Chapter 12
Perioperative Risk Assessment

Gina Adrales and Swathi Reddy

Introduction

A careful multidisciplinary approach to preoperative preparation is essential to ensure optimal patient outcomes. Determination of perioperative risk informs shared decision-making regarding the selection and timing of the surgical procedure and postoperative management. In this chapter, we will explore standards of care for preoperative testing and consultation and discuss methods of assessment of perioperative risk.

Delivery of High-Value Preoperative Care

Within the confines of a complex healthcare system, healthcare providers must seek equipoise between testing to identify risk and reduction of unnecessary studies to minimize cost and potential harm. An estimated $18 billion is spent annually in the USA on preoperative testing [1]. While some

G. Adrales (✉) · S. Reddy
Johns Hopkins University School of Medicine,
Baltimore, MD, USA
e-mail: gadrale1@jhmi.edu

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of this expenditure undoubtedly prevents perioperative complications, a portion is wasted on studies that have no impact on surgical management or outcomes. The rate of unnecessary preoperative testing is reported to be 32–45% in various studies [2, 3]. There is a growing recognition that the enormity of healthcare costs in the USA is unsustainable. This has fueled a shift to eliminate low-value care, including a decrease in preoperative medical evaluation and testing.

Choosing Wisely is an initiative of the ABIM Foundation whose mission is to stimulate patient-clinician communication about healthcare that is evidence-based, necessary, and free from harm. This health education campaign is supported by numerous medical and surgical societies, including SAGES, to prevent overuse of treatment and eliminate nonessential or duplicative care. Included in this effort are recommendations to eliminate routine preoperative testing before low-risk surgical procedures, carotid artery disease screening prior to cardiac surgery in the absence of symptoms or comorbidities, and diagnostic cardiac testing in asymptomatic patients before low- to moderate-risk surgery. Such testing may not alter management but could result in delayed care, avoidable healthcare costs, and harm from additional testing.

A potential unforeseen consequence of a reduction of preoperative assessment is a lack of patient and family preparedness. Preoperative assessment entails more than laboratory, radiologic, and cardiac tests. Preoperative evaluation promotes patient education, collaborative anesthesiology and surgical intraoperative care, postoperative and home care plans, and assurance of perioperative tools to deliver individualized care such as management of the difficult airway. While efforts to reduce low-value preoperative testing may be successful, there may be unintended consequences such as surgical no-shows or cancellations due to lack of compliance with preanesthetic eating restrictions or medication cessation [4]. These factors must be considered, particularly in caring for socioeconomically disadvantaged or less educated patient groups.

Who Is at Risk? Methods of Assessment of Perioperative Risk

Evaluation of perioperative risk begins with a history and physical exam. Basic lab testing may be added to determine patients at risk for complications through validated scoring systems.

Preoperative Evaluation and Physical Exam

All surgery patients should first undergo a thorough history and physical exam. The history is essential in stratifying risk and uncovering barriers to care. This discussion should include a detailed history of comorbidities, particularly serious cardiac and pulmonary conditions and anesthetic complications. A history of chronic pain or addiction will guide the intraoperative anesthetic plan and postoperative multimodal pain management. Prior surgical procedures, both minimally invasive and open surgeries, as well as implants including mesh and orthopedic hardware will affect surgical planning, positioning, and assessment of intraoperative procedural risk. Relevant surgical operative notes should be obtained. Prior anesthetic records should be reviewed to determine if there is a history of difficult airway or prior intraoperative cardiopulmonary event. A thorough review of the patient's medication list is crucial and should include anticoagulants and antiplatelet agents, immunosuppressive drugs, and glycemic control agents. Special consideration and advisement should be given regarding cessation of sodium glucose cotransporter-2 inhibitors starting 3–4 days prior to surgery. Medication review often overlooks the use of herbal or vitamin supplements, which can be underreported by patients. Some supplements, such as omega-3 fish oil and ginger, can increase the risk for bleeding due to antiplatelet or thrombotic inhibition effects [5]. Medication modification should be discussed with the patient prior to scheduling surgery, and plans for anticoagulation bridging and postoperative resumption of medications

should be formulated in partnership with the primary care provider.

