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REVIEW ARTICLE

Minimizing perioperative adverse events in the elderly†

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Elderly patients still have the highest postoperative mortality and morbidity rate in the adult surgical population. Preoperative clinical assessment to detect patients at high risk of post-operative events, and specific intraoperative and postoperative anaesthesia management are important to minimize postoperative adverse events in the elderly.

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Among the steadily increasing population of surgical patients aged 65 yr and older, the fastest growing sector is individuals of 85 yr or older.[149] As a result, greater numbers of patients are presenting for surgery with ageing-related, pre-existing conditions that place them at greater risk of an adverse outcome, such as cardiac or pulmonary disease or diabetes mellitus.[122] It is, therefore, not surprising that the elderly have the highest mortality rate in the adult surgical population.[108] Postoperative adverse effects on the cardiac, pulmonary, cerebral systems, and on cognitive function are the main concerns for elderly surgical patients who are at high risk. Recently some studies have focused on elderly surgical patients regarding the incidence of postoperative complications, predictors for developing postoperative complications, preoperative assessment and screening for elderly patients at high risk, and perioperative management. In this review, we document the incidence of postoperative adverse outcomes and discuss ways of improving peri-operative anaesthesia care for this vulnerable surgical population.

Anaesthesia- and surgery-related mortality

Incidence

Mortality associated with anaesthesia and surgery is defined as the death rate within 30 days of operation. Advances in anaesthetic/surgical technique and perioperative care have substantially reduced related mortality.[43 108] However, overall mortality in the general population remains at 1.2%,[108] compared with 2.2% in patients aged 60–69 yr,[108] 2.9% in those 70–79 yr,[108] 5.8–6.2% in patients over 80 yr,[43] and 8.4% in those over 90 yr.[69] Major surgery further increases elderly mortality; for example, emergency abdominal surgery results in a 9.7% mortality for patients over 80 yr,[79] thoracotomy in a 17% mortality for those over 70 yr,[20] and any major surgical procedure a 19.8% mortality in those over 90 yr.[2]

Predictive factors

The function capacity of organs reduces with ageing, resulting in decreased reserve and ability to endure stress.[75 114] Advanced age is, therefore, a significant risk factor for increased mortality.[43 108 114] Co-existing disease further depresses organ function and/or reserve, exacerbating risk.[75 108] For example, pre-existing hypertension, diabetes mellitus, or renal failure contributes to a higher incidence of perioperative myocardial infarction (MI) (5.1%), cardiac death (5.7%)[68] or ischaemia (12–17.7%).[30] Additional risk factors in the elderly[2 43 69 108] (Table 1) include the need for emergency surgery,[2 69] major surgical procedures, ASA physical status III or IV, and poor nutritional status.

One study of 80-yr-old patients concluded that MI was the leading cause of postoperative death.[43] Pre-existing cardiac disease predisposes substantial perioperative risk.[10 30 71 86 109] Patients with coronary artery disease have a 4.1% incidence of perioperative MI,[7] and a 5.5%

† This review is accompanied by Editorial II.

Table 1 Risk factors for postoperative mortality in elderly surgical patients. *MET indicates metabolic equivalent

ASA physical status	III and IV
Surgical procedures	Major and/or emergency procedures
Co-existing disease	Cardiac, pulmonary disease, diabetes mellitus, liver, and renal impairment
Functional status	<1–4 MET*
Nutritional status	Poor, albumin <35%, anaemia
Place of residence	Not living with family
Ambulatory status	Bedridden

rate of reinfarction if older than 65 yr (compared with 3.5–4.2% rate of reinfarction in the general population).[129] Ischaemic episodes reportedly occur in 24–41% of patients with coronary artery disease during the first week after major non-cardiac surgery.[30 95 96] Ischaemic heart disease combined with previous MI produces a higher incidence of postoperative MI in elderly patients than in younger patients with the same conditions.[10 129] In the general elderly population over 60 yr, the incidence of MI after non-cardiac surgery is reported to be 0.1–0.15%,[108 109] with mortality as high as 50–83%.[109] Tables 2 and 3 list the clinical predictors of increased perioperative cardiovascular risk[47] and the cardiac risk stratification index for non-cardiac surgical procedures,[47] respectively, for the general population.

The respiratory mortality ranged from 0–0.6% depending on the surgical sites and the presence of pulmonary risk factors.[18 105 134] Aspiration during anaesthesia had a high mortality of 5%.[105] The mortality of pulmonary embolism was reported from 0.03–0.64% in elderly patients who underwent incontinence surgery and total hip replacement surgery respectively.[5 133] Risk factors for developing pulmonary embolism include age, malignancy, obesity, and the type of surgery performed.[5 6 127 133] Recent studies demonstrated that prophylactic low dose aspirin or low dose low molecular weight heparin in high risk elderly surgical patients are effective and safe to prevent or decrease the morbidity or mortality of deep venous thrombosis (DVT) and pulmonary embolism.[5 6 127] Neuraxial block can reduce the odds of pulmonary embolism by 55% and deep vein thrombosis by 44%.[120] The Pulmonary Embolism Prevention Trial Collaborative Group recently reported that aspirin reduced the morbidity and mortality of DVT and pulmonary embolism by 30% with a slight increase in gastrointestinal bleeding of lesser severity in elderly patients undergoing surgery for hip fracture.[5]

The cerebrovascular mortality was 0.05% in elderly patients who underwent incontinence surgery. Perioperatively, the period of greatest risk appears to be the postoperative period.[108] It is the most physiologically stressful, with major changes in adrenergic activity, body temperature, pulmonary function, fluid balance, and perception of pain.[95] These changes cause tachycardia and hypertension, increase imbalance in oxygen supply and demand, and incur cardiac ischaemia.[96 109] Most of the pulmonary emboli occurred during the surgical procedure or within 7 days of surgery.[127]

Table 2 Clinical predictors of increased perioperative cardiovascular risk. ECG indicates electrocardiogram. *The American College of Cardiology National Database Library defines recent MI as greater that 7 days but less than or equal to 1 month (30 days). †May include 'stable' angina in patients who are unusually sedentary. ‡From reference 25 reproduced with permission. From reference 47 reproduced with permission

Major
Unstable coronary syndromes
●Recent myocardial infarction* with evidence of important ischaemic risk by clinical symptoms or non-invasive study
●Unstable or severe angina† (Canadian Class III or IV)‡
Decompensated congestive heart failure
Significant arrhythmias
●High-grade atrioventricular block
●Symptomatic ventricular arrhythmias in the presence of underlying heart disease
●Supraventricular arrhythmias with uncontrolled ventricular rate
Severe valvular desease
Intermediate
Mild angina pectoris (Canadian Class I or II)
Prior myocardial infarction by history or pathological Q waves
Compensated or prior congestive heart failure
Diabetes mellitus
Minor
Advanced age
Abnormal ECG (left ventricular hypertrophy, left bundle branch block, ST–T abnormalities)
Rhythm other than sinus (e.g. atrial fibrillation)
Low functional capacity (e.g. inability to climb one flight of stairs with bag of groceries)
History of stroke
Uncontrolled systemic hypertension

Accordingly, to decrease perioperative risk in the elderly population requires rigorous preoperative assessment of organ function and reserve, good intraoperative control of concomitant disorders such as coronary artery disease, ischaemic heart disease, hypertension, chronic obstructive pulmonary disease (COPD) or diabetes mellitus, and vigilant postoperative monitoring and pain management. For example, patient-controlled analgesia/epidural analgesia (PCA/PCEA) can decrease postoperative myocardial ischaemia.[15 124]

Postoperative cardiac complications

Physiological changes, incidence rate, and predictive factors

Ageing affects cardiac function in many ways. Stiffening of large arteries increases afterload on the heart, while myocardial stiffening impairs early diastolic filling.[53 114] The beta-adrenergic responsiveness of the heart decreases. Contractility does not change (despite prolongation in duration[26]), but the resulting increase in end-diastolic volume plays an important role in preserving maximal cardiac output during exercise. Conduction abnormalities and bradyarrhythmias are more prevalent in the elderly and hypertension is common, potentially contributing to ischaemic heart disease and sudden cardiac death.

