Chapter

13 PREOPERATIVE EVALUATION AND MEDICATION

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PREOPERATIVE ASSESSMENT: OVERVIEW

The specialty of anesthesia is continually expanding in scope, particularly in the area of perioperative medicine. The role of an anesthesiologist today encompasses not only the intraoperative period but also preoperative risk assessment and implementation of perioperative risk reduction strategies for improving surgical outcomes. The preoperative evaluation is the cornerstone of safe and effective anesthesia care. Whether performed in a specific preoperative medicine clinic or immediately before anesthesia, the goal of the medical history and physical examination is the same: to formulate an anesthetic plan to minimize risk and maximize the quality of recovery. Testing or consultation with other physicians may be indicated in advance of surgery to diagnose disease based on identified risk factors or to optimize treatment. Medical records and previous anesthetic records often reveal details about past diagnoses or complications and are always reviewed during assessment. The American Society of Anesthesiologists (ASA) Practice Advisory for Preanesthesia Evaluation provides guidance for the preanesthesia history and physical examination and for the selection and timing of preoperative tests.[1]

History and Physical Examination

A preanesthesia history includes the planned procedure, presenting illness, comorbid conditions, detailed review of systems, past anesthetic history with review of complications, assessment of allergies and medications, documentation of substance use or abuse, and the last oral intake if done on the day of surgery. Severity of disease, efficacy of treatment, and impact on daily function is explored to determine if an alteration in anesthesia plan is appropriate. The preanesthesia history is a comprehensive assessment of the patient's current state of health and ability to perform daily functions, aspects of which are combined to assign an ASA Physical Status (ASA

Table 13.1 American Society of Anesthesiologists Physical Status Classification System

ASA PS Classification[a]	Definition	Examples, including, but not limited to
ASA I	A normal healthy patient	Healthy, nonsmoking, no or minimal alcohol use
ASA II	A patient with mild systemic disease	Mild diseases only without substantive functional limitations. Examples include (but are not limited to) current smoker, social alcohol drinker, pregnancy, obesity (30 < BMI < 40), well-controlled DM/HTN, mild lung disease
ASA III	A patient with severe systemic disease	Substantive functional limitations; One or more moderate to severe diseases. Examples include (but are not limited to) poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥ 40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, premature infant PCA < 60 weeks, history (>3 months) of MI, CVA, TIA, or CAD/stents.
ASA IV	A patient with severe systemic disease that is a constant threat to life	Examples include (but are not limited to) recent (<3 months) MI, CVA, TIA, or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, sepsis, DIC, ARDS, or ESRD not undergoing regularly scheduled dialysis
ASA V	A moribund patient who is not expected to survive without the operation	Examples include (but are not limited to) ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology or multiple organ/system dysfunction
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes	

[a]The addition of "E" denotes emergency surgery. (An emergency is defined as existing when delay in treatment of the patient would lead to a significant increase in the threat to life or body part).
ARDS, Acute respiratory disease syndrome; *ASA*, American Society of Anesthesiologists; *ASA PS*, ASA physical status; *BMI*, body mass index; *CAD*, coronary artery disease; *COPD*, chronic obstructive pulmonary disease; *CVA*, cerebral vascular accident; *DIC*, disseminated intravascular coagulopathy; *DM*, diabetes mellitus; *ESRD*, end-stage renal disease; *HTN*, hypertension; *MI*, myocardial infarction; *PCA*, postconceptual age; *TIA*, transient ischemic attack.
From American Society of Anesthesiologists. ASA Physical Status Classification System. www.asahq.org.

PS) score (Table 13.1). Assessment of functional capacity, or cardiorespiratory fitness, directs further investigations. The ability to achieve a moderate level of activity without symptoms, denoted by a metabolic equivalent of task score (METS) of 4 or more predicts a low risk of perioperative complications (Box 13.1).[2] An inability to exercise indicates either lack of cardiorespiratory reserve or may result from neuromuscular or pulmonary disease, anemia, or general deconditioning, all of which indicate elevated risk.

Clinical predictors of difficult airway management identified through screening questions may prompt alterations in care (Table 13.2; also see Chapter 16). A personal or family history of malignant hyperthermia or pseudocholinesterase deficiency (also see Chapter 11) is noted so appropriate precautions are taken.

A preanesthesia physical examination begins with general inspection of the patient, such as dependent functional status (e.g., walker or wheelchair aids) or altered

Box 13.1 Metabolic Equivalents of Functional Capacity

METs—Levels of Exercise
1—Eating, working at computer, dressing
2—Walking downstairs or in your house, cooking
3—Walking 1-2 blocks
4—Raking leaves, gardening
5—Climbing 1-2 flights of stairs, dancing, bicycling
6—Playing golf, carrying clubs
7—Playing singles tennis
8—Rapidly climbing stairs, jogging slowly
9—Jumping rope slowly, moderate cycling
10—Swimming quickly, running or jogging briskly
11—Skiing cross country, playing full-court basketball
12—Running rapidly for moderate to long distances

MET, Metabolic equivalent. 1 MET = consumption of 3.5 mL O_2/min/kg of body weight.
From Jette M, Sidney K, Blümchen G. Metabolic equivalents (METS) in exercise testing, exercise prescription, and evaluation of functional capacity. *Clin Cardiol.* 1990;13:555-565.

Table 13.2 Preoperative Patient Characteristics Associated With Possible Difficult Airway Management

Difficult Mask Ventilation[a]	Difficult Direct Laryngoscopy
Age > 55 years	Reported history of difficult intubation, aspiration pneumonia after intubation, dental or oral trauma following intubation
Obstructive sleep apnea (OSA) or snoring	OSA or snoring
Previous head/neck radiation, surgery, or trauma	Previous head/neck radiation, surgery, or trauma
Lack of teeth	Congenital disease: Down syndrome, Treacher-Collins syndrome, Pierre Robin syndrome
A beard	Inflammatory/arthritic disease: rheumatoid arthritis, ankylosing spondylitis, scleroderma
Body mass index (BMI) > 26 kg/m^2	Obesity Cervical spine disease or previous surgery

[a]Data from Langeron O, Masso E, Huraux C, et al. Prediction of difficult mask ventilation. *Anesthesiology*. 2000;92:1229-1236.

Table 13.3 Components of the Airway Examination

Airway Examination Component	Nonreassuring Findings
Length of upper incisors	Relatively long
Relationship of maxillary and mandibular incisors during normal jaw closure	Prominent "overbite" (maxillary incisors anterior to mandibular incisors)
Relationship of maxillary and mandibular incisors during voluntary protrusion of mandible (ability to prognath; upper lip bite test)	Inability to bring mandibular incisors anterior to (in front of) maxillary incisors; unable to bite the upper lip
Interincisor distance	Less than 3 cm
Visibility of uvula	Not visible when tongue is protruded with patient in sitting position (e.g., Mallampati class II)
Compliance of the mandibular/oral space	Highly arched or very narrow; radiation or surgical changes; stiff, indurated, occupied by mass or nonresilient
Thyromental distance	<3 fingerbreadths or <6 cm
Length of neck	Short
Thickness of neck	Thick
Range of motion of head and neck	Cannot touch tip of chin to chest or extend neck

Modified from Apfelbaum JL, Hagberg CA, Caplan RA, et al. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. *Anesthesiology*. 2013;118:251.

respiratory status (e.g., oxygen or accessory muscle use, cyanosis). Altered mental status is important to identify. Examination includes assessment of the airway (Table 13.3)[3] including Mallampati classification (Fig. 13.1); vital signs including oxygen saturation; and measurement of height and weight. Inspection of the pulse for rate and rhythm, auscultation for murmurs, and examination for peripheral edema are done. Auscultation for abnormal breath sounds is important. Findings divergent from a patient's baseline may indicate new or evolving disease.

Investigations and Testing

Preoperative investigations are indicated for evaluating existing medical conditions or disease diagnosis when an abnormal result will have an impact on management of the patient or direct further testing (Box 13.2). Performing a battery of *screening* or *routine* preoperative tests is seldom helpful, yet this unnecessary practice persists among some physicians based on "practice tradition, belief that other physicians want tests done, medicolegal worries, concerns about surgical delays or cancellation, and lack of awareness of evidence or guidelines."[4] Yet routine (not disease-indicated) preoperative testing rarely results in changes in management or benefit to the patient.[5] Mandatory preoperative testing is not cost-conscious medical care, as testing is expensive and follow-up of results is time-consuming for limited clinical utility.[6] Preoperative tests may be indicated based on disease-based criteria, as summarized in Table 13.4, provided that abnormal results will have an impact on patient management. Also, testing for selected patients may be indicated based on the planned procedure or patient status (Table 13.5).

For most patients undergoing ambulatory or low-risk surgery, no preoperative testing is required (also see Chapter 37). For patients having ambulatory surgery with stable or nonsevere disease, there is no increase in adverse perioperative events or differences in outcome in those who have no preoperative tests.[7] Additionally, for cataract surgery (also see Chapter 31), eliminating preoperative medical testing does not change outcomes and provides a significant cost savings.[8] Investigations

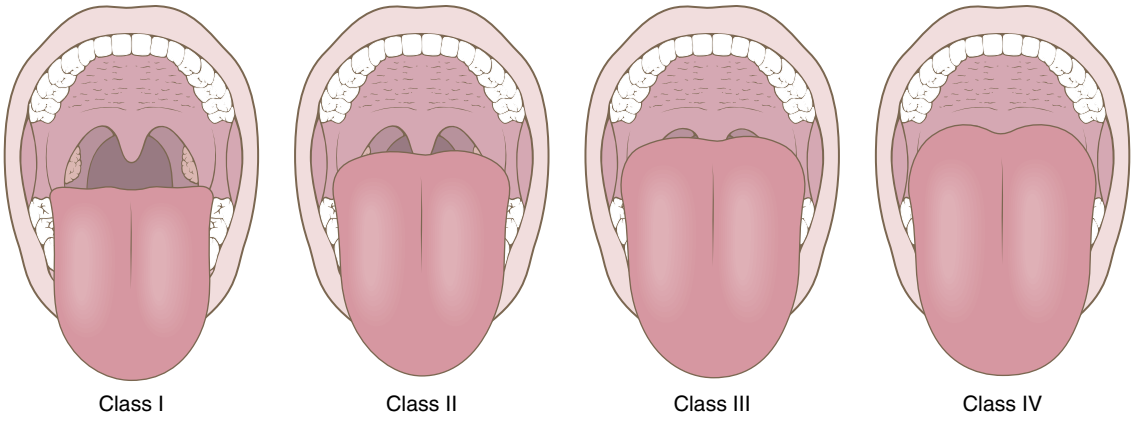


Fig. 13.1 The Mallampati airway classification is a clinical instrument used to assess the ease of obtaining an airway. Class I, visualization of the soft palate, fauces, uvula, and both anterior and posterior pillars. Class II, visualization of the soft palate, fauces, and uvula. Class III, visualization of the soft palate and the base of the uvula. Class IV (difficult), the soft palate is not visible at all.

Box 13.2 Appropriate Indications for Preoperative Testing

Preoperative testing is recommended when an abnormal result is suspected based on clinical risk factors and this result will:

- Establish a new diagnosis
- Direct further preoperative testing or consultation
- Inform preoperative medication use
- Alter intraoperative monitoring or management
- Influence choice of surgical approach or anesthetic technique
- Influence decision to postpone or cancel surgery
- Change postoperative disposition
- Establish perioperative risk profile for communication with other physicians and patient

are indicated only when clinical evaluation of the patient reveals new or worsening symptoms that warrant testing even in the absence of an upcoming procedure. Eliciting a history of increased dyspnea on exertion, new-onset chest pain, or syncope is of greater benefit than routinely ordering electrocardiogram (ECG) or chest radiographs. In choosing preoperative investigations, both the disease-based indications and risk profile of the proposed surgical procedure are considered to ensure only indicated tests are ordered and unnecessary testing avoided.

