CME

# Preoperative assessment of patients undergoing elective noncardiac surgery

**Gayle Bodner, MMS, PA-C; Emily Cabel, MMS, PA-C; Chris Kaiser, MMS, PA-C; Mackenzie Murphy, MMS, PA-C; Laura Tastad, MMS, PA-C**

**ABSTRACT**

Patient comorbidities and risk factors are important to the success of any operation, and knowing about them before surgery can help clinicians anticipate perioperative complications and optimize patient conditions. This article describes key considerations in the preoperative assessment of patients undergoing elective noncardiac surgery and describes risk stratification for common conditions.

**Keywords:** preoperative, assessment, coronary artery disease, chronic obstructive pulmonary disease, obstructive sleep apnea, diabetes

## Learning objectives

- Discuss common diseases that can affect perioperative morbidity and mortality.
- Identify tools for risk stratification in surgical patients.
- Explain the importance of communication between the primary care provider, consultants, and the perioperative care team.

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As the older population of the United States continues to grow annually, their need for surgical procedures also will increase.[1,2] How they will tolerate surgery depends on each patient's unique medical history. The medical history plus preoperative assessment do not imply approval or disapproval of a recommended operation, but rather serve to distinguish patients at high risk for complications.[3] Patient comorbidities and risk factors that are identified before surgery can help clinicians anticipate perioperative complications and provide an opportunity to address optimal medical and perioperative management. These evaluations also contribute to the informed discussion with the patient that is necessary before any procedure. Whether in primary care or specialty settings, physician assistants (PAs) play a prominent role in these evaluations. This article describes key considerations in preoperative assessment of patients undergoing elective noncardiac surgery and provides a guide to risk stratification for common conditions.

## CARDIOVASCULAR STATUS

Coronary artery disease (CAD) and heart failure are important indicators of postoperative complications. Recent cardiovascular events such as myocardial infarction (MI) or unstable angina are associated with significantly increased rates of postoperative morbidity and mortality.[4] A recent MI (defined as having occurred within 6 months of planned surgery) is an independent risk factor for perioperative stroke.[5] In a retrospective review of more than 150,000 patients over age 65 years, Hammill and colleagues observed a 63% greater risk of operative mortality in patients with heart failure compared with

**Gayle Bodner** is an assistant professor in the PA program at Wake Forest School of Medicine in Winston-Salem, N.C., an assistant professor in the Department of Anesthesiology at Wake Forest School of Medicine, and practices in the preoperative assessment clinic at Wake Forest Baptist Medical Center. **Emily Cabel** practices in family medicine at United Family Medicine in St. Paul, Minn. **Chris Kaiser** practices hospital medicine at Buffalo General Medical Center and South Buffalo Mercy Hospital in Buffalo, N.Y. **Mackenzie Murphy** practices hospital medicine at Wake Forest Baptist Medical Center. **Laura Tastad** practices in vascular surgery at Wake Forest Baptist Health-High Point (N.C.) Medical Center.
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**Key points**

- Risk stratification tools can help clinicians identify patient risk for postoperative complications.
- Preoperative assessment can help clinicians and patients optimize medical conditions before surgery and may influence perioperative planning.
- Postoperative pulmonary complications are common and contribute to significant patient morbidity and mortality.

patients without heart failure or CAD.[6] In patients scheduled for elective surgery, defined as surgery that can be postponed for as long as 12 months, a thorough assessment of cardiovascular risk can facilitate improved quality of care and shared decision-making.[4]

The 2014 ACC/AHA guidelines provide an algorithmic approach to the preoperative assessment of patients with CAD or equivalent risks.[4] Clinicians can use this approach to optimize preoperative management and minimize the risk of adverse patient outcomes.[4] Bringing in the cardiology team before elective surgery may be beneficial to patients with moderate to severe valvular disease or pulmonary hypertension, implantable cardiac devices, or known congenital heart disease.

**CAD risk estimation** Before elective, nonemergency surgical procedures, patients with established CAD or substantial risk factors for CAD should undergo risk stratification using a validated risk prediction tool (**Table 1**).[3] Clinicians can use results from these tools to aid shared decision-making with patients about the appropriateness of surgery. Risk estimates also may indicate the need for further preoperative workup.