Table 3 Cardiac risk stratification for non-cardiac surgical procedures. Risk=combined incidence of cardiac death and non-fatal myocardial infarction. †Patients in this group do not generally require further preoperative cardiac testing. From reference 47 reproduced with permission

High risk (reported cardiac risk often more that 5%)
Emergency major operations, particularly in the elderly
Aortic and other major vascular surgery
Peripheral vascular surgery
Anticipated prolonged surgical procedures associated with large fluid shifts or blood loss
Intermediate risk (reported cardiac risk generally less than 5%)
Carotid endarterectomy
Head and neck surgery
Intraperitoneal and intrathoracic surgery
Orthopaedic surgery
Prostate surgery
Low risk (reported cardiac risk often more that 1%)†
Endoscopic procedure
Superfical procedure
Cataract removal
Breast surgery

Table 4 Anaesthesia management for elderly patients undergoing major surgery

Preoperative assessment for identifying high risk patients
Careful history
Physical examination
Twelve-lead ECG
Functional status assessment
Nutrition assessment
Preoperative preparation
Effective control of co-existing disease
Stopped smoking for 8 weeks
Training in cough and lung expansion techniques
Chest physiotherapy for elderly at risk of postoperative pulmonary complications
Correct of malnutrition
Routine precautions for major surgery
Temperature monitor and control
Ripple mattress
DVT prophylaxis
Intra-arterial pressure monitoring
Haemodynamic stability
Combination of anaesthetic and vasopressor, beta-blockers or vasodilators
Avoid fluid overload
Quick recovery from anaesthesia
Use short-acting anaesthetic agents
Combine epidural anaesthesia and GA for major abdominal and thoracic surgery
Antagonize neuromuscular blocking drugs
Postoperative period
Prevent hypoxaemia
Supplemental oxygen, reversal of neuromuscular blocking drugs
Prevent hypothermia
Keep warm perioperatively
Effective postoperative pain control
Multimodal analgesia

Antihypertensive treatment appears to reduce cardiovascular mortality and heart failure.[148]

Silent ischaemia and unrecognized MI also occur.[70 153] Elderly patients at high risk for these conditions can be identified preoperatively by ambulatory electrocardiography and/or exercise or pharmacological stress testing.[70 110 153]

The most common cardiac complications associated with surgery in elderly patients are MI and myocardial ischaemia. Infarction usually occurs during the first 3 days after surgery, particularly on the first postoperative day. Most postoperative MIs are silent and have non-Q wave characteristics.[109 129] Postoperative pain control combined with residual anaesthetic effects is responsible for the silent nature of an MI, making them difficult to detect and their precise onset difficult to determine.[7 10 86 109 129] Monitoring for specific ECG changes (S–T elevation and Q wave) accompanied by elevated CK, CK-MB isoenzyme and troponin T and I levels enables diagnosis. These data also permit identification of an MI as definite, probable or possible.[10 30] Measurement of troponin T and I is replacing the use of CK, CK-MB levels to detect minor and early cardiac cell damage because of the greater sensitivity and specificity of these markers, especially in patients undergoing non-cardiac surgery with skeletal muscle injury, and those with chronic renal disease.[3] Combined with measurement of myoglobin levels or detection of prolonged ST–T change, troponin levels can be an accurate indicator allowing early detection of high risk of postoperative MI.[3] The specificity of cardiac troponin I for detection of MI (99%) was significantly different from that of MB creatine kinase (81%) ($P<0.005$).[3]

Patients at high risk of myocardial ischaemia should be monitored intraoperatively and for 3 days postoperatively for ST segment depression, a specific marker of ischaemic morbidity.[72] As with MI, troponin levels are a more sensitive and earlier indicator of myocardial ischaemia than CK levels or ST–T wave change,[10] and should be measured in patients who are at high risk or demonstrate ECG or haemodynamic evidence of cardiovascular dysfunction.[10]

Perioperative management

The principles underlying perioperative anaesthetic management of elderly surgical patients are provided in Table 4.

Preoperative cardiac assessment

Many tools are available for preoperative cardiac evaluation. Preoperative assessment of cardiac functional capacity via the estimated energy requirements for various activities (Table 5) often is adequate to identify elderly patients with good exercise tolerance.[4 47] Goldman's cardiac risk profile (Tables 6 and 7) can be used to predict morbidity/mortality in patients undergoing non-cardiac surgery.[62] For elderly patients with documented or suspected coronary artery disease, Potyk has developed a relatively easy stepwise guide that integrates patient risk into anaesthetic and surgical management strategies (Fig. 1).[113]

Clinical markers of active coronary disease can be ascertained from a careful history and functional capacity

Table 5 Estimated energy requirement for various activities. MET indicates metabolic equivalent. From reference 47 reproduced with permission

1 MET	Can you take care of yourself? Eat, dress, or use the toilet? Walk indoors around the house? Walk a block or two on level ground at 2–3 m.p.h. or 3.2–4.8 km h^{-1}? Do light work around the house like dusting or washing dishes?
4 METs	Climb a flight of stairs or walk up a hill? Walk on level ground at 4 m.p.h. or 6.4 km h^{-1}? Run a short distance? Do heavy work around the house like scrubbing floors or lifting, or moving heavy furniture? Participate in moderate recreational activities like golf, bowling, dancing, doubles tennis, or throwing a baseball or football?
>10 METs	Participate in strenuous sports like swimming, singles tennis, football, basketball, or skiing?

Table 6 Cardiac risk index. From reference 62 reproduced with permission

Risk category	Points
Aged >70 yr	5
Myocardial infarction within last 6 months	10
S_3 gallop or jugular venous distension	11
Significant valvular stenosis	3
Rhythm other than sinus or premature atrial contractions	7
Premature ventricular contractions >5/min	7
Poor general medical condition	3
Abdominal or thoracic aorta surgery	3
Emergency surgery	4
Total	53

Table 7 Goldman multifactorial risk assessment. From reference 62 reproduced with permission

Risk class	Points	Risk	
		Complication (%)	Mortality (%)
I	0–5	0.7	0.2
II	6–12	5.0	2.0
III	13–25	11	2.0
IV	>26	22	56

assessment, and then used to evaluate the level of risk and guide preoperative cardiac testing. For example, patients with minor clinical predictors appear to have low risk for coronary stenosis.[110 153] Similarly, assessment using the American College of Cardiologists (ACC)/American Heart Association (AHA) Guidelines based on clinical markers, before coronary evaluation and treatment, cardiac functional capacity, and type of surgery dramatically decreases the number of preoperative cardiac tests performed.[47] Clinical assessment using these guidelines also has been shown to reduce the costs of preoperative evaluation and to improve cardiac outcome in vascular surgery patients.[15]

Twelve-lead ECG is a screening test for all elderly patients. Left ventricular hypertrophy or ST segment depression less than 0.5 mm are independent factors associated with adverse cardiac events during major vascular surgery.[86] Clinically stable elderly patients undergoing low or intermediate risk surgical procedures usually require no further preoperative testing other than 12-lead ECG.[153] Ambulatory ECG can be used to identify patients with arrhythmias and silent ischaemic episodes,[47] but the use of these data to predict perioperative cardiac events remains controversial.[29 70]