Although commonly ordered, routine preoperative ECG does not add value to the care of surgical patients, particularly if ordered for those of advanced age[5,9] (also see Chapter 35). Recommendations for age-based testing were derived from the frequent incidence of abnormalities found on ECGs of elderly patients. The specificity of an ECG abnormality in predicting postoperative cardiac adverse events is only 26%, and a normal ECG does not exclude cardiac disease.[10] The ASA Practice Advisory for Preanesthesia Evaluation advises that age alone, in the absence of other clinical risk factors, may not be an indication for an ECG (Box 13.3).[1] ECG may be useful for suspected electrolyte abnormalities, active cardiac symptoms, suspected or known pulmonary hypertension, and arrhythmias (see Table 13.4 for more details). See Table 13.5 for recommendations from the American College of Cardiology/American Heart Association (ACC/AHA) regarding preoperative ECG.

Routine pregnancy testing, particularly of adolescents, is a controversial issue. Some practices and facilities provide patients with information about the potential risks of anesthesia and surgery on pregnancy but allow them to decline testing. Other practices mandate that all females of childbearing age undergo a urine pregnancy test on the day of surgery (also see Chapter 34). The ASA Practice Advisory for Preoperative Evaluation states that "the literature is inadequate to inform patients or physicians on whether anesthesia causes harmful effects on early pregnancy" and recommends that pregnancy testing be offered to women if the test result will alter management.[1] If proceeding with testing, rapid reliable results are obtained from urine screening and the test is best performed on the day of surgery rather than in advance unless the history suggests pregnancy.

Consultations

Forming a comprehensive preoperative management plan for a patient with complex or undifferentiated comorbid conditions is often best accomplished in collaboration with consultant specialists. The purpose of consultation is to seek specific advice regarding the diagnosis

Table 13.4 Preoperative Diagnostic Testing Recommendations[a]

Test	Clinical Scenario
Albumin	Anasarca; liver disease; malnutrition; malabsorption
β-hCG	Suspected pregnancy
CBC	Alcohol abuse; anemia; dyspnea; hepatic or renal disease; malignancy; malnutrition; personal history of bleeding; poor exercise tolerance; recent chemotherapy or radiation therapy
Creatinine	Renal disease; poorly controlled diabetes
Chest radiograph	Active, acute or chronic significant pulmonary symptoms such as cough or dyspnea; abnormal unexplained physical findings on chest examination; decompensated heart failure; malignancy within the thorax; radiation therapy[b]
Electrocardiogram	Alcohol abuse; active cardiac condition (new or worsening chest pain or dyspnea, palpitations, tachycardia, irregular rhythm, unexplained bradycardia, undiagnosed murmur, S_3, decompensated heart failure); implanted cardioverter-defibrillator (ICD); obstructive sleep apnea; pacemaker; pulmonary hypertension; radiation therapy[b]; severe obesity; syncope; use of amiodarone or digoxin
Electrolytes	Alcohol abuse; cardiovascular, hepatic, renal, or thyroid disease; diabetes; malnutrition; use of digoxin or diuretics
Glucose and/or HbA_{1c}	Diabetes; severe obesity; use of steroids
LFTs	Alcohol abuse; hepatic disease; recent hepatitis exposure; undiagnosed bleeding disorder
Platelet count	Alcohol abuse; hepatic disease; bleeding disorder (personal or family history); hematologic malignancy; recent chemotherapy or radiation therapy; thrombocytopenia
PT	Alcohol abuse; hepatic disease; malnutrition; bleeding disorder (personal or family history); use of warfarin
PTT	Bleeding disorder (personal or family history); undiagnosed hypercoagulable state; use of unfractionated heparin
TSH, T_3, T_4	Goiter; thyroid disease; unexplained dyspnea, fatigue, palpitations, tachycardia
Urinalysis	Urinary tract infection (suspected)

[a]These tests are only indicated to either establish a diagnosis, predict risk, or alter treatments in situations when it will impact perioperative management. This is less likely to be useful for low-risk procedures or in patients with chronic, stable conditions.
[b]Only with radiation therapy to chest, breasts, lungs, thorax.
β-hCG, β-Human chorionic gonadotropin [assay] (pregnancy test); *CBC*, complete blood count; *HbA1c*, glycated hemoglobin; *LFTs*, liver function tests (albumin, bilirubin, alanine, and aspartate aminotransferases); *PT*, prothrombin time; *PTT*, partial thromboplastin time; *S3*, third heart sound; *T_3*, triiodothyronine; *T_4*, thyroxine; *TSH*, thyroid-stimulating hormone.

or management of a condition in order to aid safe anesthetic planning, not for *preoperative clearance*, which is seldom helpful. A summary of the patient's medical history and relevant diagnostic testing along with a specific question or goal for consultation improves utility. Close coordination and good communication among the preoperative anesthesiologist, surgeon, and consultant are vitally important for improving perioperative outcomes and avoiding adverse events.

Preoperative consultations may be sought for the following:

(1) Diagnosis, evaluation, and improvement of a new or poorly controlled condition, or
(2) Creation of a clinical risk profile that the patient and perioperative team use to make management decisions.

ANESTHETIC IMPLICATIONS OF COMMON COMORBID CONDITIONS

Hypertension

The severity and duration of hypertension (HTN) correlate with the degree of end-organ damage, morbidity, and mortality risks. Ischemic heart disease, heart failure, renal insufficiency, and cerebrovascular disease are common in hypertensive patients. Severe preinduction of anesthesia hypertension (systolic blood pressure [BP] > 200 mm Hg) is an independent risk factor for postoperative myocardial infarction (MI).[11] Hypertensive patients are more likely to have arrhythmias, labile intraoperative BP, and myocardial ischemia. However, in patients with BP less than 180/110 mm Hg, there is little

Table 13.5 Recommendations for Patient-Specific Baseline Testing Before Anesthesia[a]

Procedure/Patient Type	Test
Injection of contrast dye	Creatinine[b]
Potential for significant blood loss	Hemoglobin/hematocrit[b]
Likelihood of transfusion requirement	Type and screen
Possibility of pregnancy	Pregnancy test[c]
End-stage renal disease	Potassium level[d]
Diabetes	Glucose level determination on day of surgery[d]

[a]Not to establish a diagnosis or to guide *preoperative* management.
[b]Results from laboratory tests within 3 months of surgery are acceptable unless major abnormalities are present or the patient's condition has changed.
[c]A routine pregnancy test before surgery is not recommended before the day of surgery. A careful history and local practice determine whether a pregnancy test is indicated.
[d]No absolute level of either potassium or glucose has been determined to preclude surgery and anesthesia. The benefits of the procedure must be balanced against the risk of proceeding in a patient with abnormal results.

Box 13.3 Recommendations for Preoperative Resting 12-Lead Electrocardiogram

Class IIa
- Preoperative resting 12-lead electrocardiogram (ECG) is reasonable for patients with known coronary heart disease, significant arrhythmia, peripheral arterial disease, cerebrovascular disease, or other significant structural heart disease, except for those undergoing low-risk surgery

Class IIb
- Preoperative resting 12-lead ECG may be considered for asymptomatic patients without known coronary heart disease, except for those undergoing low-risk surgery

Class III: No Benefit
- Routine preoperative resting 12-lead ECG is not useful for asymptomatic patients undergoing low-risk surgical procedures

From Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. *J Am Coll Cardiol.* 2014;64:e77-137.

evidence that delaying surgery improves patient outcome.[12] A true baseline BP is best established by taking several consecutive measurements in a low-stress environment, rather than immediately before induction in the operating room. Maintaining BP within 20% of the patient's baseline is recommended for adequate organ perfusion. If significant end-organ damage is present, or intraoperative hypotensive techniques are planned, risk is minimized by excellent BP control through titration of medications in advance of surgery.[12] This requires weeks of therapy for slow regression of vascular changes, as sudden decreases in BP may result in myocardial ischemia or cerebrovascular events.

Coronary Artery Disease

Coronary artery disease (CAD) varies from a mild, stable disease with little impact on perioperative outcome to a severe disease accounting for significant complications during anesthesia and surgery. The history and the physical examination, especially a determination of functional status, form the foundation for the cardiac assessment. The goal is to identify those patients likely to benefit from further medical therapy or rarely coronary revascularization before surgery. The ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery guides evaluation for CAD and appropriate testing to identify patients at risk of major adverse cardiovascular events (MACE).[9]

Not all patients with suspected CAD require stress testing or angiography. In patients with stable symptoms (e.g., excluding patients with symptomatic heart failure, significant arrhythmias, severe valvular heart disease, new-onset angina, or an acute coronary syndrome), a moderate or greater functional capacity (≥4 METS) excludes the need for further cardiac investigation.[9] Patients at low risk (<1%) of MACE based on combined clinical and surgical risk do *not* require additional testing.[9] Fig. 13.2 details an algorithm for assessment for CAD. Risk of MACE is easily calculated through online tools established by the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP).[13] These assessment tools were developed through data analysis from over 1.4 million patients at multiple institutions and incorporate patient factors and Current Procedural Terminology (CPT) codes to estimate risk of specific adverse outcomes. Alternatively, the Revised Cardiac Risk Index (RCRI) is a validated tool for assessing risk of MACE and incorporates six criteria: (1) presence of ischemic heart disease, (2) history of heart failure, (3) history of cerebrovascular disease, (4) diabetes mellitus treated with insulin, (5) creatinine level of 2 mg/dL or more, and (6) intrathoracic, intra-abdominal, or supra-inguinal vascular procedures.[14] The presence of 0, 1, 2, or 3 of these factors is associated with 0.5%, 1.3%, 4%, and 9% risk of MACE, respectively.[14] Therefore, the presence of 2 or more RCRI criteria constitutes increased risk. Patients with increased risk of MACE (>1%) who cannot function at 4 METs of exertion may benefit from pharmacologic stress testing but only if the results will have an impact on perioperative care.[9]