The physical exam should begin with an assessment of overall well-being and collection of vital signs. Uncontrolled hypertension, tachycardia, or bradycardia should prompt evaluation by the patient's primary physician for medical optimization. The general appearance of a patient can be informative with regard to screening for frailty, mobility, and ability to participate in perioperative care. A standard exam should include auscultation of the heart and lungs as well as identification of prior surgical incisions, existing hernias, and skin infection that may affect abdominal surgery and surgical outcomes. Examination concerns specific to anesthesia would be an airway and neck assessment, which is used to ascertain intubation difficulty and risk of cardiopulmonary complication due to sleep apnea or acid reflux. Brief dental exam or history of poor dentition may indicate elevated risk at intubation and risk for infection, particularly after planned prosthetic mesh implants.

For the elective surgical patient, the preoperative evaluation should ideally occur early enough to allow for involvement of a multidisciplinary team including the anesthesiologist, primary care physician, and other subspecialists such as the patient's cardiologist and pulmonologist as needed. A dietician should be involved preoperatively in the case of malnourished, frail, or obese patients. All candidates should be initially evaluated by the primary care provider or a perioperative medical specialist, who will be involved in preoperative optimization of comorbidities as well as postoperative management [6].

Biochemical, Hematologic, and Nutritional Evaluation

Laboratory tests are indicated prior to procedures with higher risk for perioperative complications and in high-risk patients, including morbidly obese and diabetic patients.

Routine hemoglobin and hematocrit levels are recommended by the American Society of Anesthesiologists for patients of advanced age and those preparing for surgery associated with high risk of blood loss [7]. All geriatric patients should have a preoperative creatinine [8]. The need for additional studies, such as liver function panel and coagulation studies, should be directed by the history and physical findings and concern for comorbidities, such as cirrhosis.

We recommend obtaining a hemoglobin A1c in patients with a preexisting diagnosis of diabetes or prediabetes. Fasting glucose level is not recommended for asymptomatic patients [9]. Glycemic control in the diabetic patient is indicated to minimize the risks of infection and wound healing complications. Preoperative protein deficiency is associated with an increased risk of complications, including poor wound healing, and is present in up to 32% of bariatric surgery patients [10]. As such, a nutritional profile including albumin, iron, folate, ferritin, and a fasting lipid panel should be obtained [11]. However, for asymptomatic non-geriatric patients, routine nutrition laboratory testing is not recommended [9].

Surgery-Specific Factors

Surgical urgency is a major determinant of perioperative risk. Urgent or emergent status elevates the risk of complications compared to elective procedures [12]. The American College of Cardiology and American Heart Association define the following: (1) emergency surgery as threatened life or limb without intervention within 6 h, (2) urgent surgery as threatened life or limb without intervention within 24 h, (3) time-sensitive surgery as necessary within 1–6 weeks, and (4) elective surgery as a procedure that can be deferred for up to 1 year [13]. A thoughtful assessment of the risk of blood loss, hemodynamic effect and stress response, fluid requirements, and length of the surgical procedure is important in determining the risk of cardiac events. Surgical risk stratification is

based on urgency and surgical type [14]. Breast and ophthalmology procedures are considered low-risk, whereas adrenalectomy and complex bowel surgery are considered high-risk surgeries that warrant assessment of patient functional capacity.

Pulmonary Complications

Postoperative pulmonary complications are a significant contributor to postoperative mortality and morbidity. Even a single mild pulmonary complication is associated with early mortality, ICU admission, and longer hospitalization among patients with American Society of Anesthesiologists (ASA) 3 status [15].

Procedural and patient factors influence the risk of pulmonary complications. Upper abdominal and thoracic procedures impart a decrease in functional residual capacity which can lead to atelectasis and pneumonia. The establishment of pneumoperitoneum is associated with increased peak airway pressures, hypercarbia, and acidosis. Age is an independent predictor of pulmonary complications [16]. All patients should be screened for smoking, as smokers are 1.7 times more likely than nonsmokers to have pulmonary complications and are at greater risk for postoperative general morbidity, wound complications, critical care admission, and neurologic complications [17]. Obstructive lung disease, pulmonary hypertension, and congestive heart failure increase the risk of pulmonary complications [18, 19]. The prevalence of obstructive sleep apnea (OSA) ranges from 35% to 60% in the morbidly obese. Severe undiagnosed obstructive sleep apnea is an independent risk factor for surgical complications [20]. Patients with uncontrolled or suspected obstructive sleep apnea should undergo sleep medicine evaluation with sleep study.