The use of advanced cardiac tests to evaluate risk should be considered primarily when anaesthetic and surgical management are likely to depend on test results. For example, conduction abnormalities and supraventricular and ventricular arrhythmias are not uncommon in elderly patients,[62] and the underlying cardiac disease must be investigated before surgical treatment. In patients with second-degree (Mobiz II) or third-degree (complete) atrioventricular block, insertion of a temporary or permanent pacemaker will be necessary before elective surgery.[47] Patients with cardiac murmurs should be referred for echocardiographic examination before elective surgery to detect aortic stenosis or regurgitation or mitral stenosis, common conditions in the elderly population.[47] Symptomatic or severe aortic stenosis must be treated by aortic valve replacement before non-cardiac major surgery.[47] Patients with aortic regurgitation should receive some form of preoperative prophylaxis for endocarditis.[47] Preoperative dobutamine stress echocardiography (DTS) or radianuclide ventriculography (RVG) screening for vascular surgical patients at high risk is unnecessary.[68 126]

Clinically unstable elderly patients with ischaemic heart disease or severe coronary artery stenosis placing them at high risk of perioperative MI should be referred for angiography and prophylactic coronary revascularization[126] before undergoing high risk surgery. Indications for coronary angiography are defined by the ACC/AHA.[47]

Exercise stress testing provides an objective measure of functional capacity and information about preoperative myocardial ischaemia or cardiac arrhythmias. It is recommended by the ACC/AHA as the first non-invasive test for ambulatory patients.[47] For patients at intermediate risk scheduled for elective high risk surgical procedures such as major vascular surgery, the decision to perform exercise stress testing depends on the patient's functional status, and the risk associated with the specific procedure. Patients aged 65 yr or older who are able to perform at least 2 min of supine bicycle exercise, raising the heart rate above 99 beats min^{-1}, are at low risk for perioperative cardiac complications.[60] For elderly patients who cannot undergo exercise stress testing because of a bedridden condition, claudication or lower extremity pain,[110] dipyridamole thallium scintigraphy, or dopamine stress echocardiography can provide the essential information.[110] Intermediate-risk patients undergoing surgery with evidence of cardiac ischaemia will require postoperative intensive care and intensive monitoring. Detection of severe cardiac ischaemia mandates

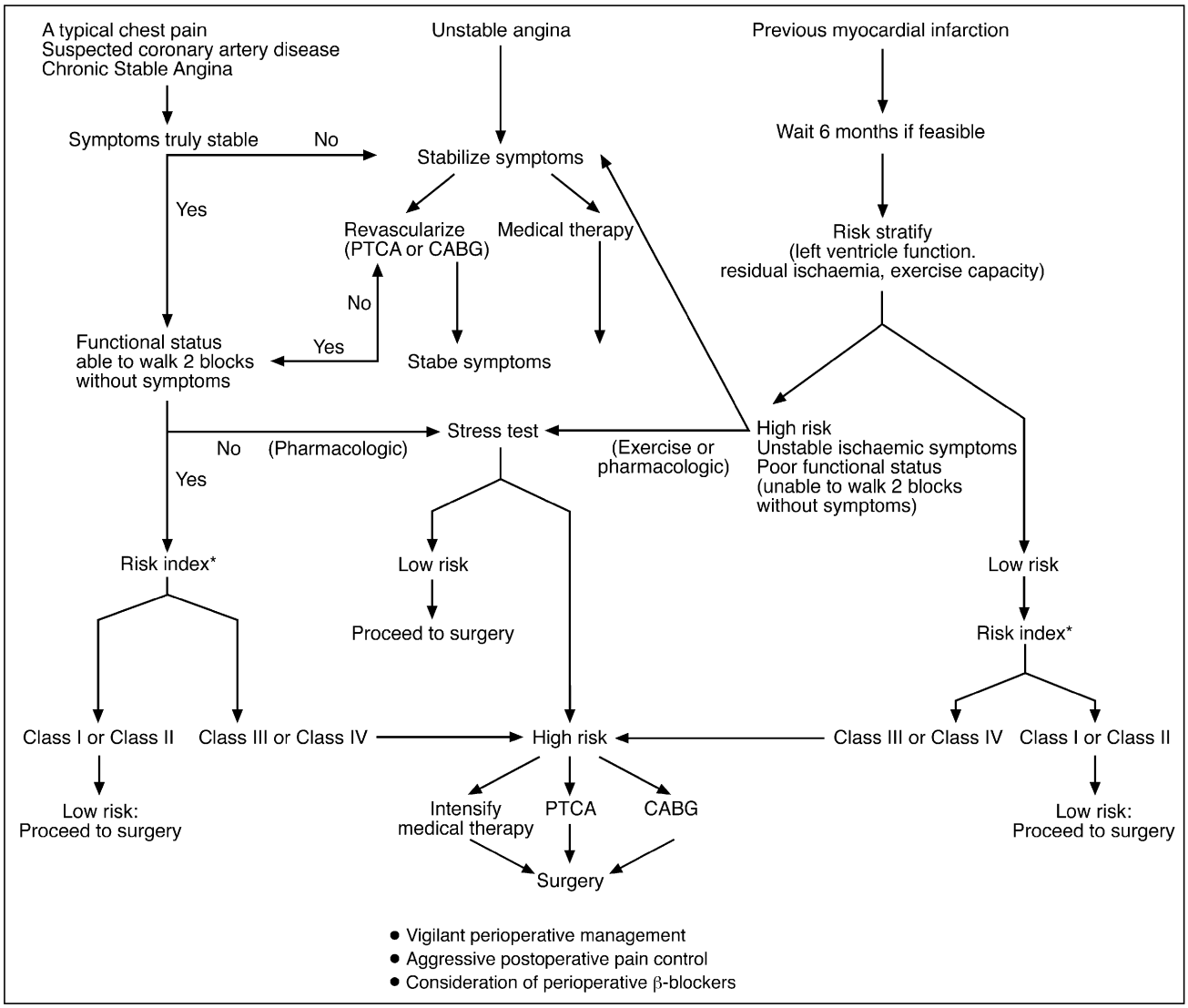


Fig 1 Approach to patients with known or suspected coronary artery disease undergoing elective surgery. For all patients undergoing surgery, antianginal medications should be taken with a sip of water on the morning of surgery; aspirin therapy should be discontinued for 7 days; and diuretic therapy should be discontinued on the morning of surgery. * indicates preoperative risk indexes described by Goldman *et al.* and modified by Detsky *et al.* PTCA, percutaneous transluminal coronary angioplasty; CABG, coronary artery bypass grafting. From reference 110, reproduced with permission.

cancellation of surgery or performance of a less invasive elective procedure.

Anaesthetic management

Perioperative anaesthetic management varies according to the needs of the patient and of the surgical procedure. In elderly patients, the overall goals are to provide an appropriate operative environment, preserve myocardial and haemodynamic function, control for the effects of pre-existing disease on surgery, and avoid adverse perioperative events such as myocardial ischaemia or infarction.