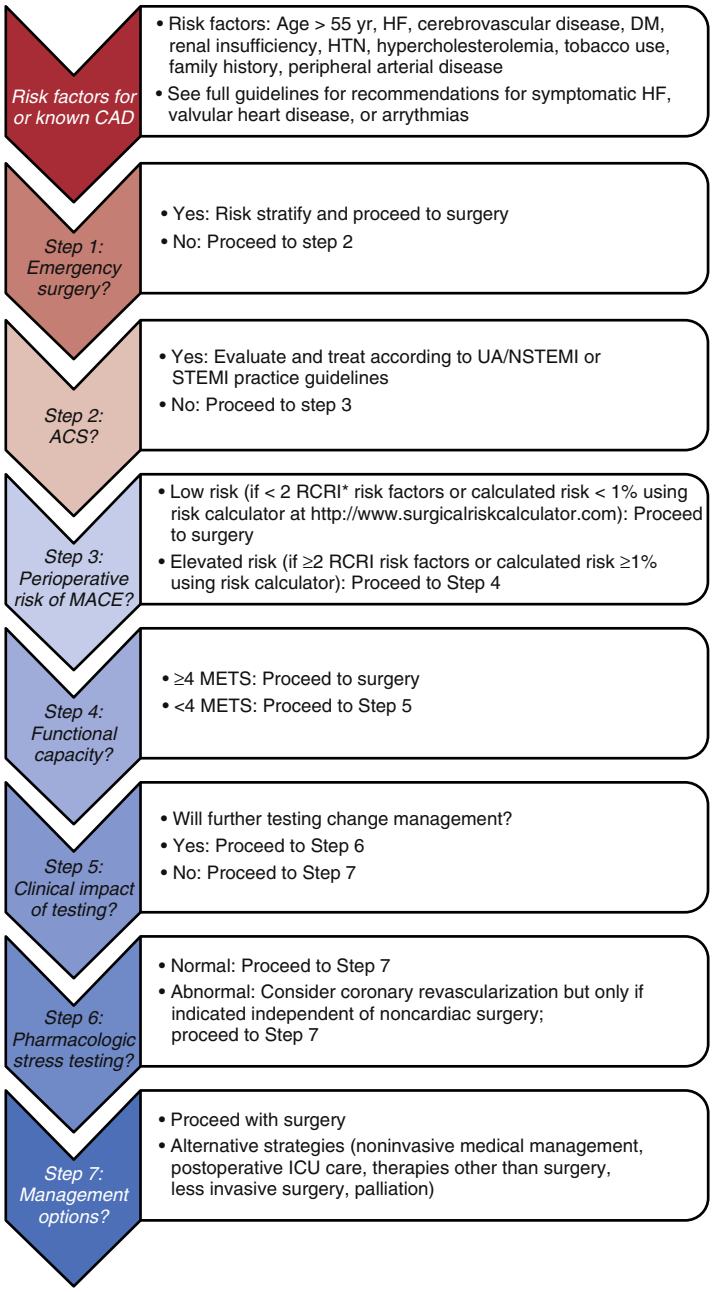


Fig. 13.2 Simplified algorithm for cardiovascular evaluation of patients for noncardiac surgery. *ACS,* Acute coronary syndrome; *CAD,* coronary artery disease; *Cr,* serum creatinine; *DM,* diabetes mellitus; *HF,* heart failure; *ICU,* intensive care unit; *MACE,* major adverse cardiac event; *METS,* metabolic equivalent of task score; *NSTEMI,* non–ST-segment elevation myocardial infarction; *STEMI,* ST-segment elevation MI; *UA,* unstable angina. *Revised Cardiac Risk Index (RCRI) = ischemic disease, HF, DM, Cr > 2, cerebrovascular disease or higher risk surgery (intrathoracic, intra-abdominal, or vascular). (Modified from Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. *J Am Coll Cardiol.* 2014;64:e77-137.)

Box 13.4 Recommendations for Perioperative Management of Antiplatelet Drugs in Patients With Coronary Stents

- Premature discontinuation of thienopyridine (e.g., clopidogrel or ticlopidine) therapy has potentially catastrophic consequences. Health care providers should discuss strategies for periprocedural antiplatelet therapy with the patient's cardiologist prior to discontinuation.
- Elective procedures requiring discontinuation of thienopyridine therapy should be deferred until 1 month after placement of bare metal stents (BMS).
- Elective procedures requiring discontinuation of thienopyridine therapy should be deferred until 6 months after placement of a drug-eluting stent (DES) if placed for stable coronary artery disease, or until 12 months after DES if placed for acute coronary syndrome (ACS) or in other high risk situations (e.g., multiple stents, small stents, recent in-stent stenosis).
- Proceeding with urgent surgery within 3 to 6 months following DES placement may be considered if the risk with delayed surgery is greater than the stent thrombosis risk.
- Patients with either a BMS or DES should continue aspirin if at all possible throughout the procedure. The recommended daily dose is 81 mg (range 75-100 mg) as the bleeding risk is lower and with comparable ischemic protection.

Levine GN, Bates ER, Bittl JA, et al. 2016 ACC/AHA Guideline Focused Update on Duration of Dual Antiplatelet Therapy in Patients With Coronary Artery Disease. A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines 68(10): 1082-1115.

Contrary to what might be expected, coronary revascularization with percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG) before noncardiac surgery does not benefit most patients with CAD. The only randomized prospective study of preoperative revascularization versus medical management failed to show a difference in outcome.[15] Noncardiac surgery soon after revascularization is actually associated with higher rates of morbidity and mortality.[15] Only those patients with unstable or severe disease who would undergo revascularization even in the absence of noncardiac surgery are likely to benefit from preoperative revascularization. The management of antiplatelet agents is complex in patients having preoperative PCI, especially with drug-eluting stents (DES), as they require months, if not a lifetime, of antiplatelet therapy to prevent catastrophic stent restenosis or acute thrombosis. The type of stent, DES or bare metal stent (BMS), must be identified and managed in collaboration with a cardiologist according to published recommendations, which were updated in 2016 by the ACC/AHA (Box 13.4).[16,16a] Prescribed antiplatelet therapy should not be interrupted during the high-risk period without consultation with a cardiologist familiar with coronary stents and an in-depth discussion with the patient regarding the risks of terminating these drugs, especially for elective procedures.[16] If at all possible, aspirin is continued throughout the perioperative period and the thienopyridine (typically clopidogrel) restarted as soon as possible. Evidence supports continuation of aspirin for high-risk patients (secondary prevention or after coronary stenting) during most procedures despite the small risk of bleeding complications.[17] See Fig. 13.3 for details regarding antiplatelet agents in specific situations. In the event of stent thrombosis, PCI can be performed safely even in the immediate postoperative period, so high-risk patients are best managed in facilities with immediate access to interventional cardiology.[12]

Further medical therapy with β-adrenergic blockade or statin therapy in patients with CAD may reduce MACE. See Box 13.5 for a summary of these recommendations.

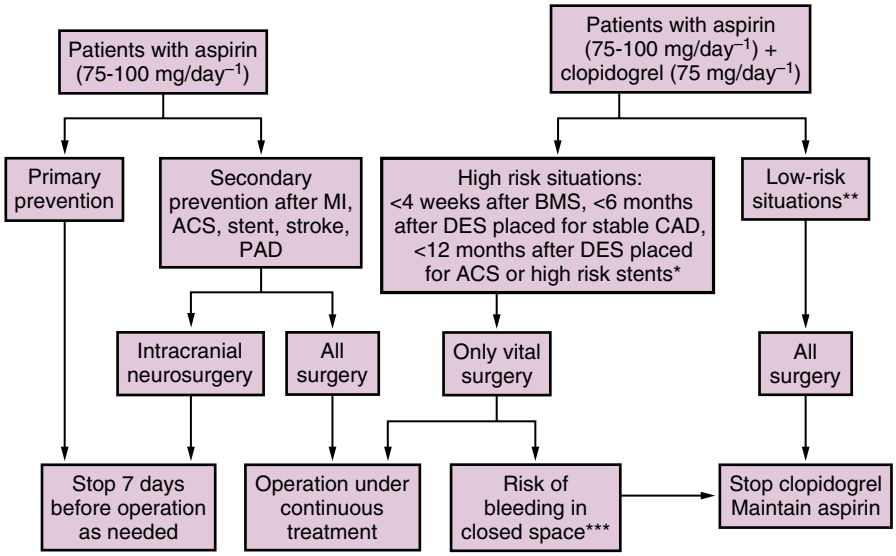
Heart Failure

Heart failure is a significant risk factor for perioperative adverse events. Patients with symptomatic heart failure are at a significantly increased risk of perioperative death than patients with CAD, especially those with left ventricular ejection fraction (LVEF) of less than 30%.[9] Heart failure may be caused by systolic dysfunction (decreased ejection fraction from abnormal contractility), diastolic dysfunction (increased filling pressures with abnormal relaxation but normal contractility and ejection fraction), or a combination of the two. Symptoms and signs of heart failure include complaints of shortness of breath, fatigue, orthopnea, paroxysmal nocturnal dyspnea, rales/crackles, or third heart sound. Assessment of left ventricular function by echocardiography may be indicated in patients with a change in physical status (Box 13.6).[9] Diastolic dysfunction accounts for up to half of all cases of heart failure, but there is little science to guide care in the perioperative period. Advanced age and hypertension are associated with diastolic dysfunction. Because decompensated heart failure is a high-risk cardiac condition, elective surgery should be postponed until it is controlled.

Based on the New York Heart Association Functional Classification,[18] patients with class IV failure (symptoms at rest) need evaluation by a cardiologist before undergoing anesthesia. Minor procedures with monitored anesthesia care (MAC) may proceed as long as the patient's condition is stable.

Valvular Disease

Cardiac murmurs can be clinically unimportant or a sign of valvular abnormalities. Functional murmurs from turbulent flow across the aortic or pulmonary outflow tracts are found with high-output states (hyperthyroidism, pregnancy, anemia). Elderly patients and those with risk factors for CAD, a history of rheumatic fever, excessive intravascular volume, pulmonary disease, cardiomegaly, or an abnormal ECG and a murmur are more likely to have valvular disease. Diastolic murmurs are always pathologic and require evaluation. If significant valvular disease is suspected, evaluation with



MI, Myocardial infarction; *ACS,* acute coronary syndrome; *PAD,* peripheral arterial disease; *PCI,* percutaneous coronary intervention; *BMS,* bare metal stent; *DES,* drug-eluting stent.

*High-risk stents: long (>36 mm), proximal, overlapping, or multiple stents, stents in chronic total occlusions, or in small vessels or bifurcated lesions.

**Examples of low-risk situations: >1 month after BMS, stroke, uncomplicated MI, PCI without stenting.

***Risk of bleeding in closed space: intracranial neurosurgery, intra-medullary canal surgery, posterior eye chamber ophthalmic surgery. In these situations, the risk/benefit ratio of upholding vs. withdrawing aspirin must be evaluated for each case individually; in case of aspirin upholding, early postoperative re-institution is important.

Fig. 13.3 Algorithm for perioperative management of patients taking antiplatelet therapy. (From Chassot PG, Delabays A, Spahn DR. Perioperative antiplatelet therapy: the case for continuing therapy in patients at risk of myocardial infarction. *Br J Anaesth.* 2007;99:316-328. Modified to reflect updates in Levine GN, Bates ER, Bittl JA, et al. 2016 ACC/AHA Guideline focused update on duration of dual antiplatelet therapy in patients with coronary artery disease. A report of the American College of Cardiology/American Heart Association Task Force on clinical practice guidelines. 2016;68[10]: 1082-1115.)

Box 13.5 Perioperative Risk Reduction with β-Adrenergic Blockade and Statins: Recommendations

β-Adrenergic Blockade

Class I

- β-Adrenergic blockers should be continued in patients undergoing surgery who have been on β-adrenergic blockers chronically.

Class IIa

- It is reasonable for the management of β-adrenergic blockers after surgery to be guided by clinical circumstances, independent of when the agent was started.

Class IIb

- In patients with intermediate- or high-risk myocardial ischemia noted in preoperative risk stratification tests, it may be reasonable to begin perioperative β-adrenergic blockers.
- In patients with three or more Revised Cardiac Risk Index (RCRI) risk factors (e.g., diabetes mellitus, HF, CAD, renal insufficiency, cerebrovascular accident), it may be reasonable to begin β-adrenergic blockers before surgery.
- In patients with a compelling long-term indication for β-adrenergic blocker therapy but no other RCRI risk factors, initiating β-adrenergic blockers in the perioperative setting as an approach is of uncertain benefit to reduce perioperative risk.
- In patients in whom β-adrenergic blocker therapy is initiated, it may be reasonable to begin perioperative β-adrenergic blockers long enough in advance to assess safety and tolerability, preferably more than 1 day before surgery.

Class III: Harm

- β-Adrenergic blocker therapy should not be started on the day of surgery.

Statins

Class I

- Statins should be continued in patients currently taking statins and scheduled for noncardiac surgery.

Class IIa

- Perioperative initiation of statin use is reasonable in patients undergoing vascular surgery.

Class IIb

- Perioperative initiation of statins may be considered in patients with clinical indications according to guideline-directed medical therapy who are undergoing elevated-risk procedures.

CAD, Coronary artery disease; *HF,* heart failure.
From Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. *J Am Coll Cardiol.* 2014;64:e77-e137.

Box 13.6 Assessment of Left Ventricular Function: Recommendations

Class IIa
- It is reasonable for patients with dyspnea of unknown origin to undergo preoperative evaluation of left ventricular (LV) function.
- It is reasonable for patients with heart failure with worsening dyspnea or other change in clinical status to undergo preoperative evaluation of LV function.