The Revised Cardiac Risk Index (RCRI) is a validated and widely accepted tool to evaluate the risk for major complications including cardiac arrest, MI, or death. The RCRI consists of six predictors of risk; however, only one of those predictors takes into consideration the type of surgical procedure.[4] The RCRI does not consider sex, age, smoking history, or hypertension in assessing risk of major cardiac complications.[4]

Two newer indexes developed by the American College of Surgeons (ACS) are the National Surgical Quality Improvement Program's (NSQIP) Myocardial Infarction or Cardiac Arrest, and the NSQIP Surgical Risk Calculator.[7] Both tools are derived from a large multicenter study consisting of more than 1 million surgical procedures.[4] The NSQIP tools include the type of procedure when estimating perioperative risk. The ACC/AHA guidelines conclude that these tools may offer the best estimation of surgery-specific risk.[4]

Patients with a low calculated risk of perioperative adverse reactions (RCRI score less than 2 or NSQIP less than 1%) may proceed to surgery without further cardiac testing.[4] Patients with higher risk may benefit from assessment of their functional capacity or exercise tolerance, which is a strong predictor of perioperative adverse reactions.[4] Patients with low functional capacity have a higher risk of adverse reactions; those with high capacity often can proceed to surgery without further workup.[4]

The 2014 ACC/AHA guidelines recommend no additional testing in patients with moderate to excellent functional capacity, which is generally expressed as greater than 4 metabolic equivalents (METs) of activity. An exercise stress test is the most accurate predictor of functional capacity; however, stress testing is not appropriate for all patients. In the absence of a recent exercise stress test, the clinician can have a discussion with the patient about activities of daily living, which can provide an estimate of the patient's functional capacity (**Table 2**).[4,8] Additionally, the Duke Activity Status Index, which takes into account a range of self-reported activities, has been shown to predict death or complications after major elective noncardiac surgery.[9]

If the patient's functional capacity is poor or difficult to estimate, consider more testing if the results will influence the plan of care.[4] Even for a patient with many risk factors, if the planned surgery is low-risk (for example, ophthalmologic surgery, plastic surgery, or hand surgery), the risk of adverse cardiac events is low. These patients do not benefit from additional evaluation; however, major vascular surgery would entail higher risk.[4] When additional testing is warranted, clinicians should consider pharmacologic stress testing. If the result is abnormal, the patient should undergo revascularization according to clinical practice guidelines.[4] In this case, consider cancelling or delaying elective surgery in consultation with the cardiology care team.

In patients who have had a previous MI, the data suggest that more than 60 days should elapse before noncardiac surgery in the absence of a coronary intervention. Additionally, in patients undergoing percutaneous coronary intervention, elective noncardiac surgery should be postponed until 30 days after a bare metal stent is placed. For patients receiving a drug-eluting stent, the optimal delay is 365 days after stent placement, but surgery can be considered after 180 days if the risk of delay is outweighed by risk of stent thrombosis.[4,10] Patients on dual antiplatelet therapy require thoughtful consideration for timing of surgery, particularly if cessation of P2Y12 platelet inhibitor therapy is mandated (**Table 1**).[10]

As the prevalence of heart failure rises with a growing aging population, clinicians must consider patients' heart failure status in the preoperative setting. Patients with signs and symptoms of decompensated heart failure have the highest risk of complications among patients having noncardiac surgery.[4] Risk is correlated with the degree of systolic dysfunction; the greatest risk is seen in patients with a left ventricular (LV) ejection fraction of less than 35%.[4] Consider assessing LV function in patients with

**TABLE 1.** Common preoperative assessment and risk screening tools

| Tool | Type of assessment | Resource |
|---|---|---|
| RCRI | Cardiovascular risk in noncardiac surgery | www.mdcalc.com/revised-cardiac-risk-index-pre-operative-risk |
| NSQIP MICA | Risk calculator that includes surgical site differentiation | www.surgicalriskcalculator.com/miorcardiacarrest |
| NSQIP Surgical Risk Calculator | Risk calculator that uses specific current procedure terminology code (CPT) | http://riskcalculator.facs.org/RiskCalculator/ |
| Duke Activity Status Index | Patient-reported activities for estimate of functional capacity in METs | www.mdcalc.com/duke-activity-status-index-dasi |
| 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery | Decision-making for cardiovascular testing before noncardiac surgery | www.onlinejacc.org/content/64/22/e77 (Figure 1 for risk assessment and Figure 2 for algorithm in patients with recent cardiac stents) |
| 2016 ACC/AHA guideline focused update on duration of dual antiplatelet therapy in patients with coronary artery disease | Treatment algorithm for the timing of elective noncardiac surgery in patients with coronary stents | www.onlinejacc.org/content/68/10/1082 (Figure 6 for medication management considerations) |
| STOP-Bang | Screen obstructive sleep apnea in any patient | www.stopbang.ca/osa/screening.php |
| MELD | Risk of postoperative mortality for all types of major surgery in patients with cirrhosis | www.mayoclinic.org/medical-professionals/transplant-medicine/calculators/post-operative-mortality-risk-in-patients-with-cirrhosis/itt-20434721 |
| CTP | Estimates severity of cirrhosis | www.mdcalc.com/child-pugh-score-cirrhosis-mortality |
| ACS National Surgical Quality Improvement Program | Optimal perioperative care of older adults | www.facs.org/-/media/files/quality-programs/geriatric/acs-nsqip-geriatric-2016-guidelines.ashx |

worsening symptoms or in those suspected of being in heart failure.[4] Preoperative evaluation of patients with heart failure should include informed discussion and can help with shared decision-making.[4]