General and regional anaesthesia (epidural or spinal) result in comparable short- and long-term cardiac morbidity and mortality in the elderly following peripheral vascular surgery, total hip arthroplasty, or transurethral prostate resection.[32 40 45 48] Thoracic epidural anaesthesia in vascular surgery, coronary artery bypass grafting, and abdominal surgical procedure appears to provide greater benefit than the other techniques: it attenuates the perioperative stress response, improves myocardial oxygenation, reduces the release of troponin T, and effectively controls refractory unstable angina pectoris as a result of sympatholysis.[77 89 104] Some studies also report that epidural anaesthesia decreases blood loss during total hip arthroplasty, prevents intraoperative hypertension in patients with intraoperative ischaemia, and results in a lower incidence of reoperation for inadequate tissue perfusion during vascular surgery.[32 40 120] Perioperative infusion of bupivacaine and

fentanyl significantly reduced the amount of perioperative myocardial ischaemia in elderly patients with traumatic hip fracture.[124] Local anaesthesia caused fewer ischaemic episodes than general anaesthesia in high risk elderly patients who underwent cataract surgery.[61] A recent systemic review on 141 trials including 9559 patients reported that overall mortality and the number of MI were reduced by one-third in patients who were allocated to neuraxial block.[120] These advantages strongly support the use of regional anaesthesia and analgesia for elderly patients undergoing surgery.[61 73 120 124]

Maintaining intraoperative and postoperative haemodynamic stability is crucial to ensuring a balance between myocardial oxygen delivery and oxygen demand in the elderly.[48] It is prudent to maintain perioperative heart rate and arterial pressure within 20% of the normal awake value and the haematocrit should be maintained above 30%.[131] Hypertensive patients are prone to wide fluctuations in these parameters during surgery, especially at the induction of anaesthesia and tracheal extubation, because of decreased intravascular fluid volume and baroreflex sensitivity.[107] Hypertension detected on admission to hospital is not uncommon in elderly patients, and elevated systolic arterial pressure (treated or untreated) and untreated mild hypertension on admission are reported to increase the incidence of silent cardiac ischaemia.[70] For example, patients over 70 yr with hypertension and diabetes mellitus undergoing surgery who have intraoperative increases in arterial pressure of more than 20 mm Hg lasting 15 min or more have a higher incidence of postoperative ischaemic cardiac complications than their counterparts.[30] These patients also are likely to display an exaggerated pressor response to tracheal intubation and to require vasodilators to control intraoperative hypertensive episodes.[16]

Antihypertensive therapy should be continued on the day of surgery, with the exception of drugs such as reserpine. Clonidine or a beta-blocking drug should be given preoperatively to patients with mild or moderate hypertension or admission systolic hypertension[107]. In patients over 50 yr old with essential hypertension undergoing intestinal or orthopaedic surgery, perioperative administration of clonidine 6 mg kg^{-1} orally 120 min before anaesthesia and 3 mg kg^{-1} i.v. over the final hour of surgery appears to reduce sympathetic output, increase sensitivity to phenylephrine, and improve circulatory stability.[107] In contrast, perioperative discontinuation of long-term clonidine or beta-blocker therapy can cause rebound hypertension,[47] so should be carefully evaluated. Severe hypertension (e.g. diastolic arterial pressure $\geqslant$110 mm Hg) should be well controlled before elective surgery after 2 weeks effective antihypertensive therapy.[51]

Long-term beta-blocker therapy is not popular for elderly hypertensive patients with MI because of its limited effectiveness in the presence of diabetes, asthma or heart failure, and unacceptable side effects such as bradycardia, hypotension, cardio-inhibitory and vasopressor carotid sinus syndromes, depression, fatigue, and reduced libido.[83] Perioperatively, the primary side effects of beta-blocker administration are hypotension, bradycardia, and bronchospasm,[145] conditions easily detected by routine perioperative monitoring. Moreover, short-term perioperative use of beta-blocking drugs does not appear to have a harmful effect: in one study of beta-blocker *vs* placebo, the incidence of systemic arterial pressure greater than 80–90 mm Hg and/or heart rate greater than 40 beats min^{-1} was rare and did not differ between the two groups.[145] Therefore, assuming no contraindications, prophylactic beta-blocker therapy may be useful in avoiding adverse cardiac outcome in elderly hypertensive patients undergoing major surgery at intermediate or high risk of a negative outcome.[47] Further randomized controlled trials in elderly patients need to be carried out.

Risk of myocardial ischaemia and mortality can be reduced in patients at high risk of coronary artery disease by administration of atenolol.[145] In two recent prospective randomized studies, atenolol was given intravenously before induction of anaesthesia and every 12 h postoperatively until patients could tolerate oral administration, which continued until postoperative day 7 or the day of discharge, whichever came first. This regimen resulted in a 50% lower incidence of myocardial ischaemia during the first postoperative 48 h, a 40% lower incidence during the first postoperative week, and reduced risk for death at 2 yr.[145]

Risk of perioperative myocardial ischaemia increases in the presence of tachycardia. One study has reported that intraoperative tachycardia resulted in postoperative reinfarction in 14% of patients with previous MI.[129] Continuous perioperative infusion of esmolol appears to be effective in controlling heart rate below the ischaemic threshold, thereby reducing the incidence of postoperative myocardial ischaemia in patients with significant preoperative cardiac ischaemia who are undergoing vascular surgery.[115]

Nitroglycerin also reduces the incidence of myocardial ischaemia.[44] Perioperative use is recommended for patients previously taking nitroglycerin to control ischaemic signs or symptoms or those who develop symptoms of ischaemia postoperatively.[47] Further study is needed to define the use of nitroglycerin in elderly patients who have hypertension with bradycardia.

That intraoperative hypotension is a risk factor for postoperative myocardial ischaemia remains controversial.[10] Preoperative hypertensive patients appear more likely to develop intraoperative hypotension than non-hypertensive patients. In one study, intraoperative hypotension (30% decrease from pre-induction arterial pressure) resulted in perioperative reinfarction in 20% of patients with previous MI.[129] Another study of patients undergoing non-cardiac surgery with hypertension and diabetes mellitus reported ischaemic cardiac complications in 19% of patients who had intraoperative decreases in MAP greater than 20 mm Hg lasting 60 min or more. Decreases greater than 20 mm Hg

lasting 5–59 min increased the incidence of postoperative ischaemic cardiac complications.[30] A third study of the incidence of postoperative myocardial infarction in patients with ischaemic heart disease undergoing non-cardiac surgery found no significant difference in intraoperative hypotensive episodes between patients with and without MI.[10] One current study reported that deliberate hypotension to MAP of 45–55 mm Hg induced by epidural anaesthesia was safe for elderly patients over 70 or 50–69 yr with co-existing cardiac disease, hypertension, or diabetes mellitus who underwent total hip replacement. Patients were given supplemental oxygen, continuous haemodynamic monitoring, and sufficient i.v. infusion to avoid hypovolaemia. The postoperative cardiovascular complication rate was 6% and postoperative delirium was 9% in this patient group.[152]

However, it seems prudent to maintain arterial pressure within 20% of the awake value. Efforts should be made to avoid intraoperative hypotension or to shorten the duration of hypotension when it occurs.