Class IIb
- Reassessment of LV function in clinically stable patients with previously documented LV dysfunction may be considered if there has been no assessment within a year.

Class III: No benefit
- Routine preoperative evaluation of LV function is not recommended.

From Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. *J Am Coll Cardiol.* 2014;64:e77-e137.

Box 13.7 Valvular Heart Disease: Perioperative Recommendations for Aortic and Mitral Valve Disease

Class I
1. It is recommended that patients with clinically suspected moderate or greater degrees of valvular stenosis or regurgitation undergo preoperative echocardiography if there has been either (1) no prior echocardiography within 1 year or (2) a significant change in clinical status or physical examination since last evaluation.
2. For adults who meet standard indications for valvular intervention (replacement and repair) on the basis of symptoms and severity of stenosis or regurgitation, valvular intervention before elective noncardiac surgery is effective in reducing perioperative risk.

Class IIa
1. Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable to perform in patients with asymptomatic severe aortic stenosis.
2. Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable in adults with asymptomatic severe mitral regurgitation.
3. Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable in adults with asymptomatic severe aortic regurgitation (AR) and a normal LVEF.

Class IIb
1. Elevated-risk elective noncardiac surgery using appropriate intraoperative and postoperative hemodynamic monitoring may be reasonable in asymptomatic patients with severe mitral stenosis if valve morphologic appearance is not favorable for percutaneous mitral balloon commissurotomy.

LVEF, Left ventricular ejection fraction.
From Nishimura RA, Otto CM, Bonow RO, et al. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation.* 2014;129:e521-e643.

echocardiography is recommended if general or spinal anesthesia is planned. In patients found to have a severe valvular lesion (regurgitation or stenosis) for which intervention would be indicated, preoperative repair should be considered prior to nonurgent surgery (Box 13.7).[19]

Antibiotic prophylaxis to prevent infective endocarditis is no longer recommended for patients with valvular abnormalities in native hearts (Box 13.8).[20] Patients with previous cardiac transplant and valvular disease, or with a prosthetic valve, do require prophylaxis but only for certain dental procedures or manipulation of infected tissue. Recommendations for infective endocarditis prophylaxis are contained in Box 13.8.

Cardiac Implantable Electronic Devices

Pacemakers and implantable cardioverter-defibrillators (ICDs) are types of cardiac implantable electronic devices (CIEDs). They can be affected by electromagnetic interference (EMI) commonly encountered during procedures, such as from monopolar cautery, external radiation, magnetism, or other electrical stimulation. A CIED may sense EMI and interpret it (1) as an underlying heart rate and inappropriately hold pacing (called *oversensing*) while the patient is bradycardic or (2) as an arrhythmia and deliver an inappropriate defibrillation for the perceived abnormality. Oversensing may cause hemodynamic instability in a pacer-dependent patient (whose underlying heart rate is very slow or absent) during periods of continuous EMI (e.g., prolonged periods of cautery, magnetic resonance imaging). Inappropriate defibrillation may result in unexpected patient movement at a critical moment, such as during ocular surgery or neurosurgery, causing serious patient harm. If occurring during ventricular repolarization (R-on-T wave), defibrillation can actually cause ventricular fibrillation. For these reasons, if EMI is anticipated, the CIED requires preoperative management (e.g., deactivation of the ICD or placement of the pacemaker in asynchronous mode). Consultation with the device manufacturer or cardiologist may be needed and contact information is usually recorded on a wallet card carried by the patient.

Sometimes, the use of a magnet is appropriate to temporarily alter CIED function. In general, a magnet will cause a pacemaker to pace in an asynchronous mode at a set rate (e.g., it will ignore all external stimuli and continue to pace regardless of EMI or a patient's underlying rate). A magnet will generally cause an ICD to suspend antitachyarrhythmia features.

Box 13.8 Recommendations for Endocarditis Prophylaxis in Cardiac Conditions Associated With the Highest Risk of Adverse Outcome

Class IIa

1. Prophylaxis against infective endocarditis is reasonable for the following patients *at highest risk* for adverse outcomes from infective endocarditis who undergo dental procedures that involve manipulation of either gingival tissue or the periapical region of teeth or perforation of the oral mucosa:
   - Patients with prosthetic cardiac valves or prosthetic material used for cardiac valve repair.
   - Patients with previous infective endocarditis.
   - Patients with CHD.
   - Unrepaired cyanotic CHD, including palliative shunts and conduits.
   - Completely repaired congenital heart defect repaired with prosthetic material or device, whether placed by surgery or by catheter intervention, during the first 6 months after the procedure.
   - Repaired CHD with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device (both of which inhibit endothelialization).
   - Cardiac transplant recipients with valve regurgitation due to a structurally abnormal valve.

Class III

1. Prophylaxis against infective endocarditis is not recommended for nondental procedures (such as transesophageal echocardiogram, esophagogastroduodenoscopy, or colonoscopy) in the absence of active infection.

CHD, Congenital heart disease.
Modified from Nishimura RA, Carabello BA, Faxon DP, et al. ACC/AHA 2008 guideline update on valvular heart disease: focused update on infective endocarditis: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines: endorsed by the Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. *Circulation*. 2008;118:887-896.

These rules do not always apply for certain devices, so preoperative interrogation by the electrophysiology service is recommended to verify magnet function and reprogram the CIED if needed. An important exception is for a CIED that functions as both a patient's pacemaker *and* ICD. In this case, a magnet will *only* deactivate the ICD and will *not* affect the pacing function, so these devices require reprogramming if EMI is anticipated in a pacemaker-dependent patient.[21] ICDs are deactivated with either a magnet or reprogramming only after arrival to a facility with devices for monitoring and external cardioversion. If a CIED is reprogrammed, the device must be re-interrogated and re-enabled before the patient leaves a monitored setting. Methods to avoid EMI interference include use of bipolar (vs. monopolar) cautery when possible and placement of the Bovie return pad to avoid current transmission across the CIED. Generally, procedures below the umbilicus will not cause EMI with a CIED.

Table 13.6 Positive Predictive Factors of Postoperative Pulmonary Complications[a]

Risk Factor	Odds Ratio
Potential Patient-Related Risk Factor	
Advanced age	2.09-3.04
ASA class ≥ II	2.55-4.87
CHF	2.93
Functionally dependent	1.65-2.51
COPD	1.79
Weight loss	1.62
Impaired sensorium	1.39
Cigarette use	1.26
Alcohol use	1.21
Potential Procedure-Related Risk Factor	
Aortic aneurysm repair	6.90
Thoracic surgery	4.24
Abdominal surgery	3.01
Upper abdominal surgery	2.91
Neurosurgery	2.53
Prolonged surgery	2.26
Head and neck surgery	2.21
Emergency surgery	2.21
Vascular surgery	2.10
General anesthesia	1.83
Perioperative transfusion	1.47
Laboratory Tests	
Albumin level < 35 g/L	2.53
Chest radiography	4.81

[a]At least fair to good evidence to support the particular risk factor.
ASA, American Society of Anesthesiologists; *CHF*, congestive heart failure; *COPD*, chronic obstructive pulmonary disease.
Modified from Smetana GW, Lawrence VA, Cornell JE. American College of Physicians: preoperative pulmonary risk stratification for noncardiothoracic surgery: systematic review for the American College of Physicians. *Ann Intern Med*. 2006;144:581-595.

Pulmonary Disease

Pulmonary disease increases both pulmonary and nonpulmonary perioperative complications. Predictors of postoperative pulmonary complications (PPC) include advanced age, heart failure, chronic obstructive pulmonary disease (COPD), smoking, general health status (including impaired sensorium and functional dependency), and obstructive sleep apnea (OSA) (Table 13.6).[22] Well-controlled asthma does not increase perioperative complications, whereas

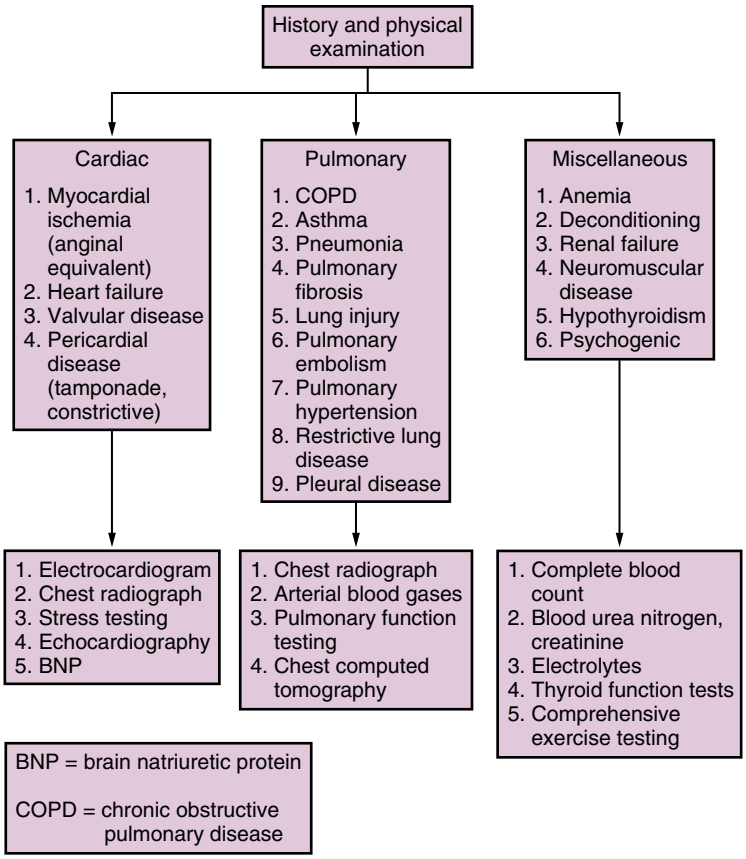


Fig. 13.4 Guideline for the evaluation of dyspnea.

patients with poorly controlled asthma (as evidenced by wheezing at the time of anesthetic induction) are at risk for complications. Unlike asthma, increasing COPD severity increases the risk of pulmonary complications; however, there is no degree of severity that absolutely precludes surgery. The risks with COPD are less than those with heart failure, advanced age, or poor general health.

The value of routine and often expensive preoperative testing is appropriately and increasingly questioned. Surprisingly, routine pulmonary function tests, chest radiography, or analysis of arterial blood gases do not predict pulmonary risk and offer little more information than can be determined by clinical evaluation. PPC rates are reduced by maximizing airflow in obstructive disease, treating infections and heart failure, and using lung expansion maneuvers such as coughing, deep breathing, incentive spirometry, positive end-expiratory pressure (PEEP), and continuous positive airway pressure (CPAP). "Prehabilitation" before surgery through regulated exercise to increase the functional capacity of patients may be an effective means of improving recovery and decreasing complications.[23]

A history of dyspnea is commonly caused by COPD or asthma. However, there are many other pulmonary and nonpulmonary causes of dyspnea from which these must be differentiated. Myocardial ischemia, heart failure, restrictive lung disease, anemia, and neuromuscular disorders can cause dyspnea. See Fig. 13.4 for a suggested diagnostic plan for delineating dyspnea.