## PULMONARY CONDITIONS

**Chronic obstructive pulmonary disease (COPD)** More patients in the surgical population have COPD than in the general population. Those diagnosed before surgery have longer average operative times and spend four times as long recovering in the hospital as patients without COPD.[11] Based on a multicenter database analysis, Gupta and colleagues found that patients with COPD had an overall mortality of 6.7% compared with 1.4% for those without COPD.[11] Additionally, after controlling for more than 50 comorbidities and type of surgery, they found that COPD was independently associated with postoperative pneumonia, respiratory failure, MI, sepsis, renal failure requiring dialysis, and wound dehiscence.[11] Preoperative evaluation can identify opportunities to optimize treatment before elective surgery and can inform the patient discussion.[11]

Established treatments for patients with COPD include inhaled beta agonists, anticholinergics, corticosteroids, and supplemental oxygen. Little data are available to suggest alternative management of patients preoperatively. Short courses of oral corticosteroids have been used in patients with COPD in an attempt to reduce postoperative pulmonary complications, despite mixed evidence to support their use.[12,13]

In patients whose symptoms are concerning for COPD exacerbation, consider delaying surgery until baseline lung function is achieved. For patients with disease ranging from moderately severe to severe, specific documentation and communication with the anesthesia team will enable the clinician to select appropriate airway instrumentation, anesthetic agent, ventilation, and provide careful intraoperative and postoperative monitoring.[11,14]

**Tobacco use** Overall, there are more tobacco smokers in the surgical population than in the general population.[15] Although findings in the literature are inconsistent, a systematic review and meta-analysis by Gronkjaer and colleagues found no higher risk of mortality or cardiovascular complications in this subset of patients.[16] However, in their study preoperative tobacco use correlated with increased rates of postoperative morbidity, infection, prolonged wound healing, neurologic complications, ICU admissions, and postoperative pulmonary complications.[16] Some data suggest that patients who abstain from tobacco use for 4 to 8 weeks before surgery have a reduced risk of postoperative complications compared with those who continue smoking.[16] In this context, and knowing the health risks of tobacco use, the preopera-

**TABLE 2.** Estimated functional capacity based on activities of daily living and corresponding METs[8,9]

| Functional capacity (METs) | Activities |
|---|---|
| Excellent (>10) | Mountain biking, running (9-minute mile), soccer (competitive) |
| Good (7-10) | Pushups, cycling 10 mph, walking uphill, jogging |
| Moderate (4-6) | Carrying 15-lb load, brisk walking, climbing stairs, mowing lawn, trimming shrubs |
| Poor (<4) | Vacuuming, sweeping, washing dishes, cooking, light walking |

tive setting is a good time for clinicians to encourage patients to stop smoking.

**Obstructive sleep apnea (OSA)** Many patients undergo surgery without being aware that they have OSA.[17] OSA is present in substantially higher rates in some surgical patients compared with the general population—for example, up to 70% of patients undergoing bariatric surgery have OSA.[17] Obesity and older age are considered to be contributing factors for many surgical patients.[17] Patients with OSA are at higher risk of postoperative pulmonary and cardiac complications than those without OSA.[17] Expert consensus guidelines recommend screening for OSA; this is despite limited evidence that the use of preoperative screening tools for OSA reduces patient complications.[17]

One such screening resource recommended by the Society of Anesthesia and Sleep Medicine task force guidelines is the STOP-Bang screening tool.[17] The STOP-Bang tool is the most validated in the surgical population; patients with a score of 3 or higher have increased rates of postoperative complications.[17] Identifying patients at risk can help target perioperative precautions and interventions, and may help reduce patient complications.

For patients with OSA who are appropriately managed, the clinician should document sleep study results and positive airway pressure (PAP) settings, if possible, before surgery for proper postoperative monitoring and decisions about opioid use.[18] Because observational data suggest that PAP therapy may help reduce postoperative pulmonary complications, patients should be encouraged to use their device before and after surgery.[18] Additionally, when appropriate, all patients should continue using the device during their hospitalization, and clinicians should take measures during preoperative consultations to increase patient adherence.[18]

## DIABETES MANAGEMENT

A major goal of preoperative diabetes management is to minimize acute hyperglycemia before, during, and after surgery because it is associated with poor clinical outcomes.[19,20] Perioperative hyperglycemia affects between 20% and 40% of general surgery patients and up to 80% of postcardiac surgery patients with or without a diagnosis of diabetes.[20]