Postoperative respiratory complications in elderly patients

Physiological changes, incidence rate, and predictive factors

COPD, pneumonia, and sleep apnoea are common in the elderly. Closing capacity increases with age,[24] and forced expiratory volume in 1 s (FEV_1) declines 8–10% each decade because of decreased compliance of the pulmonary system and of muscle power.[82] Arterial blood oxygen tension decreases progressively with age-induced ventilation/perfusion mismatch, diffusion block, and anatomial shunt.[132]

Postoperatively, pulmonary complications occur in 2.1–10.2% of elderly patients[108] and include pneumonia, hypoxaemia, hypoventilation, and atelectasis, all of which prolong intensive care unit stay and increase elderly mortality. Clinical predictors of adverse pulmonary outcome include the site of surgery, duration and type of anaesthesia, COPD, asthma, preoperative hypersecretion of mucus, and chest deformation.[80 81 100 144] The most significant of these is the site of surgery.[81 144] Obesity and older age are no longer considered risk factors.[130] Chronic smoking within 1 month preoperatively increases risk approximately sixfold.[18]

The most important preoperative assessment instruments remain a detailed history, clinical examination, and evaluation of functional status.[81] The presence of dyspnoea, smoking, coughing, and wheezing should be addressed in the history.[130] Pulmonary function tests such as the ability to climb several flights of stairs can offer as much predictive value as spirometric assessment of pulmonary function.[150] For example, the results can be used to determine whether to cancel a proposed surgery or perform a less invasive procedure conferring less risk, such as laparoscopy, to decrease the likelihood of adverse outcome.[130] Preoperative spirometry is useful in identifying patients at risk for adverse outcome following thoracic or upper abdominal surgery.[130] Emergency, thoracic, and abdominal surgery have the highest pulmonary complication rates.[81 144]

Functional predictors include increased residual volume, and decreased FEV_1 and single-breath transfer factor for carbon monoxide (TL, CO, SB).[13] A decrease in the ratio of FEV_1 tovital capacity (FEV_1/VC) and in Pa_{O_2} are risk factors in patients undergoing vascular surgery.[144] For patients with COPD undergoing bilateral volume reduction surgery, the inability to walk at least 200 m in 6 min before or after pulmonary rehabilitation or a resting room air Pa_{CO_2} $\geqslant$45 mm Hg result in increased postoperative mortality and prolonged hospital stay (>21 days).[134] Aspiration as a result of significant impariment of protective laryngeal reflexes function can also cause severe postoperative pulmonary deterioration in elderly patients.[105]

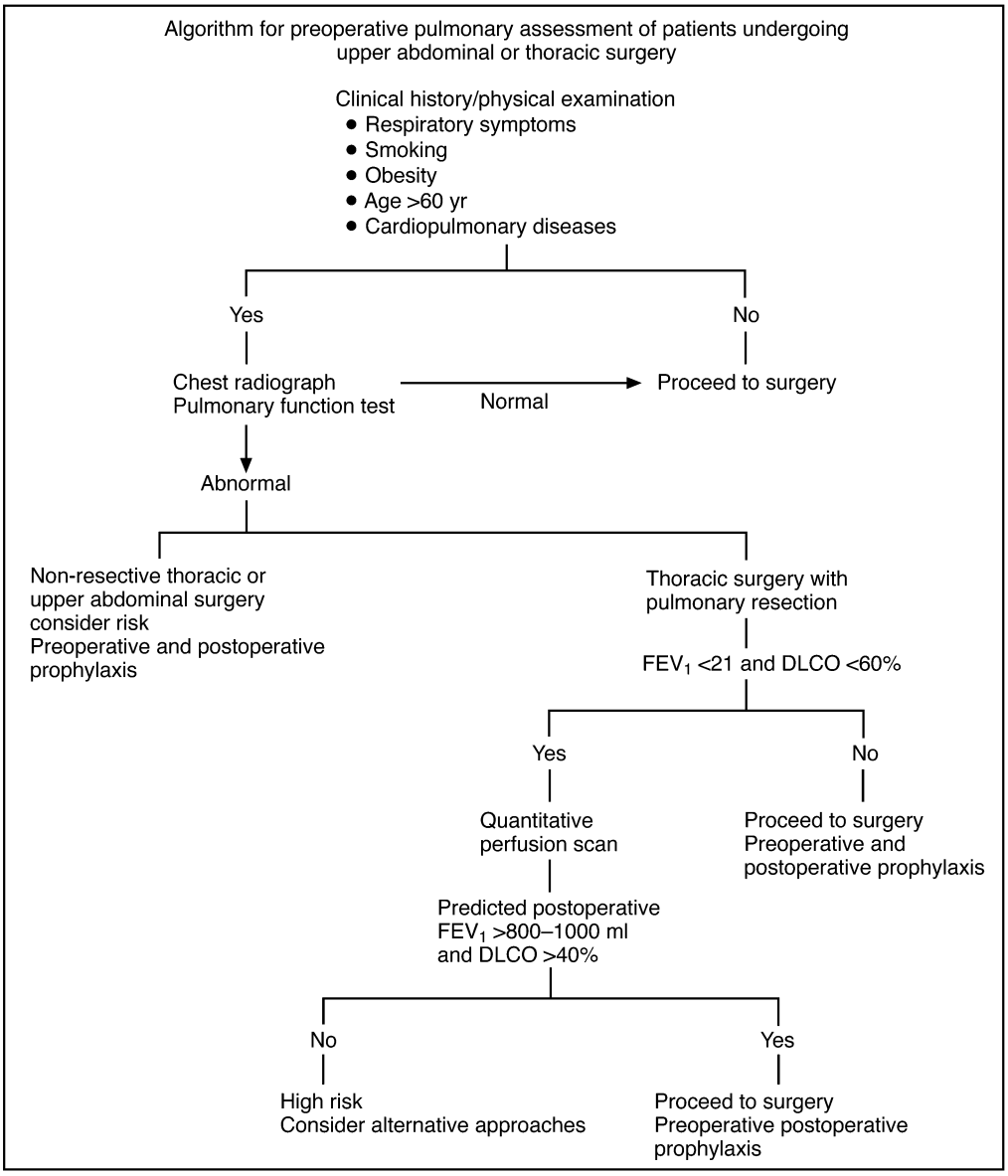
Perioperative management

Preoperative preparation

Patients at high risk of pulmonary complications require some preparation for surgery to minimize risk (Table 4). An algorithm exists for preoperative pulmonary assessment of patients undergoing upper abdominal or thoracic surgery (Fig. 2).[80] Patients who smoke cigarettes should quit at least 8 weeks before surgery to minimize high airway reactivity and risk of bronchospastic obstruction of the airway, mucus trapping, and regional atelectasis.[18 130] High risk elderly patients should be trained in forced cough and lung expansion techniques before surgery, as well as in how to cooperate with the ventilator to avoid discomfort during postoperative ventilation. Patients with COPD should receive preventive therapy with mucolytic and bronchodilating agents.[64] Prophylactic ventilation, however, is ineffective in avoiding pulmonary complications in high risk elderly patients undergoing major, elective abdominal aortic reconstruction.[128] Perioperative chest physical therapy can decrease the incidence of postoperative pulmonary complications,[28] but pulmonary infection should be well controlled before surgery.[64]

Anaesthesia technique

Anaesthesia has profound effects on pulmonary function and gas exchange, resulting in decreased functional reserve capacity (FRC), increased closing volume (CV), and impaired hypoxic pulmonary vasoconstricton (HPV). Regional anaesthesia confers significantly lower risk of postoperative hypoxaemia.[100 120] Regional anaesthesia also is preferred for transurethral resection of the prostate (TURP), because it reduces the risk of pulmonary oedema,



From reference 80. Reproduced with permission

Fig 2 Algorithm for preoperative pulmonary assessment of patients undergoing upper abdominal or thoracic surgery.

decreases blood loss, and permits early detection of any change in mental status.[8] Spinal anaesthesia reduces central venous pressure, potentially resulting in greater absorption of irrigating fluid than general anaesthesia.[59] Epidural analgesia may reduce the incidence of postoperative atelectasis and pulmonary infection,[11 120] and, relative to general anaesthesia, epidural anaesthesia appears to reduce significantly the incidence of postoperative pulmonary complications in 80-yr-old patients.[139] The combination of general anaesthesia and intra- and postoperative epidural analgesia reportedly decreases the incidence of respiratory complications in patients undergoing abdominothoracic oesophagectomy and improves the rate of recovery, as indicated by early extubation and shorter ICU and hospital stay.[21 120] However, avoiding general anaesthesia with tracheal intubation may reduce the risk of postoperative bronchospasm.