Obstructive Sleep Apnea

Obstructive sleep apnea (OSA) is caused by intermittent airway obstruction (also see Chapter 50) and is a risk factor for perioperative complications.[24] Patients with OSA have increased rates of diabetes, hypertension, atrial fibrillation, bradyarrhythmias, ventricular ectopy, stroke, heart failure, pulmonary hypertension, dilated cardiomyopathy, and CAD.[22] Ventilation via a mask, direct laryngoscopy, endotracheal intubation, and fiberoptic visualization of the airway are more difficult in patients with OSA.[24] Such patients are likely to have perioperative airway obstruction, hypoxemia, atelectasis, myocardial ischemia, pneumonia, and prolonged hospitalizations.[25]

Snoring, daytime sleepiness, hypertension, obesity, and a family history of OSA are risk factors for OSA.[26] The

STOP-BANG questionnaire was developed and validated in an anesthesia preoperative clinic to screen for OSA (Fig. 13.5).[26] Patients who use CPAP devices should bring them for their procedures. The ASA and the Society of Ambulatory Anesthesia (SAMBA) have published recommendations for the perioperative care of patients with OSA, which includes preoperative diagnosis and treatment of OSA if possible and appropriateness of ambulatory surgery.[27,28]

Obesity

Extreme obesity is defined by a body mass index (BMI) of 40 or more. Obese patients may have OSA, heart failure, diabetes, hypertension, pulmonary hypertension, difficult airways, decreased arterial oxygenation, and increased gastric volume. Special equipment is needed to care for obese patients: oversized BP cuffs, airway management devices, and large procedure tables and gurneys to support excessive weight.

Diabetes Mellitus

Patients with poorly controlled diabetes are at risk for perioperative complications for multiple reasons. End-organ damage from chronic hyperglycemia results in renal insufficiency, strokes, peripheral neuropathies, visual impairment, and cardiovascular disease. Poorly controlled diabetes, as assessed by elevated glycosylated hemoglobin ($HbA_{1c} \geq 7\%$), contributes to surgical site infections, bloodstream infections, other morbidity, and death.[29] Increased HbA_{1c} preoperatively predicts perioperative glucose levels.[30] Targeting control in the short-term perioperative period likely will not have a substantial impact on outcomes in diabetics having surgery; however, optimal preoperative control of blood sugar should be a goal before elective higher risk surgeries. Diabetic ketoacidosis and hypoglycemia (glucose < 70 g/dL) are the only conditions that absolutely warrant perioperative intervention. The goals of glucose control are to prevent hypoglycemia during fasting and to avoid extreme hyperglycemia and ketosis.

Renal Disease

Renal disease is associated with hypertension, cardiovascular disease, excessive intravascular volume, electrolyte disturbances, metabolic acidosis, and often a need to alter the types and amounts of anesthetic drugs administered. Hemodialysis should be performed the day before elective surgery to avoid complications related to hyper- or hypovolemia and major electrolyte abnormalities. Many patients with renal insufficiency are chronically hyperkalemic and tolerate slight increases in serum potassium concentrations without consequence. A serum potassium concentration less than 6 mEq/dL obtained immediately prior to surgery is acceptable.

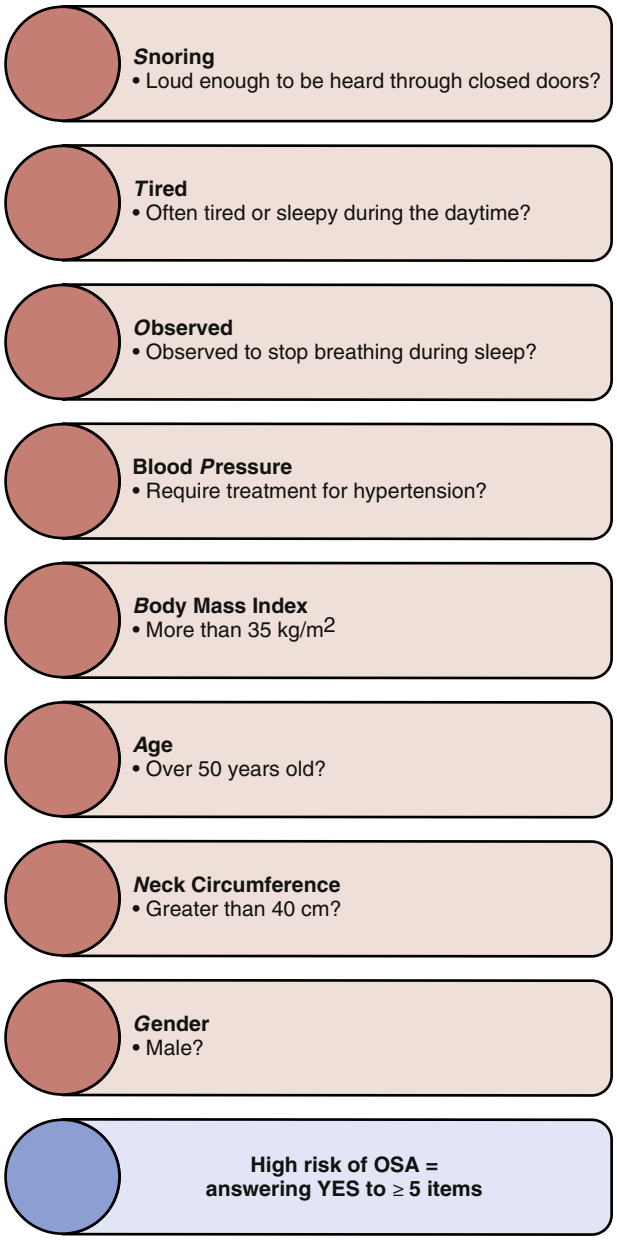


Fig. 13.5 STOP-BANG screening questionnaire for obstructive sleep apnea (OSA). (From Chung F, Yegneswaran B, Liao P, et al. STOP Questionnaire. A tool to screen patients for obstructive sleep apnea. *Anesthesiology.* 2008;108:812-821.)

Radiocontrast media transiently decrease glomerular filtration rate (GFR) in almost all patients, but patients with diabetes or renal insufficiency are at significantly increased risk of developing contrast-induced nephropathy. Simple hydration with nonhyperchloremic solution and maintenance of adequate mean arterial BP reduce injury.[31]

Anemia

Preoperative anemia is a common finding and is strongly associated with the need for blood transfusion (also see Chapter 24). Both anemia and transfusions increase morbidity and mortality risks.[32] An evaluation of the cause of anemia is indicated before elective procedures. Simply reviewing the mean corpuscular volume (MCV) for classification as micro-, normo-, or macrocytic will guide the need for further testing. Iron studies and screening for occult blood loss in microcytic anemia is especially helpful, as this common cause of anemia may be improved with preoperative iron supplementation. Erythropoietin administration is indicated in certain patients (e.g., renal insufficiency, anemia of chronic disease, refusal of transfusion) if significant blood loss is anticipated.[33] For asymptomatic patients with chronic anemia and no history of CAD who may be planning low-risk procedures, the minimal physiologic perturbations during a well-conducted anesthetic are unlikely to pose enough risk to warrant transfusion unless the hemoglobin is less than 6 g/dL[33] (also see Chapter 24). Patients with sickle cell disease are managed in concert with a hematologist familiar with the disease.

Elderly Patients

Elderly patients (also see Chapter 35) have declines in organ function and respond differently to medications. They have an increased number of comorbid conditions including arthritis, hypertension, heart disease, diabetes, renal insufficiency, and vascular disease. Patients older than 85 years with a history of hospital admission within the previous 6 months are at high risk for postoperative admission after ambulatory surgery.[34] Yet, the rate of perioperative complications among the very elderly (>85 years old) does not exclude them from having surgical procedures[35] (also see Chapter 35). Discharge planning in advance may lessen the costs of perioperative elder care. Preoperative clinics can be designed to offer multidisciplinary care and postdischarge planning that coordinates with surgical, nursing, and social service departments. Many elderly patients have or desire advance directives or do-not-resuscitate (DNR) orders, which require special discussion. Automatically suspending or enforcing DNR orders while in the operating room does not fully respect a patient's right to autonomy and informed consent regarding anesthesia and surgery. Several options for modification of DNR orders exist and they should be discussed with the patient in advance (Fig. 13.6 and Box 13.9).

FORMULATION OF AN ANESTHETIC PLAN

Risk Assessment and Informed Consent

There are several important factors to consider when formulating an anesthetic plan, which may make certain choices more advisable than others (Box 13.10). Risk assessment is useful to compare outcomes, control costs, allocate compensation, and assist in the difficult decisions to recommend canceling or postponing a procedure when the risks are too severe or likely. A simple and robust risk assessment tool used commonly is the ASA PS classification system (see Table 13.1); however, additional procedure-related risk must also be considered (Fig. 13.7). The ACS NSQIP surgical risk calculator provides a more complete estimate of patient and procedural risk.[13] Assessment of risk is important in order to inform patients during the consent process (Box 13.11).

Informed consent must be obtained for all nonemergency procedures and is a legal requirement in all jurisdictions of the United States and is extensively used internationally. At a minimum, informed consent involves the indications for the treatment in terms a layperson can understand and elucidation of alternatives. Many anesthesiologists perform preoperative evaluation and obtain informed consent moments before a patient will undergo a major, potentially life-threatening or disfiguring procedure. The effects of extensive disclosure are stressful at a time when patients and families may be ill prepared to rationally consider the implications. Informed consent should contain a discussion of risks that are common but minor, as well as rare but serious complications (see Box 13.11). Throughout the preoperative discussion, a professional and reassuring interaction will assist in allaying patient anxiety.

Medications

Instructions to patients to continue or discontinue medications are a critical part of a perioperative plan, as medications can be beneficial or detrimental during surgery, or the sudden cessation of therapy may be harmful. Patient comorbid conditions and the nature of the procedure are considered when managing medications. A summary of recommendations for perioperative administration of medications is in Table 13.7. Several drug classes deserve special mention.

Generally, cardiac medications and antihypertensive drugs are continued preoperatively. Angiotensin-converting enzyme inhibitors (ACEIs), angiotensin receptor blockers (ARBs), diuretics, and anticoagulants may be beneficial even on the day of surgery. Decisions about these drugs depend on the intravascular volume, hemodynamic status, the degree of cardiac dysfunction, the adequacy of arterial BP control of the patient, and any anticipated anesthetic or intravascular volume concerns. The best approach for patients with severe disease is to continue all cardiac medications. A similar approach is likely beneficial for patients who do not require general anesthesia or who are undergoing low- to intermediate-risk procedures. If ACEIs and ARBs are continued, doses of drugs used to induce anesthesia and other anesthetics may be altered. The potential for hypotension must be balanced against

_____ Option 1 - Full Resuscitation

I, _____, desire that full resuscitation measures be employed during my anesthesia and in the postanesthesia care unit, regardless of the situation.

_____ Option 2 - Limited Resuscitation: Procedure-directed

During my anesthesia and in the postanesthesia care unit, I, _____, refuse the following procedures:

_____ Option 3 - Limited Resuscitation: Goal-directed

I, _____, desire attempts to resuscitate me during my anesthesia and in the postanesthesia care unit only if, in the clinical judgement of the attending anesthesiologist and surgeon, the adverse clinical events are believed to be both temporary and reversible.

_____ Option 4 - Limited Resuscitation: Goal-directed

I, _____, desire attempts to resuscitate me during my anesthesia and in the postanesthesia care unit only if, in the clinical judgement of the attending anesthesiologist and surgeon, such resuscitation efforts will support the following goals and values of mine: _____

_____ _____
Patient or surrogate signature Date

_____ _____
Physician signature Date

_____ _____
Witness signature Date

Fig. 13.6 Anesthesia care for the patient with an existing do-not-resuscitate (DNR) order. (From Truog RD, Waisel DB. Do-not-resuscitate orders: from the ward to the operating room; from procedures to goals. *Int Anesthesiol Clin.* 2001;39:53-65.)

Box 13.9 Do-Not-Resuscitate (DNR) Orders in the Perioperative Period

The administration of anesthesia necessarily involves some practices and procedures that might be viewed as "resuscitation" in other settings. Prior to procedures requiring anesthetic care, any existing directives to limit the use of resuscitation procedures (that is, do-not-resuscitate orders and/or advance directives) should, when possible, be reviewed with the patient or designated surrogate. As a result of this review, the status of these directives should be clarified or modified based on the preferences of the patient. One of the three following alternatives may provide for a satisfactory outcome in many cases.