Cardiac Considerations

The American College of Cardiology and American Heart Association outlined an algorithm to assess the risk of a major cardiac adverse event in its 2014 guideline [21]. This includes a determination of the urgency of the surgery and clinical evaluation for acute coronary syndrome. A validated instrument to determine cardiac complication risk, such as the Revised Cardiac Risk Index (Table 12.1), is then applied. Alternatively, the surgical risk calculator by the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) is utilized. Patients at low risk (<1%) for a major cardiac adverse event do not need further diagnostic testing. Patients at increased risk with poor functional capacity (<4 Measurement of Exercise Tolerance Before Surgery METs) should undergo pharmacologic stress testing if it is expected that the results would change management. Additional cardiac testing is pursued based on the number of clinical risk factors present. Noninvasive cardiac testing is indicated for patients with one to two risk factors

Table 12.1 Revised cardiac risk index [21]

Clinical parameter	**RCRI points**
History of cerebrovascular disease	1
Diabetes mellitus requiring insulin	1
Serum creatinine >2 mg/dL	1
History of ischemic heart disease	1
High-risk surgery	1
Points	**Risk**
0	0.4%
1	0.9%
2	6.6%

who are undergoing intermediate risk procedures (1–5% risk of cardiac event) such as intraabdominal surgery [14]. Patients with functional capacity greater than 4 METs do not need additional testing.

The Canadian Cardiovascular Society Guidelines on perioperative cardiac risk assessment include the following strong recommendations [22]:

1. Measurement of brain natriuretic peptide (BNP) or N-terminal fragment of proBNP (NT-proBNP) in patients who are 65 years of age or older, are 45–64 years of age with significant cardiovascular disease, or have a Revised Cardiac Risk Index score ≥1
2. No preoperative resting echocardiography, coronary computed tomography angiography, exercise or cardiopulmonary exercise testing, or pharmacological stress echocardiography or radionuclide imaging to enhance perioperative cardiac risk estimation
3. No initiation or continuation of acetylsalicylic acid for the prevention of perioperative cardiac events, except in patients with a recent coronary artery stent or who will undergo carotid endarterectomy
4. Avoidance of α2 agonist or β-blocker initiation within 24 h before surgery
5. Withholding of angiotensin-converting enzyme inhibitor and angiotensin II receptor blocker starting 24 h before surgery
6. Smoking cessation before surgery
7. Daily measurement of troponin for 48–72 h after surgery in patients with an elevated NT-proBNP/BNP before surgery or if there is no NT-proBNP/BNP measurement before surgery, in those who have a Revised Cardiac Risk Index score ≥1, and in those aged 45–64 years with significant cardiovascular disease or aged 65 years or older
8. Initiation of long-term acetylsalicylic acid and statin therapy in patients who suffer myocardial injury/infarction after surgery

The management and timing of surgery in patients with cardiac stents is a frequently encountered issue. Elective surgery is contraindicated in patients with recent coronary stent placements within 6 months of placement due to the elevated risk of stent thrombosis. Timing of elective noncardiac surgery is partially dependent on the type of stent placed (bare metal versus drug-eluting stent) and whether cessation of antiplatelet agents is needed.

Special Considerations in Obese Patients

Obesity is an independent risk factor for cardiovascular disease, and as such, a routine electrocardiogram (ECG) and chest radiograph are recommended as well as a preoperative consultation with the anesthesiologist [6]. Obesity is a known risk factor for coronary artery disease, heart failure, cardiomyopathy, and arrhythmias. In fact, the mortality risk from heart disease is two to three times greater in a patient with a BMI greater than 35 kg/m^2 compared with a person of normal or lean BMI [23]. BMI >35 kg/m^2 is an independent risk factor for postoperative pneumonia, respiratory failure, and surgical site infection [24]. Although intraabdominal surgery is considered an intermediate risk procedure by the American Heart Association, all patients should initially be evaluated by ECG and a chest radiograph. This should be followed by stress testing in indicated patients. Traditional exercise stress testing may not be feasible in obese patients, and nuclear perfusion studies are similarly limited by body habitus. In most cases, pharmacologic stress echocardiography will be the effective alternative of choice [25].

Chronic Liver Disease

Cirrhosis is associated with an increased risk of perioperative morbidity and mortality [9]. MELD scores should be calculated for all cirrhotic patients to assess perioperative risk.

Patients with MELD score >10 are at higher risk for perioperative morbidity [26]. The risk of complications continues to rise with rising MELD scores. The postoperative mortality rate for patients with MELD scores of 15 or greater is substantial at over 50% [26].