Postoperatively, the residual effects of anaesthetic agents, prolonged effects of neuromuscular blocking drugs, and post-surgical pain can contribute to pulmonary complications. Postoperative hypoxaemia is common,[100] as is respiratory depression, which a survey of 198 103 anaesthetics has cited as the most common cause of postoperative death and coma attributable to anaesthesia.[135] Almost all patients surveys received opioid analgesics and neuromuscular blocking drugs for which antagonists were not administered.[135] Similarly, risk of a critical event appears to increase with the combined use of opioid premedication, intraoperative fentanyl greater than 2.0 μg kg^{-1} h^{-1}, and neuromuscular

blocking drugs.[43] Risk also increases in the presence of residual pancuronium-induced block.[17] Applying these data to elderly patients, it is important to remember that: (1) the perioperative opioid requirement for the elderly is lower than that of younger patients,[50] (2) short-, or intermediate-acting neuromuscular blocking drugs are to be used, and (3) antagonists should be given to reverse residual neuromuscular blocking drugs effects. In addition, supplemental oxygen should be given by facemask during awaking from anaesthesia, transfer to the post-anaesthesia care unit, and for several days postoperatively to prevent late nocturnal hypoxaemia.[121]

Fluid replacement

Perioperative fluid replacement must be managed carefully in elderly patients to prevent the development of postoperative pulmonary oedema as a result of age-related prolonged extracellular water (ECW) expansion. Compared with 5 days for young patients with sepsis, elderly septic patients require 10 days to excrete overexpanded ECW.[31] The elderly also require more prolonged inotropic and ventilatory support.[31] Renal function deteriorates with age with reduction in renal plasma flow, glomerular filtration rate, and altered renal tubular function. The renal ability to balance sodium and water is impaired in elderly patients as a result of low plasma renin activity, urinary and blood aldosterone levels, and decreased response to ADH.[131] Urine output monitoring and pulmonary artery catheterization are more valuable to guide fluid therapy in elderly patients than in young patients[131]. Fluid replacement should be controlled within normal maintenance levels, and vasoconstrictors, inotropic drugs, and small colloid infusions should be used to manage hypotensive episodes in elderly patients with emphysema or those undergoing lobectomy, pneumonectomy, and lung volume reduction procedures.[38] In the presence of cardiac or renal disease, i.v. fluids should be cautiously administered in elderly patients undergoing TURP. To prevent the TURP syndrome, plasma sodium levels must be monitored closely during this procedure. Another method is to regularly measure breath ethanol by irrigating with an ethanol containing glycine solution.

Postoperative cerebrovascular complications

Physiological changes, incidence rate, and predictive factors

Ageing is accompanied by a progressive loss of neurones in the brain and a decline in grey-matter tissue.[156] In addition, neurotransmitter molecules and receptors for dopamine and catecholamines are reduced in number. Vision, hearing, taste, and touch/sensation are compromised.[147] The threshold for pain increases, but this does not alter the need for perioperative analgesia in the elderly because the perceived severity of pain is strongly influenced by intense emotional and psychological factors.[67] Cognitive function declines progressively,[78] and co-existing disease accelerates this process. The autonomic reflex responses for maintaining homeostasis,[37] thermoregulation,[27] laryngeal reflex activity, and overall baroreflex responsiveness are significantly impaired.[111] Regional cerebral blood flow (rCBF) in the parietal, temporo-parietal, and temporal cortex decreases, particularly in the presence of carotid atherosclerosis[35].

Stroke is defined as a focal neurological deficit having a sudden onset and persisting for longer than 24 h. Risk factors for stroke in elderly patients include hypertension, atherosclerosis, physical inactivity, compromised cerebral vessel wall integrity, co-existing cerebrovascular and/or ischaemic heart disease, carotid occlusion, peripheral vascular disease, diabetes mellitus, and intraoperative haemodynamic instability (Table 8).[154] The most prevalent of these is hypertension, control of which can safely and effectively decrease elderly cerebrovascular morbidity and mortality.[14] Most published stroke rates reflect outcome of vascular or coronary artery bypass graft surgery. One recent study of elderly women undergoing surgery to treat incontinence reported a 0.3% cerebrovascular accident rate.[133] The highest incidence of ischaemic stroke appears to be associated with previous cerebrovascular disease, COPD and previous vascular disease (PVD), which confer a thirteenfold, ninefold, and eightfold increase in risk, respectively.[88]

Perioperative management

Preoperative history detailing neurological symptoms and physical examination for carotid bruits should be performed routinely in elderly patients undergoing neurological as well as other major surgical procedures. Preoperative carotid scanning in patients with these symptoms or signs can identify those at high risk for adverse outcome following coronary artery bypass graft surgery and/or vascular surgery.[41] For patients who have carotid bruits, additional testing is essential to detect the severity of the carotid stenosis. The overall principles of anaesthetic management for neurological procedures in the elderly are listed in Table 4.

Carotid endarterectomy may be indicated to prevent stroke in elderly patients who have transient ischaemia or asymptomatic stenosis greater than 60% of the diameter of the internal carotid artery.[12] Although carotid endarterectomy has a higher incidence of stroke than any other non-cardiac surgical procedure,[12 133] elderly patients appear to be able to tolerate carotid endarterectomy without increased risk of postoperative stroke and death.[12] Regional anaesthesia may be preferred for carotid endarterectomy because it permits reliable cerebral monitoring without the use of electroencephalography and results in fewer postoperative complications.[52] However, general anaesthesia facilitates control of arterial blood pressure, ventilation, and oxygenation. In addition, transcranial Doppler monitoring can be

Table 8 Risk factors for postoperative stroke in elderly

Preoperative factors:	Pre-existing cerebrovascular disease
	Ischaemic cardiac disease
	Atherosclerosis
	Carotid occlusion
	Preoperative vascular disease
	Hypertension
	Diabetes mellitus
	Physical inactivity
Intraoperative and postoperative factors	Haemodynamic instability
	Hypoxaemia

used during general anaesthesia to assess cerebral perfusion, detect intraoperative emboli, and prevent stroke.[58] Cerebral protection during carotid endarterectomy is achieved with the use of hypothermia, barbiturate drugs, and induced hypertension. Perioperative control of systemic arterial pressure also is important because both hypertension and hypotension predispose to neurological morbidity.[154]

Postoperative delirium

Incidence rate and predictive factors

Postoperative delirium is characterized by incoherent thought and speech, disorientation, impaired memory, and attention. The reported incidence of this effect varies from 5.1 to 61.3%,[34 39 65] a wide range likely because of differences in diagnostic criteria, study populations, and methods of observation. Elderly patients usually manifest delirium following a lucid interval of 1 postoperative day or more, a condition known as interval delirium.[34] Symptoms are often worse at night. Alternatively, the condition can be silent and unnoticed, or misdiagnosed as depression.[138] However, the effects of elderly postoperative delirium are evident in increased morbidity, delayed functional recovery, and prolonged hospital stay. Fortunately, the postoperative cognitive dysfunction is a reversible condition in the majority of elderly surgical patients. Only 1% has persistent cognitive dysfunction at 1–2 yr after the surgery.[1]