A. *Full Attempt at Resuscitation:* The patient or designated surrogate may request the full suspension of existing directives during the anesthetic and immediate postoperative period, thereby consenting to the use of any resuscitation procedures that may be appropriate to treat clinical events that occur during this time.
B. *Limited Attempt at Resuscitation Defined With Regard to Specific Procedures:* The patient or designated surrogate may elect to continue to refuse certain specific resuscitation procedures (e.g., chest compressions, defibrillation, or tracheal intubation). The anesthesiologist should inform the patient or designated surrogate about which procedures are (1) essential to the success of the anesthesia and the proposed procedure and (2) which procedures are not essential and may be refused.
C. *Limited Attempt at Resuscitation Defined With Regard to the Patient's Goals and Values:* The patient or designated surrogate may allow the anesthesiologist and surgical/procedural team to use clinical judgment in determining which resuscitation procedures are appropriate in the context of the situation and the patient's stated goals and values. For example, some patients may want full resuscitation procedures to be used to manage adverse clinical events that are believed to be quickly and easily reversible but to refrain from treatment for conditions that are likely to result in permanent sequelae, such as neurologic impairment or unwanted dependence upon life-sustaining technology.

From American Society of Anesthesiologists. Ethical Guidelines for the Anesthesia Care of Patients With Do-Not-Resuscitate Orders or Other Directives That Limit Treatment. October 16, 2013. www.asahq.org.

Box 13.10 Considerations That Influence the Choice of Anesthetic Technique

Patient Factors
- Coexisting diseases
- Risk of aspiration
- Age of the patient
- Patient cooperation
- Anticipated ease of airway management
- Coagulation status
- Previous response to anesthesia
- Preference of the patient

Procedural Factors
- Site of the surgery
- Operative technique (e.g., laparoscopic versus open approach)
- Position of the patient during surgery
- Duration of surgery

Logistical Factors
- Postoperative disposition
- Postoperative analgesic plan
- Equipment availability (e.g., ultrasound)

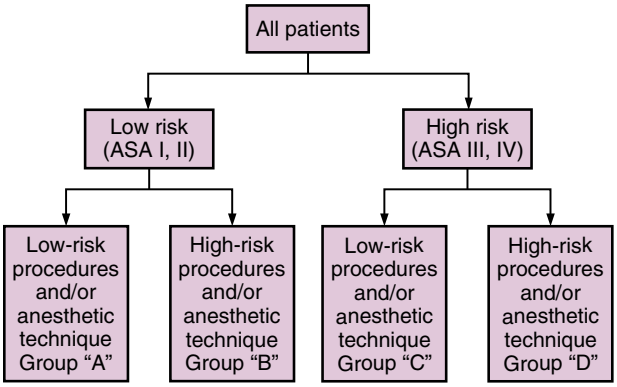


Fig. 13.7 Example of a risk classification incorporating both patient comorbid conditions and surgical severity. ASA, American Society of Anesthesiologists. (From Pasternak LR. Risk assessment in ambulatory surgery: challenges and new trends. *Can J Anaesth.* 2004;51[S1]:R1-R5.)

Box 13.11 Commonly Disclosed Risks of Anesthesia

With General Anesthesia

Frequently occurring, minimal impact
- Oral or dental damage
- Sore throat
- Hoarseness
- Postoperative nausea/vomiting
- Drowsiness/confusion
- Urinary retention

Infrequently occurring, severe impact
- Awareness
- Visual loss
- Aspiration
- Organ failure
- Malignant hyperthermia
- Drug reactions
- Failure to wake up/recover
- Death

With Regional Anesthesia

Frequently occurring, minimal impact
- Prolonged numbness/weakness
- Post-dural puncture headache
- Failure of technique

Infrequently occurring, severe impact
- Bleeding
- Infection
- Nerve damage/paralysis
- Persistent numbness/weakness
- Seizures
- Coma
- Death

Modified from O'Leary CE. Informed consent: principles and practice. *ASA Monitor.* 2010;74:20-21.

the positive therapeutic impact of continuing these drugs perioperatively.[36]

It is recommended (class I indication) that β-blockers be continued in patients who take them to treat angina, symptomatic arrhythmias, or hypertension (see Box 13.5).[37] Minimizing risk for high-risk patients scheduled for elective surgery may entail postponing surgery to optimize β-adrenergic blockers and statin therapy (see Box 13.5). Statins reduce length of hospital stay and risk of stroke, renal dysfunction, MI, and even death.[38,39] Terminating statin administration is associated with an increased risk.[40]

Aspirin is commonly used to decrease vascular events in patients with known or suspected vascular disease, diabetes, renal insufficiency, or simply advanced age. Traditionally, aspirin was withdrawn in the perioperative period because of concern of bleeding, but this practice has come under scrutiny. A meta-analysis of almost 50,000 patients undergoing a variety of noncardiac surgeries (30% taking aspirin perioperatively) found that aspirin increased bleeding complications by a factor of 1.5, but not the severity of bleeding, except in patients undergoing intracranial surgery and possibly transurethral resection of the prostate.[17] However, acute coronary syndromes in at-risk patients are more common after aspirin cessation, and uncertainty remains over best-practice recommendations.[17,41] Aspirin is withheld for 5 to 7 days before elective surgery in patients without guideline-based indications for aspirin therapy.[41] For most minor, superficial procedures such as cataract extraction, endoscopies, and peripheral procedures, the risk of withdrawing aspirin in at-risk patients is more than the risk of bleeding, so aspirin is continued. Aspirin is discontinued if taken only for primary prevention (no history of stents, strokes, MI) (see Fig. 13.3 and Table 13.7).[42] Aspirin administration should be continued if taken for secondary prevention (history of stents or vascular disease), except for procedures with a risk of bleeding in closed spaces (e.g., intracranial, intraspinal).[41]

Table 13.7 Preanesthesia Medication Instructions

Continue on Day of Surgery	Discontinue on Day of Surgery Unless Otherwise Indicated
Antidepressant, antianxiety, and psychiatric medications (including monoamine oxidase inhibitors[a])	
Antihypertensives • Generally to be continued	Antihypertensives • May consider discontinuing angiotensin-converting enzyme inhibitors or angiotensin receptor blockers 12-24 h before surgery if taken only for hypertension; especially with lengthy procedures, significant blood loss or fluid shifts, use of general anesthesia, multiple antihypertensive medications, well-controlled blood pressure

Aspirin[b]
• Patients with known vascular disease
• Patients with previous cardiac stents
• Before cataract surgery
• Before vascular surgery
• Taken for secondary prophylaxis (vascular disease of any type)
	Aspirin[b]
	• Discontinue 5-7 days before surgery
	  • If risk of bleeding > risk of thrombosis
	  • For surgeries with serious consequences from bleeding
	  • If taken only for primary prophylaxis (no known vascular disease)

Asthma medications	
Autoimmune medications • Methotrexate (if no risk of renal failure)	Autoimmune medications • Methotrexate (if risk of renal failure) • Entanercept (Enbrel), infliximab (Remicade), adalimumab (Humira): check with prescriber (typically *not* stopped for inflammatory bowel disease)
β-Blockers	
Birth control pills	Birth control pills (if high risk of thrombosis)
Clopidogrel (Plavix)[a] • Patients with drug-eluting stents for <6 months • Patients with bare metal stents for <1 month • Before cataract surgery	Clopidogrel (Plavix)[a] • Patients not included in group recommended for continuation • Patients with drug-eluting stents for 3-6 months if risk of delaying surgery is greater than risk of stent thrombosis
Diuretics • Triamterene, hydrochlorothiazide	Diuretics • Potent loop diuretics
Eye drops	
Estrogen compounds • When used for birth control or cancer therapy (unless high risk of thrombosis)	Estrogen compounds • When used to control menopause symptoms or for osteoporosis
Gastrointestinal reflux medications • Histamine antagonists, proton-pump inhibitors, gastric motility agents	Gastrointestinal reflux medications • Particulate antacids (e.g., Tums)
	Herbals and nonvitamin supplements • 7-14 days before surgery
Insulin • *Type 1 diabetes*: take ~ one third of intermediate to long-acting (NPH, Lente) • *Type 2 diabetes*: take up to one half long-acting (NPH) or combination (70/30) preparations • Glargine (Lantus): decrease only if dose is ≥1 unit/kg • With insulin pump delivery, continue lowest nighttime basal rate • Discontinue if blood sugar level <100	Hypoglycemic agents, oral Insulin • Regular insulin (*exception*: with insulin pump, continue lowest basal rate—generally nighttime dose)

Continued

Table 13.7 Preanesthesia Medication Instructions—cont'd

Continue on Day of Surgery	Discontinue on Day of Surgery Unless Otherwise Indicated
Opioid medications for pain or addiction	
Seizure medications	
	Nonsteroidal antiinflammatory drugs • Discontinue for 5 half-lives of the drug[c]
Statins	
	Topical creams and ointments
Steroids (oral or inhaled)	
Thyroid medications	
	Vitamins, minerals, iron
	Viagra or similar medications • Discontinue 24 h before surgery
Warfarin • Cataract surgery	Warfarin[d] • Discontinue 5 days before surgery if normal INR (international normalized ratio) is required

[a]See text for details.
[b]Except when the risk or consequences of bleeding are severe (generally only with intracranial or posterior eye procedures). If regional anesthesia considered, see Table 13.8.
[c]See Table 13.8.
[d]Bridging may be necessary; see text and Table 13.9 for details.

The management of antiplatelet agents (e.g., aspirin, nonsteroidal antiinflammatory drugs [NSAIDs], clopidogrel) and anticoagulants (e.g., heparin, low-molecular-weight heparin [LMWH], dabigatran, rivaroxiban) in patients having regional or neuraxial anesthesia is complex. The American Society of Regional Anesthesia (ASRA) stratifies recommendations for management by the bleeding complication risk of the procedure: low risk (e.g., peripheral nerve blocks); intermediate risk (e.g., paravertebral blocks); and high risk (e.g., epidural instrumentation, intrathecal catheter).[43] Peripheral regional anesthesia in patients taking aspirin is safe and endorsed by the ASRA; however, the decision to continue aspirin during intermediate- or high-risk procedures requires shared assessment and risk stratification.[43] NSAIDs are held for five half-lives of the drug for high-risk procedures only.[43] Clopidogrel is discontinued 7 days before a planned neuraxial procedure.[43] LMWH is discontinued 12 (for prophylactic dosing) to 24 hours (for therapeutic dosing) before procedures with a risk of bleeding or a planned neuraxial procedure[43] (also see Chapter 17). Warfarin may increase bleeding except during minor procedures such as cataract surgery and is held 5 days before surgery if a normal international normalized ratio (INR) is required.[43] Table 13.8 details current recommendations for commonly encountered medications (for complete recommendations, the reader is referred to the ASRA guidelines).[43]

Bridging anticoagulation with LMWH while longer acting anticoagulants are not given may be indicated for patients at high risk (>10% annual risk) of arterial thromboembolism (e.g., stroke) or recurrent venous thromboembolism. Table 13.9 details an approach to risk stratification, although there are additional high-risk patient features that may not fall directly into these categories.[44] For patients at low risk, bridging anticoagulation is not recommended.[45]

Type 1 diabetics have an absolute insulin deficiency and require insulin to prevent ketoacidosis even if they are not hyperglycemic. Type 2 diabetics are often insulin-resistant and prone to extreme hyperglycemia. Both type 1 and 2 diabetics should discontinue intermittent short-acting insulin (also see Chapter 29). Patients with insulin pumps continue with their lowest basal rate, which is typically a nighttime rate. Type 1 diabetics take a small amount (usually one third to one half) of their usual intermediate- to long-acting morning insulin (e.g., Lente or NPH) the day of surgery to avoid ketoacidosis. Type 2 diabetics take none or up to half a dose of intermediate- to long-acting (e.g., Lente or NPH) or a combination (70/30 preparations) insulin on the day of surgery. Ultra-long-acting insulin such as glargine insulin is taken as scheduled.

