2.9% versus 4.7%), reduced pulmonary embolism (0.6% versus 1.4%), reduced myocardial infarction (0.9% versus 1.3%) and reduced postoperative pneumonia (3.1% versus 5.1%). Additional advantages for regional anaesthesia were reduced transfusion requirements, less respiratory failure and a reduced incidence of postoperative renal failure. Another systematic review restricted to randomised trials on hip fracture patients concluded there was a reduced early mortality with regional anaesthesia but no difference in mortality by three months. There was a tendency to a reduced incidence of thromboembolic complications, postoperative confusion and requirements for blood transfusion in the regional anaesthesia group. Possibly because of the smaller number of studies then the difference was not so marked as for the larger systematic review for all types of surgery.

Intra-operative care

Whichever anaesthetic method is chosen to reduce the risk of adverse cardiac events tachycardia and hypotension should be avoided at all costs. The heart rate should be maintained within 20% of the normal value and the haematocrit should be kept above 30%. A 20% incidence of myocardial infarction has been reported in patients who had a previous infarction and had surgery during which a 30% fall in blood pressure from the preoperative value occurred.

Postoperative care

The elderly deserve the same or even greater resources in the postoperative period as for younger patients. Age itself should be no bar to admission to intensive or high dependency care units. Some key aspects of postoperative care for the elderly include:

- Adequate pain control
- Discontinue intravenous lines and urinary catheters as soon as possible
- Early mobilisation and sitting out of bed
- Nutritional support as appropriate
- Planning for discharge home.

Pain control

Uncontrolled pain increases the risk of cardiac ischaemia, hypertension, tachycardia and hypoxia. Effective analgesia reduces pulmonary complications, adverse cardiac events, allows early mobilisation and reduces hospital stay. For the elderly early mobilisation reduces the risk of thromboembolic complications and other problems of recumbency. Unfortunately pain control after surgery (and before for traumatic conditions such as hip fracture) for elderly patients presents a dilemma for the physician. Adequate doses of drugs such as the opiates may control the pain but result in an increased risk of side effects in comparison to the younger patient. The elderly are more prone to sedation, respiratory depression and
hypotension secondary to opiates than younger patients. In addition the opiate requirement may be lower in the elderly than for a comparable procedure in a younger patient. Intravenous opiates also may take a longer time to become effective and a more careful titration of dose over a longer time period is needed if this method of administration is used.

Non-steroidal anti-inflammatory drugs have been advocated as an alternative to opiates. These drugs have a higher risk of side effects in the elderly notably gastrointestinal irritation and bleeding, renal impairment and disturbances of coagulation. These adverse effects on platelets are lower for those newer drugs which are selective inhibitors of cyclo-oxygenase type 2. However the full place for these drugs is still being evaluated, and they may be just as nephrotoxic as the older non-specific drugs.

Nerve blocks such as a femoral ‘three in one’ block, in which local anaesthesia is injected into the femoral sheath in the groin, may be used. Such blocks have been shown to be effective in controlling pain but as yet it has not been documented that this beneficial effect reduces the incidence of postoperative complications.

Newer developments include patient controlled epidural analgesia. This may be started at the time of hospital admission as has been reported in two randomised studies of hip fracture patients. Both studies documented a reduction in the occurrence of adverse cardiac events such as myocardial ischaemic and congestive cardiac failure in those who had the continuous epidural. Using a combination of opiates and local anaesthetics for patient controlled epidural analgesia reduces the occurrence of unwanted side effects such as respiratory depression from opiates and hypotension from local anaesthetics. Unfortunately confusional states or dementia preclude the use of patient controlled analgesic methods in many patients.

Parkinson’s disease

This disease is more common in the elderly and will be exacerbated by trauma and the stress of a surgical procedure. In addition most medications used to control the symptoms of Parkinson’s disease have a short half-life (1–3 h) and discontinuation of medication produces increased muscle rigidity. Furthermore many of these drugs may interact with those used in anaesthesia, and antidopaminergic drugs such as anti-emetics will exacerbate symptoms of Parkinson’s disease. During anaesthesia operative hypotension is more common from a reduced sympathetic tone. Additional anaesthetic problems include an increased risk of airway obstruction secondary to muscular dysfunction and an increased risk of aspiration. Sedatives and opioids increase these risks. The surgeon and anaesthetist need to be aware of these problems. The patient’s regular medication for control of Parkinson’s symptoms should be continued over the peri-operative period.

Mobilisation and Rehabilitation

The key to successful rehabilitation is early ambulation after surgery. Delayed ambulation is associated with increased incidence of pneumonia, urinary tract infection, thromboembolism, delirium, pressure sores and increased hospital stay. Keeping an elderly patient confined to bed generally means that they are unable to take adequate nutrition and muscle wasting will occur. Therefore the longer the patient is kept in bed the longer it will take to mobilise the patient. Generally it will not be possible to impose restrictions on elderly patients, such as weight bearing. Frail often confused elderly patients will not be able to comply with these restrictions, and the physician should question whether any such limits are justified. Other aspects of rehabilitation involve a multi-disciplinary approach with the assistance of occupational therapy, physiotherapy and social support services, to enable the patient to regain their independence.

Many elderly fear that surgery may result in either death or permanent disability. A clear explanation of the treatment and expected outcome is required to enable the patient to become motivated in recovering. This is also necessary for family and other carers to assist in the planning for the eventual discharge of the patient from hospital. Those who do not receive a clear treatment plan and expected recuperation times will become disillusioned and lose the will to recover.

The future

With the increasing life expectancy, the number of surgical procedures performed in the elderly will increase. Better understanding of the physiology of ageing should lead to better surgical care. Less invasive alternatives to conventional surgery may also improve the outcome for surgical conditions. More procedures will be undertaken under regional or local anaesthesia. Perhaps in the future with specialisation within orthopaedics. We shall see the training of orthopaedic surgeons with a specialist
interest and expertise in the treatment of orthopaedic and/or traumatic conditions in the elderly.

References

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