Preoperative risk factors predisposing to delirium include ageing, lack of education, re-operation, polypharmacy and drug interaction, alcohol and sedative-hypnotic withdrawal, endocrine and metabolic compromise, impaired vision and hearing, sleep deficiency, anxiety, depression, and dementia.[39 76 101 106] Bilateral total knee arthroplasty is associated with a significantly higher incidence of acute delirium than unilateral total knee arthroplasty in patients over 80 yr.[92] Moller's study[101] on 1218 patients over 60 yr who underwent major surgical procedures demonstrated that increasing age and duration of anaesthesia, little education, a second operation, postoperative infections and respiratory complications were risk factors for early postoperative cognitive dysfunction. Only age is a risk factor for late postoperative cognitive dysfunction. Hypoxaemia and hypotension do not appear to be predictors.[101] Intraoperative risk factors include hypoperfusion and microemboli of air or blood cells during cardiac surgery, fat embolism during orthopaedic surgery, severe bilateral loss of vision in ophthalmological patients, and major intraoperative blood loss (haematocrit <30%).[98 106] However, in Moller's study, there was no relation between cognitive dysfunction and blood loss (the amount of blood loss was not reported).[101] Postoperative room change to a quiet, dark and isolated environment also may contribute.[137]

Recent studies did not show that anticholinergic drugs, barbiturate premedication or benzodiazepines are implicated in the development of postoperative delirium.[101 116 151] Preoperative psychoactive agents seemed to be a modifiable risk factor for postoperative delirium.[39] There appears to be no difference in the effects of general, epidural, or spinal anaesthesia on the incidence of postoperative delirium following total knee arthroplasty or TURP procedures.[101 119 151] However, cognitive function appears to be better preserved in elderly patients who undergo TURP with regional anaesthesia without intraoperative sedation.[33] Postoperative patient-controlled epidural analgesia can improve mental status in elderly patients.[97] The use of auditory evoked potentials and the bispectral index to monitor hypnotic status and detect awakening during general anaesthesia can help anaesthetists to adjust the delivery of anaesthetic agents as needed to maintain surgical anaesthesia.[46 57] One recent randomized double-blinded study in elderly hip or knee replacement surgery in our hospital confirmed that bispectral index monitoring, in particular, may decrease anaesthetic requirement during general anaesthesia and facilitate more rapid recovery.[155] However, this study failed to show any difference between cognitive function with or without bispectral index monitoring.[155]

Perioperative management

The principles of prevention are listed in Table 9. Preoperative assessment of the patient's physical and mental status and documentation of chronic medications are important to recognize and reduce the risk associated with pre-existing sensory or perceptual deficits. A multicomponent intervention strategy aimed at six risk factors—cognitive impairment, sleep deprivation, immobility, visual or hearing impairment, and dehydration—may be effective in preventing postoperative delirium.[74]

As no specific risk factors for cognitive dysfunction have been proven to relate to anaesthetic management and postoperative pain control,[101] early recognition of delirium is important.

Nurses should be well trained in detecting the earliest signs of delirium. Where possible, ambulatory surgery should be encouraged because of its short surgical duration and permitting elderly patients to recover in their familiar home environment. Herniorrhaphy and ophthalmological procedures in elderly patients are being performed in

ambulatory surgical units under local and monitored anaesthesia care regimens.[51] The increasing use of laparoscopy will allow more elderly surgical patients to return home on the day of surgery.

Speech, consciousness, perception, orientation, coherence, memory, and motor activity can be assessed preoperatively to determine baseline cognitive status and postoperatively to measure change in function using the Mini Mental State Examination (MMSE) (Table 10), which is reliable, easy to conduct, and useful for serial testing in fluctuating conditions.[54] MMSE should be administered to patients at high risk of postoperative delirium.

Once postoperative confusion has been diagnosed, elderly patients should be managed with extra vigilance. Postoperative complications such as pneumonia, urinary tract infection, electrolyte disorder or fluid imbalances are major reasons for postoperative delirium in elderly patients. After the appropriate cause is identified and treated, the preferred approach for treating delirium is oral administration of haloperidol 0.25–2.0 mg 1–2 h before bedtime. For more agitated patients, haloperidol can be delivered intramuscularly, 0.5 mg per h, until symptoms are adequately controlled. Chlorpromazine also is effective, but can lead to a severe reduction in arterial pressure. Diazepam can be used alone or in combination with other antipsychotic drugs and is especially effective for delirium tremens. Thiamine is the key drug for the management of Korsakoff's psychosis.

If delirium progresses to coma, standard treatment for control of the airway, breathing, and circulation should be instituted. After recovery from an acute episode, a psychiatric or psychosocial referral may aid early functional rehabilitation. Nursing assistance at home will help to rehabilitate patients who are discharged early from hospital. Physiotherapy and occupational therapy also may be important adjuncts to rehabilitation.[106]

Postoperative hypothermia

Perioperative hypothermia is prevalent in both young and elderly surgical patients, but more frequent, pronounced and prolonged in the elderly who have compromised ability to regain normal thermoregulatory control quickly.[142] In the early postoperative period, mild hypothermia can elevate norepinephrine concentrations and increase peripheral vasoconstriction and arterial blood pressure, thereby contributing to cardiovascular ischaemia and arrhythmia.[55] Mild hypothermia may also increase blood loss during total hip replacement procedures[125] and the risk of wound infection,[66] decrease drug metabolism, and prolong hospitalization.[87]

Anaesthetics and ambient temperature contribute to hypothermia.[36] As drug metabolism is impaired[87] and anaesthetic-induced inhibition of thermoregulatory response is more severe than in younger patients,[84] use of the lowest possible effective dosage/concentration of anaesthetic agent in the elderly is important. Whether anaesthesia is general or regional appears to have no effect on the production of perioperative hypothermia.[19]

Maintaining normothermia can reduce the risk of adverse outcome. It has been shown to decrease cardiac morbidity by 55%, and a perioperative core temperature of 36.7 (0.1) *vs* 35.4 (0.1)°C reportedly reduces cardiac morbidity during the early postoperative period.[56] Elderly patients should, therefore, be maintained at normal core body temperature. Intraoperative techniques for maintaining core temperature include the use of warmed cotton blankets, a warmed water mattress, warmed i.v. fluid, heated and humidified inspired gases, and forced air warming. The latter is both effective and safe.[85] The only exception to this recommendation for normothermic control is neurosurgery, where mild hypothermia (34°C) is of benefit because it decreases cerebral metabolism and prevents cerebral ischaemia.[136] Temperature must be returned to normal as soon as possible.

Postoperatively, shivering is not common in elderly patients. However, when it occurs, it increases metabolic rate by 20–38%.[23] Factors contributing to postoperative shivering include intraoperative hypothermia (infusion of cold fluids, inhalation of cold and dry anaesthetic gases, exposure of internal organs, duration of surgery, and age and sex), decreased sympathetic activity, adrenal suppression, uninhibited spinal reflexes, and postoperative pain.[23 102] Although no relationship has been demonstrated between axillary temperature and the occurrence of shivering,[23] postoperative shivering can be treated by skin-surface warming, radiant heat application, or pharmacological approaches.[102] The drugs useful for controlling shivering include methylphenidate, orphenadrine, magnesium sulphate, the opiates (fentanyl, morphine and meperidine), naloxone, clonidine, nefopam, and ketanserin. Meperidine and clonidine are effective for managing both postoperative shivering and postoperative pain.[102]