Metformin is held on the day of surgery but will not cause hypoglycemia if continued during fasting periods

Table 13.8 Management Recommendations for Selected Antiplatelet/Anticoagulant Medications Before Regional or Neuraxial Procedures

	When to Stop			
Drug	**High-Risk Procedure**	**Intermediate-Risk Procedure**	**Low-Risk Procedure**	**When to Restart**
Aspirin and combination	Primary prophylaxis: 6 days OR seconday prophylaxis: shared assessment and risk stratification[a]	Shared assessment and risk stratification[a]	No	24 hours
NSAIDs	5 half-lives	No	No	24 hours
Diclofenac	1 day			
Ketorolac	1 day			
Ibuprofen	1 day			
Indomethacin	2 days			
Naproxen	4 days			
Meloxicam	4 days			
Antiplatelets				
Dipyridamole	2 days	No	No	N/A
Clopidogrel	7 days	7 days	No	12-24 hours
Anticoagulants				
Warfarin	5 days, normal INR	5 days, normal INR	No OR shared assessment and risk stratification[a]	24 hours
IV heparin infusion	4 hours	4 hours	4 hours	2 hours[b]
Subcutaneous heparin, bid and tid	8-10 hours	8-10 hours	8-10 hours	2 hours
LMWH: prophylactic	12 hours	12 hours	12 hours	4 hours after low-risk OR 12-24 hours after interme-diate- to high-risk procedures
LMWH: therapeutic	24 hours	24 hours	24 hours	
Dabigatran	4-5 days OR 6 days (impaired renal function)	4-5 days OR 6 days (impaired renal function)	Shared assessment and risk stratification[a]	24 hours
Rivaroxaban	3 days	3 days		
Apixaban	3-5 days	3-5 days		
Fibrinolytic agents	48 hours	48 hours	48 hours	48 hours

[a]Case-by-case analysis of risks and benefits of continued therapy recommended.
[b]If an intermediate- or high-risk procedure was bloody, then a 24-hour interval should be observed.
bid, Twice a day; *INR*, international normalized ratio; *IV*, intravenous; *LMWH*, low-molecular-weight heparin; *tid*, three times a day.
Modified from Narouze S, Benzon HT, Provenzano DA, et al. Interventional spine and pain procedures in patients on antiplatelet and anticoagulant medications: guidelines from the American Society of Regional Anesthesia and Pain Medicine, the European Society of Regional Anaesthesia and Pain Therapy, the American Academy of Pain Medicine, the International Neuromodulation Society, the North American Neuromodulation Society, and the World Institute of Pain. *Reg Anesth Pain Med*. 2015;40:182-212.

Table 13.9 Risk Stratification for Perioperative Thromboembolism: Assessment of Need for Perioperative Bridging Anticoagulation

	Indication for Anticoagulation Bridging Therapy		
Risk Stratum	**Mechanical Heart Valve**	**Atrial Fibrillation**	**Venous Thromboembolism**
High[a]	• Any mitral valve prosthesis • Any caged-ball or tilting disc aortic valve prosthesis • Recent (within 6 months) stroke or TIA	• $CHADS_2$ score of 5 or 6 • Recent (within 3 months) stroke or TIA • Rheumatic valvular heart disease	• Recent (within 3 months) VTE • Severe thrombophilia (e.g., deficiency of protein C, protein S, or antithrombin; antiphospholipid antibodies; multiple abnormalities)
Moderate	• Bileaflet aortic valve prosthesis and one or more of the following risk factors: AF, prior stroke or TIA, HTN, DM, heart failure, age >75 yr	• $CHADS_2$ score of 3 or 4	• VTE in past 3-12 months • Nonsevere thrombophilia (e.g., heterozygous factor V_{Leiden} or prothrombin gene mutation) • Recurrent VTE • Active cancer (treated within 6 months or palliative)
Low	• Bileaflet aortic valve prosthesis without AF and no other risk factors for stroke	• $CHADS_2$ score of 0 to 2 (assuming no prior stroke or TIA)	• VTE >12 months and no other risk factors

[a]High-risk patients may also include those with prior stroke or TIA occurring >3 months before the planned surgery and a $CHADS_2$ score <5, those with prior VTE during temporary interruption of anticoagulation, or those undergoing certain types of surgeries associated with an increased risk of stroke or other thromboembolism (e.g., cardiac valve replacement, carotid endarterectomy, major vascular surgery).
AF, Atrial fibrillation; *$CHADS_2$*, congestive heart failure, hypertension, age ≥75 years, diabetes mellitus, and stroke or TIA (2 points for stroke or TIA); *DM*, diabetes mellitus; *HTN*, hypertension; *TIA*, transient ischemic attack; *VTE*, venous thromboembolism.
From Douketis JD, Spyropoulos AC, Spencer FA, et al. Perioperative management of antithrombotic therapy: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest*. 2012;141(2 Suppl):e326S-e350S.

of 1 to 2 days. There is no risk of lactic acidosis with metformin in patients with a functioning liver and kidneys, and surgery does not need to be delayed in patients who take metformin on the day of surgery.[46] Sulfonylurea drugs with very long half-lives (e.g., chlorpropamide) can cause hypoglycemia in fasting patients. Newer oral drugs (acarbose, pioglitazone) used as single-agent therapy do not cause hypoglycemia during fasting. However, to avoid confusion, all oral hypoglycemic drugs are generally withheld on the day of surgery.

Patients taking steroids regularly take their usual dose on the day of surgery. Stress-associated adrenal insufficiency in some patients may require additional steroids perioperatively. A normal daily adrenal output of cortisol (30 mg) is equivalent to 5 to 7.5 mg of prednisone. The hypothalamic-pituitary axis (HPA) is not suppressed with less than 5 mg/day of prednisone or its equivalent. The HPA is suppressed with more than 20 mg/day of prednisone or its equivalent when taken for more than 3 weeks. The risk of adrenal insufficiency may remain up to 1 year after use of high-dose steroids. Supplementation with steroids depends on the amount of stress, duration, and severity of the procedure and the regular daily dose of steroid (Table 13.10). Infections, psychosis, poor wound healing, and hyperglycemia increase with high doses of perioperative steroids, which are rarely necessary.[47]

Herbals and supplements are discontinued 7 to 14 days before surgery. The exception is valerian, a central nervous system depressant, which may cause a benzodiazepine-like withdrawal when discontinued. If possible, intake of valerian should be tapered before a planned anesthetic. Mandatory discontinuation of these medications, or cancellation of anesthesia when these medications have been continued, is not supported by available data.

Historically, monoamine oxidase inhibitors (MAOIs) were discontinued for 3 weeks before surgery because of their long duration of action and potential for extremely exaggerated response to sympathomimetics. However, discontinuation of MAOIs may produce severe depression or result in suicide, so the safest alternative is to continue MAOIs and adjust the anesthetic plan. Other drugs associated with withdrawal are continued perioperatively, including anxiolytics, opioids, and nicotine-replacement therapies.

Patients with a history of severe postoperative nausea and vomiting (PONV) can be offered a prescription for a scopolamine patch to be placed 2 to 4 hours

Table 13.10 Recommendations for Perioperative Glucocorticoid Coverage

Surgical Stress	Hydrocortisone-Equivalent	Preoperative	Intraoperative	Postoperative Days 1 and 2
Minor (e.g., inguinal herniorrhaphy)	25 mg/day for 1 day, then usual daily dose	None[a]	None[a]	Usual daily dose[a,b]
Moderate (e.g., colectomy, total joint replacement, lower extremity revascularization)	50-75 mg/day for 1-2 days, then usual daily dose	50 mg[a] hydrocortisone	20 mg[a] hydrocortisone every 8 h	20 mg[a] hydrocortisone every 8 h
Major (e.g., pancreatoduodenectomy, esophagectomy)	100-150 mg/day for 2-3 days, then usual daily dose	50 mg[a] hydrocortisone	50 mg[a] hydrocortisone every 8 h	50 mg[a] hydrocortisone every 8 h

[a]If postoperative complications occur, continued glucocorticoid administration will be necessary commensurate with the level of stress.
[b]If the postoperative course is uncomplicated, the patient can resume the usual steroid dose on postoperative day 1.
From Salem M, Tainsh RE, Bromberg J, et al. Perioperative glucocorticoid coverage. A reassessment 42 years after emergence of a problem. *Ann Surg*. 1994;219:416-425.

Table 13.11 Guidelines for Food and Fluid Intake Before Elective Surgery[a] in Healthy Patients[b]

Food or Fluid Intake	Minimum Fasting Period	Examples
Clear liquids	2 h	Water, fruit juices without pulp, sports drinks, carbonated beverages, tea, and coffee (no dairy)
Breast milk	4 h	
Infant formula	6 h	
Nonhuman milk	6 h	Cow, goat, or soy milk
Light meal	6 h	Toast, clear liquids, nonalcoholic beverages
Full meal	>8 h	Fried or fatty foods, meat, alcoholic beverages

[a]These guidelines apply to any patient undergoing general anesthesia, regional anesthesia, or monitored anesthesia care. They are not intended for patients undergoing procedures under local anesthesia only, when impairment of upper airway reflexes is not anticipated.
[b]These guidelines may not apply to, or may need to be modified for, (1) patients with coexisting diseases or conditions that can affect gastric emptying or fluid volume (e.g., pregnancy, obesity, diabetes, hiatal hernia, gastroesophageal reflux disease, ileus or bowel obstruction, emergency care, enteral tube feeding) and (2) patients in whom airway management might be difficult.
Modified from American Society of Anesthesiologists Committee. Practice guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: application to healthy patients undergoing elective procedures: an updated report by the American Society of Anesthesiologists Committee on Standards and Practice Parameters. *Anesthesiology*. 2011;114:495-511.

preoperatively. Patients with angle-closure glaucoma should not be given scopolamine. Premedication to alter gastric contents may be beneficial in patients at risk for aspiration. H_2 antagonists (ranitidine, famotidine), proton pump inhibitors (omeprazole), and antacids (sodium citrate) increase gastric fluid pH, whereas prokinetics (metoclopramide) stimulate gastric emptying.

Fasting Guidelines

In preparation for elective surgery, current ASA practice guidelines recommend that healthy patients may consume clear liquids (e.g., water, juice without pulp, coffee or tea without cream or milk) until 2 hours before anesthesia; breast milk until 4 hours before anesthesia; nonhuman milk, infant formula, or a light meal until 6 hours before anesthesia; and no fatty food or alcoholic beverages for at least 8 hours before anesthesia (Table 13.11).[48] In the past, patients were restricted from all intake (nothing by mouth, or nil per os [NPO]) after midnight before anesthesia and this may still be advisable for patients with delayed gastric emptying (e.g., gastroparesis, diabetes, ileus, or bowel obstruction), but for healthy patients, carbohydrate-rich fluids until 2 to 3 hours before surgery is part of Enhanced Recovery After Surgery (ERAS) protocols, as this improves early return of bowel function.[49]

CONCLUSION

Thorough preoperative evaluation and tailored preanesthetic medication instructions decrease complications and improve outcomes during and after procedures requiring anesthesia. Innovation in best practice for preoperative preparation requires ongoing research and willingness to modify systems of care. Anesthesiologists play a key role in perioperative outcomes by identification and modification of risk throughout the perioperative period.