Frailty

Frailty refers to a vulnerable subset of patients with diminished physical function and limited physiologic reserve. There are two aspects of frailty, including phenotypic frailty and deficit accumulation [27]. Phenotypic frailty refers to biologic decline manifested by weight loss, fatigue, and weakness. Index frailty or deficit accumulation is determined by an assessment of comorbidities, weakness, and walking speed. Frailty assessment tools are designed to identify patients at risk for postoperative morbidity and mortality, longer hospitalization, and discharge to higher level of care. Preoperative frailty assessment is recommended for older patients to allow for more robust discussion with patients and their families about perioperative risk and postoperative care needs.

Risk Assessment Tools

Over the last decade, multiple perioperative risk assessment tools have been proposed for surgery patients to assist in risk stratification. The American Society of Anesthesiologists (ASA) Status (see Table 12.2) guides planning for intraoperative and postoperative monitoring and is commonly used to stratify patients in outcomes research. The Revised Cardiac Risk Index and Caprini Risk Assessment Model for venous thromboembolism are utilized frequently to assess cardiovascular complication risk and to guide testing and prophylaxis measures.

In 2013, the ACS published a surgical risk calculator derived from the NSQIP data, the most robust surgical

Table 12.2 American Society of Anesthesiologists (ASA) classification

ASA I	Normal, healthy
ASA II	Mild systemic disease
ASA III	Severe systemic disease
ASA IV	Severe systemic disease that is constant threat to life
ASA V	Moribund patient not expected to survive without the operation
ASA VI	Brain-dead patient whose organs are being removed for donor purposes

outcomes program to date. This calculator estimates the risk of multiple complications within the 30-day postoperative period using 21 predictive variables (https://riskcalculator.facs.org) [28]. This risk calculator has been validated in multiple populations including geriatric patients, various cancer populations, and procedure-specific studies. Limitations of the ACS NSQIP Risk Calculator include that the model is derived from a limited set of 393 participating hospitals, which perform only about 30% of all surgeries in the USA. As such, it may not account for the variation in outcomes seen across all US hospitals. The accuracy of the tool is further dependent on coding and reporting accuracy at the individual institution level [29].

Current Standards of Care: Which Asymptomatic Patients Should Undergo Preoperative Testing and Consultation?

Pulmonary Assessment

In general, routine chest X-rays are not required for asymptomatic patients. Chest radiograph is recommended for

patients with known cardiovascular and pulmonary disease; patients more than 50 years old who will have upper abdominal, thoracic, or abdominal aortic surgery; and patients with Class 3 obesity (BMI ≥ 40 kg/m^2) [16, 30]. Routine pulmonary function testing is not recommended.

Pulmonary and preoperative anesthesiology evaluation can be considered for patients with severe obesity, history of difficult intubation, elevated Mallampati score, and positive sleep apnea screening questionnaires. The STOP-Bang Questionnaire (see Table 12.3) and Berlin Questionnaire are commonly used [31, 32]. The Berlin Questionnaire calculates risk for sleep apnea based on snoring frequency and intensity, observed apnea during sleep, fatigue after sleep and during waking time, history of falling asleep while driving, and hypertension [32].

Cardiovascular Assessment

Electrocardiogram is recommended for patients with known cardiovascular disease or for patients to undergo higher-risk

Table 12.3 STOP-Bang Questionnaire for obstructive sleep apnea [31]

	No	Yes
Snore loudly?		1
Daytime fatigue?		1
Has anyone observed you stop breathing?		1
High blood pressure?		1
BMI ≥ 35 kg/m^2		1
Age > 50		1
Neck circumference (>43 cm in males, 41 cm in females)		1
Male sex		1

Low risk 0–2, intermediate 3–4, high risk 5–8 (or >2 and male or BMI > 35 kg/m^2)

surgical procedures, regardless of symptoms. Routine ECG or echocardiogram is not indicated for asymptomatic patients preparing for low-risk surgeries. Stress testing is reserved for higher-risk patients with poor functional capacity (<4 METs).

Conclusion

Identification of patients at risk for perioperative cardiopulmonary complications through careful history and examination and validated risk indices is imperative in the delivery of high-value care. Adherence to standards for selective preoperative testing and consultations reduces cost without the expense of increased mortality or morbidity. For certain patient populations, preoperative evaluation by primary care or anesthesiology providers remains a vital means to deliver patient education, manage expectations, and optimize modifiable perioperative risk factors. This may be particularly important in safety-net hospitals and for frail and socioeconomically disadvantaged patients.

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