Postoperative pain management

Postoperative pain increases the risk of adverse outcome in elderly patients by contributing to cardiac ischaemia, tachycardia, hypertension, and hypoxaemia. Effective analgesia can reduce the incidence of myocardial ischaemia and pulmonary complications, accelerate recovery, promote early mobilization, shorten hospital stay, and decrease medical care costs.[11 21 120 124 139] Early mobilization which enhances recovery, prevents DVT and decreases morbidity and mortality in elderly patients, can be achieved by epidural anaesthesia or balanced analgesia.[120 123] However, postoperative pain control often is inadequate in the elderly, because of concerns about drug overdose, adverse response, or risk of opioid addiction. Control is made more difficult by the fact that the expression and perception of pain are affected by changes in the patient's mental status.[50]

Current postoperative analgesic techniques include: sustained-release morphine[63]; non-steroidal anti-inflammatory

drugs (NSAIDs); PCA/PCEA;[9] local anaesthetic techniques (neuroaxial,[9] intra-articular,[117] nerve block[118]); and non-pharmacological management (transcutaneous acupoint electrical stimulation).[146] However, few studies of these techniques focus on the analgesic requirements of the elderly. PCA and PCEA are recommended because they permit use of relatively low doses of opioids and result in fewer complications than intramuscular opioids.[49] Epidural analgesia has been recommended after thoracic, abdominal, and major vascular surgical procedures.[38 130] However, the PCA/PCEA technique can be used only in patients who can participate in self-medication, which excludes those with cognitive dysfunction. For patients with dysfunction, pain management must rely on the physician's judgment and measures of vital signs such as arterial pressure, heart rate, respiratory rate, restlessness, and sweating, which are, unfortunately, non-specific for pain control.

The morphine requirement for PCA for elderly patients can be calculated using the following formula:[94] average first 24 h postoperative morphine requirement (mg)=100 – age. The initial bolus and subsequent incremental doses should be low to safeguard elderly patients. Oxygen saturation should be monitored[90] to avoid analgesia-induced hypoxaemia, which is common. To minimize the risk of an opioid-related adverse effect, a balanced analgesic technique combining opioids, non-opioids, and local anaesthetic agents should be used.[118] The combination of opioids and local anaesthetics such as bupivacaine or ropivacaine for PCEA can produce satisfactory analgesia without episodes of either respiratory depression or sustained hypotension.[21 42] Epidural ropivacaine at 0.1–0.2% can provide adequate pain control with less motor block than a higher concentration of bupivacaine 0.175% would induce.[9 22]

Choosing a less invasive surgical procedure, when possible, can decrease postoperative pain in elderly patients. Laparoscopic procedures appear to be an effective alternative. For example, laparoscopic cholecystectomy is safe, and results in minimal pain, a short hospital stay, and quick recovery compared with open cholecystectomy in elderly patients.[91] Laparoscopic herniorrhaphy, nephrectomy and nephroureterectomy for tumour removal, paraoesophageal hernia repair, and laparoscopy-assisted colon resection for carcinoma also are possible in elderly patients.[99 141 143]

Table 9 Prevention of postoperative delirium. From reference 106 reproduced with permission. *MMSE, Digit Symbol Substitution Test. †From reference 74 reproduced with permission. ‡From reference 65 reproduced with permission

Preoperative assessment
Detailed history of drugs
Medical problem evaluation
Detection of sensory or perceptual deficits
Detection of cognitive impairment by neuropsychologic testing*
Mental preparation (orientation and communication) before to surgery†
Use of geriatric-anesthesiologic programme‡
Intraoperative precautions
Adequate oxygenation and perfusion
Correct the electrolyte imbalance
Adjust drug dose
Minimize the variety of drugs
Avoid atropine, flurazepam, scopolamine
Postoperative care
Environmental support
Well-lit cheerful room
Quiet surroundings
Keep patient oriented
Visit by friend or family
Pain control
Postoperative intervention (hearing aid, vision aid, non-pharmacological sleep aid, early mobilization, correction of dehydration)†
Identify risk-associated drugs
Anticholinergics
Depressants
H_2-antagonists
Reassure patient and family

Malnutrition

Malnutrition is not unusual in the elderly. A survey of nutrition status in patients over 70 yr indicates that 7% have a lower haemoglobin value, and that 11.4% of elderly men and 16.9% of elderly women have albumin levels less than 35 g litre^{-1}.[93] Severe protein malnutrition also may be present.[112]

Table 10 Minin-mental state exam. From reference 54 reproduced with permission

Maximum score	
	Orientation
5	What is the (yr) (season) (month) (date)(day)? [1 point]
5	Where are we: (state) (country) (town) (hospital) (floor)?
	Registration
3	Name three objects; 1 s to say each. Then ask the patient all three after you have said them. Give 1 point for each correct answer. Then repeat them until he learns all three. Count trials and record.
	Attention and calculation
4	Serial 7's. 1 point for each correct. Stop after five answers. Alternatively spell 'world' backwards.
	Recall
3	Ask for the three objects repeated above. Give 1 point for each correct.
	Language
9	Name a pencil, and watch (2 points). Repeat the following 'No ifs, ands or buts' [1 point]. Follow a three-stage command: 'Take a paper in your right hand, fold it in half, and put it on the floor' [3 points]. Read and obey the following: CLOSE YOUR EYES [1 point]. Write a sentence [1 point] Copy design [1 point]
30	Total score

The risk factors for malnutrition in the elderly include social isolation, limited financial resources, poor dentition, alcohol consumption, weight loss, depression, diarrhoea, constipation or any other chronic medical disease,[103] and polypharmacy.[93] Adverse effects of malnutrition include delayed wound healing, greater risk of sepsis, wound infection, and increased mortality.[103 112 140] Preoperative assessment of nutrition status is, therefore, important for elderly patients. Global assessment should include dietary history and physical and laboratory evaluation. Simplified tools such as the Nutritional Risk Assessment Scale and the Mini Nutritional Assessment should be applied.[103] When malnutrition is detected, intervention in the form of a nutritional supplement is indicated, and related underlying diseases such as anaemia should be treated before the elective surgical procedures.

Obesity is another type of malnutrition in elderly patients who are at increased risk of diabetes mellitus and cardiovascular disease. Anaesthetists should pay more attention in obese patients to: the compromised airway; the risk of decreased intrathoracic volume; and intraoperative head and arm position by the use of padding pillows beneath the head to maintain the cervical spine in the plane of the long axis of the thoracic spine.

Conclusion

Perioperative morbidity and mortality in elderly patients will continue to be an important problem. Preoperative clinical assessment to recognize patients at intermediate or high risk of postoperative events by careful history taking, physical examination, and function capacity assessment is important to guide anaesthesia management and to decrease cost by reducing the number of preoperative cardiac or pulmonary tests. Specific intraoperative and postoperative anaesthesia management in terms of maintenance of haemodynamic stabilization and normothermia, effective postoperative pain control, and prevention of hypoxaemia, will minimize postoperative adverse events in the elderly. To summarize the recommendations for clinical management of the elderly.

1. Preoperative assessment to determine the elderly patients at high risk of postoperative adverse outcome.
2. Preoperative testing (invasive or non-invasive) only when test results are likely to change the proposed surgery or intervention, or to indicate the need for high risk invasive monitoring such as pulmonary artery catheterization.
3. Effective perioperative control of co-existing disease.
4. Maintenance of stable perioperative haemodynamics for all elderly patients using vasopressor or vasodilator drugs, or beta-adrenoceptor block, or a combination of appropriate therapies.
5. Where possible, use of a less invasive surgical procedure, for example laparoscopy on an ambulatory basis.
6. Intensive perioperative monitoring of high risk patients.
7. Prevention of hypoxaemia, hypothermia, and delirium.
8. Effective postoperative pain control.

Incorporating each of these elements into decision making for perioperative management of elderly patients can only benefit outcome in this rapidly growing and increasingly vulnerable surgical population.

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