QUESTIONS OF THE DAY

1. What principles should guide the anesthesia provider when deciding whether to obtain preoperative diagnostic testing before elective surgery? What is the difference between routine and disease-indicated preoperative testing?
2. A patient presents for preoperative evaluation with blood pressure of 180/110 mm Hg. What perioperative risks are increased for this patient? What additional factors should be evaluated before deciding whether to proceed with surgery?
3. What are the intraoperative risks in a patient with a cardiac implantable electronic device (CIED) (implanted cardioverter-defibrillator or pacemaker)? Is there a consistent response of a CIED to magnet placement? Under what circumstances should a CIED be reprogrammed prior to surgery?
4. A patient is receiving clopidogrel (Plavix) after drug-eluting coronary stent placement. How many months after stent placement can clopidogrel be discontinued prior to elective surgery with a risk of bleeding? Would the time period be different if the patient had received a bare metal stent instead?
5. A patient with chronic atrial fibrillation is receiving prophylactic warfarin therapy. How should the anesthesia provider decide whether the patient should receive anticoagulation bridging therapy before elective surgery?
6. What are the ASA recommended preoperative fasting guidelines for liquids and solid food? Under what circumstances might a patient benefit from a strict "nothing by mouth after midnight" fasting period?

REFERENCES

1. Apfelbaum JL, Connis RT, Nickinovich DG, et al. Practice advisory for preanesthesia evaluation: an updated report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation. *Anesthesiology*. 2012;116:522–538.
2. Jette M, Sidney K, Blümchen G. Metabolic equivalents (METS) in exercise testing, exercise prescription, and evaluation of functional capacity. *Clin Cardiol*. 1990;13:555–565.
3. Apfelbaum JL, Hagberg CA, Caplan RA, et al. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. *Anesthesiology*. 2013;118:251.
4. Brown SR, Brown J. Why do physicians order unnecessary preoperative tests? A qualitative study. *Fam Med*. 2011;43(5):338–343.
5. van Klei WA, Bryson GL, Yang H, et al. The value of routine preoperative electrocardiography in predicting myocardial infarction after noncardiac surgery. *Ann Surg*. 2007;246:165–170.
6. Finegan BA, Rashiq S, McAlister FA, O'Connor P. Selective ordering of preoperative investigations by anesthesiologists reduces the number and cost of tests. *Can J Anaesth*. 2005;52:575–580.
7. Chung F, Yuan H, Yin L, et al. Elimination of preoperative testing in ambulatory surgery. *Anesth Analg*. 2009;108:467.
8. Keay L, Lindsley K, Tielsch J, et al. Routine preoperative medical testing for cataract surgery. *Cochrane Database Syst Rev*. 2012;(3): CD007293.
9. Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. *J Am Coll Cardiol*. 2014;64:e77–e137.
10. Liu LL, Dzankic S, Leung JM. Preoperative electrocardiogram abnormalities do not predict postoperative cardiac complications in geriatric surgical patients. *J Am Geriatr Soc*. 2002;50:1186–1191.
11. Wax DB, Porter SB, Lin H-M, et al. Association of preanesthesia hypertension with adverse outcomes. *J Cardiothorac Vasc Anesth*. 2010;24:927–930.
12. Howell SJ, Sear JW, Foëx P. Hypertension, hypertensive heart disease and perioperative cardiac risk. *Br J Anaesth*. 2004;92:570–583.
13. Bilimoria KY, Liu Y, Paruch JL, et al. Development and evaluation of the universal ACS NSQIP surgical risk calculator: a decision aid and informed consent tool for patients and surgeons. *J Am Coll Surg*. 2013;217:833–842. e1-e3. See also http://www.riskcalculator.facs.org. or surgicalriskcalculator.com/miorcardiacarrest.com.
14. Lee TH, Marcantonio ER, Mangione CM, et al. Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. *Circulation*. 1999;100:1043–1049.
15. McFalls EO, Ward HB, Moritz TE, et al. Coronary-artery revascularization before elective major vascular surgery. *N Engl J Med*. 2004;351:2795–2804.
16. Grines CL, Bonow RO, Casey DE, et al. Prevention of premature discontinuation of dual antiplatelet therapy in patients with coronary artery stents: a science advisory from the American Heart Association, American College of Cardiology, Society for Cardiovascular Angiography and Interventions, American College of Surgeons, and American Dental Association, with representation from the American College of Physicians. *Circulation*. 2007;115:813–818.

16a. Levine GN, Bates ER, Bittl JA, et al. ACC/AHA Guideline Focused Update on Duration of Dual Antiplatelet Therapy in Patients With Coronary Artery Disease. A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines 2016; 68(10):1082–1115.

17. Burger W, Chemnitius JM, Kneissl GD, Rücker G. Low-dose aspirin for secondary cardiovascular prevention—cardiovascular risks after its perioperative withdrawal versus bleeding risks with its continuation—review and meta-analysis. *J Intern Med*. 2005;257:399–414.
18. American Heart Association. About Heart Failure: classes of Heart Failure. April 6, 2015 http://www.heart.org/HEARTORG/Conditions/HeartFailure/AboutHeartFailure.
19. Nishimura RA, Otto CM, Bonow RO, et al. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2014;129:e521–e643.
20. Nishimura RA, Carabello BA, Faxon DP, et al. ACC/AHA 2008 guideline update on valvular heart disease: focused update on infective endocarditis: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines: endorsed by the Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. *Circulation*. 2008;118:887–896.
21. Crossley GH, Poole JE, Rozner MA, et al. The Heart Rhythm Society (HRS)/American Society of Anesthesiologists (ASA) Expert Consensus Statement on the perioperative management of patients with implantable defibrillators, pacemakers and arrhythmia monitors: facilities and patient management this document was developed as a joint project with the American Society of Anesthesiologists (ASA), and in collaboration with the American Heart Association (AHA), and the Society of Thoracic Surgeons (STS). *Heart Rhythm*. 2011;8:1114–1154.
22. Smetana GW, Lawrence VA, Cornell JE. American College of Physicians: preoperative pulmonary risk stratification for noncardiothoracic surgery: systematic review for the American College of Physicians. *Ann Intern Med*. 2006;144:581–595.
23. Mayo NE, Feldman L, Scott S, et al. Impact of preoperative change in physical function on postoperative recovery: argument supporting prehabilitation for colorectal surgery. *Surgery*. 2011;150:505–514.
24. Liao P, Yegneswaran B, Vairavanathan S, et al. Postoperative complications in patients with obstructive sleep apnea: a retrospective matched cohort study. *Can J Anaesth*. 2009;56:819–828.
25. Hwang D, Shakir N, Limann B, et al. Association of sleep-disordered breathing with postoperative complications. *Chest*. 2008;133:1128–1134.
26. Chung F, Yegneswaran B, Liao P, et al. STOP questionnaire: a tool to screen patients for obstructive sleep apnea. *Anesthesiology*. 2008;108:812–821.
27. American Society of Anesthesiologists Task Force on Perioperative Management of patients with obstructive sleep apnea. Practice guidelines for the perioperative management of patients with obstructive sleep apnea: an updated report by the American Society of Anesthesiologists Task Force on Perioperative Management of patients with obstructive sleep apnea. *Anesthesiology*. 2014;120(2):268–286.
28. Joshi GP, Ankichetty SP, Gan TJ, Chung F. Society for Ambulatory Anesthesia consensus statement on preoperative selection of adult patients with obstructive sleep apnea scheduled for ambulatory surgery. *Anesth Analg*. 2012;115(5):1060–1068.
29. Lipshutz AK, Gropper MA. Perioperative glycemic control. *Anesthesiology*. 2009;110:408–421.
30. Moitra VK, Greenberg J, Arunajadai S, Sweitzer B. The relationship between glycosylated hemoglobin and perioperative glucose control in patients with diabetes. *Can J Anaesth*. 2010;57:322–329.
31. Zarbock A, Milles K. Novel therapy for renal protection. *Curr Opin Anaesthesiol*. 2015;28:431–438.
32. Lasocki S, Krauspe R, von Heymann C, et al. PREPARE: the prevalence of perioperative anaemia and need for patient blood management in elective orthopaedic surgery: a multicentre, observational study. *Eur J Anaesthesiol*. 2015;32:160–167.
33. American Society of Anesthesiologists Task Force on Perioperative Blood Management. Practice guidelines for perioperative blood management: an updated report by the American Society of Anesthesiologists Task Force on Perioperative Blood Management. *Anesthesiology*. 2015;122(2):241–275.
34. Fleisher LA, Pasternak LR, Herbert R, Anderson GF. Inpatient hospital admission and death after outpatient surgery in elderly patients: importance of patient and system characteristics and location of care. *Arch Surg*. 2004;139:67–72.
35. Polanczyk CSA, Marcantonio E, Goldman L, et al. Impact of age on perioperative complications and length of stay in patients undergoing noncardiac surgery. *Ann Intern Med*. 2001;134:637–643.
36. Rosenman DJ, McDonald FS, Ebbert JO, et al. Clinical consequences of withholding versus administering renin-angiotensin-aldosterone system antagonists in the preoperative period. *J Hosp Med*. 2008;3:319–325.
37. Wijeysundera DN, Duncan D, Nkonde-Price C, et al. Perioperative beta blockade in noncardiac surgery: a systematic review for the 2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2014;130:2246–2264.
38. Ouattara A, Benhaoua H, Le Manach Y, et al. Perioperative statin therapy is associated with a significant and dose-dependent reduction of adverse cardiovascular outcomes after coronary artery bypass graft surgery. *J Cardiothorac Vasc Anesth*. 2009;23:633–638.
39. Kapoor AS, Kanji H, Buckingham J, et al. Strength of evidence for perioperative use of statins to reduce cardiovascular risk: systematic review of controlled studies. *BMJ*. 2006;333:1149.
40. Le Manach Y, Godet G, Coriat P, et al. The impact of postoperative discontinuation or continuation of chronic statin therapy on cardiac outcome after major vascular surgery. *Anesth Analg*. 2007;104:1326–1333.
41. Gerstein NS, Carey MC, Cigarroa JE, Schulman PM. Perioperative aspirin management after POISE-2: some answers, but questions remain. *Anesth Analg*. 2015;120:570–575.
42. Chassot PG, Delabays A, Spahn DR. Perioperative antiplatelet therapy: the case for continuing therapy in patients at risk of myocardial infarction. *Br J Anaesth*. 2007;99:316–328.
43. Narouze S, Benzon HT, Provenzano DA, et al. Interventional spine and pain procedures in patients on antiplatelet and anticoagulant medications: guidelines from the American Society of Regional Anesthesia and Pain Medicine, the European Society of Regional Anaesthesia and Pain Therapy, the American Academy of Pain Medicine, the International Neuromodulation Society, the North American Neuromodulation Society, and the World Institute of Pain. *Reg Anesth Pain Med*. 2015;40:182–212.
44. Douketis JD, Spyropoulos AC, Spencer FA, et al. Perioperative management of antithrombotic therapy: antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest*. 2012;141(2 suppl):e326S–e350S.
45. Langeron O, Masso E, Huraux C, et al. Prediction of difficult mask ventilation. *Anesthesiology*. 2000;92:1229–1236.

46. Salpeter SR, Greyber E, Pasternak GA, Salpeter EE. Risk of fatal and nonfatal lactic acidosis with metformin use in type 2 diabetes mellitus. *Cochrane Database Syst Rev*. 2010;(4): CD002967.
47. Salem M, Tainsh RE, Bromberg J, et al. Perioperative glucocorticoid coverage. A reassessment 42 years after emergence of a problem. *Ann Surg*. 1994;219:416–425.
48. American Society of Anesthesiologists Committee. Practice guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: application to healthy patients undergoing elective procedures: an updated report by the American Society of Anesthesiologists Committee on Standards and Practice Parameters. *Anesthesiology*. 2011;114(3):495–511.
49. Miller TE, Roche AM, Mythen M. Fluid management and goal-directed therapy as an adjunct to Enhanced Recovery After Surgery (ERAS). *Can J Anaesth*. 2015;62:158–168.