Chronic hyperglycemia has been found to be a predictor of increased length of stay, irrespective of plasma glucose level on the day of surgery.[19] Factors that contribute to the triggered hormonal activation associated with the stress of surgery and anesthesia include invasiveness of the procedure, intraoperative fluid requirements, surgeries involving the thorax and abdomen, and general anesthesia versus local or neuraxial anesthesia.[20] Diagnosed diabetes or hyperglycemia in surgical patients has been shown to lead to increased morbidity and mortality.[20] This increase has multiple components that can include unrecognized hyperglycemia, prescribing errors, multiple comorbidities including microvascular and macrovascular complications, increased perioperative infections, and inadequate institutional guidelines or staff training for management of diabetes and hyperglycemia.[21]

The goal of maintaining normoglycemia can be challenging in patients with poorly controlled diabetes. To avoid these complications, the American Diabetes Association focuses on clinical decision-making for patients with diabetes who are undergoing noncardiac elective procedures. The literature lacks a specific preoperative hemoglobin A1C cutoff as a contraindication to surgery. However, studies show that an A1C greater than 7% is associated with an increase in infectious complications, and an A1C greater than 8% tends to be associated with increased postoperative complications and longer hospital stays.[17,20] Clinicians conducting preoperative evaluations should use their judgment and collaborate with the surgical team to determine if patients should improve their glycemic control before surgery.

Another important aspect in managing patients with diabetes preoperatively is scheduling the surgery for an appropriate time to avoid prolonged fasting that may result in hypoglycemia. To avoid this situation, clinicians should request that patients be scheduled as early in the day as possible.[21] Additionally, calculating the expected length of the procedure helps determine immediate preoperative care, from minor medication changes to more involved perioperative plans pertaining to variable-rate IV insulin infusion.[21] Preoperative carbohydrate loading can counteract some of the hormonal response associated with surgical stress and the state of starvation. Giving the patient carbohydrate-rich drinks up to 2 hours before surgery has been shown to reduce postoperative insulin resistance and length of stay in patients undergoing major abdominal surgery.[20]

## HEMATOLOGIC CONSIDERATIONS

Preoperative anemia also can be a factor. In a review of 18 large observational studies that involved 650,000 surgical patients, the incidence of preoperative anemia was shown to vary from 10.5% to 47.9%.[22] In that study, the prevalence

of anemia was higher than in the general population, and varied by type of surgery, patient population, and World Health Organization definition of anemia (according to age, sex, and pregnancy status).[22] The cause of preoperative anemia is complex and may be multifactorial for some patients. In those age 65 years and older, one-third of cases can be attributed to nutrient deficiency (iron, vitamin B12, or folic acid) and another third to chronic inflammation (including chronic kidney disease); the last third is unexplained.[22] Other causes of preoperative anemia include activation of immune and inflammatory cytokines that can lead to decreased red blood cell longevity, poor erythropoietin response, pathologic iron homeostasis, and blood loss secondary to multiple diagnostic tests.[22]

Severe and moderate preoperative anemia has been associated with increased risk of postoperative morbidity, mortality, and ICU admissions compared with patients who have normal hemoglobin levels.[22,23] Correcting anemia before surgery has been found to be more cost-effective and safer than managing its complications, especially if blood transfusions are necessary during the surgery.[24] In a study that used the ACS NSQIP database for noncardiac surgery patients who have severe anemia, Glance and colleagues found that the need for intraoperative blood transfusion of 1 to 2 units was associated with a higher risk of pulmonary, septic, wound, and thromboembolic complications as well as 30-day mortality compared with nontransfused patients.[23] Poor outcomes associated with transfusions can result from surgical bleeding and other confounding factors. The American Association of Blood Banks' clinical practice guidelines recommend adhering to restrictive transfusion protocols (hemoglobin level of 7 to 8 g/dL) because fewer patients die if they are under restrictive strategies.[25] IV iron infusion has been proposed as an option for correcting preoperative low hemoglobin; however, this has not been widely studied.[26]

Clinicians in primary care and surgical settings may choose to further evaluate, initiate treatment, or to consider delaying surgery until patients' preoperative hemoglobin can be optimized.[27] One preoperative anemia clinic and treatment algorithm was described by Guinn and colleagues.[27] Many models exist, but their model addressed patients undergoing joint replacement. The algorithm can be applied to most patients with preoperative anemia and risk of perioperative blood transfusion. The stepwise algorithm considers laboratory markers to guide evaluation, and also takes into consideration whether to administer erythropoietin, oral or IV iron, and when to obtain a hematology referral.[27]

Consider bleeding and clotting disorders during preoperative evaluations. The patient history should include personal and family history of abnormal bleeding as well as a review of medications that may pose an additional risk of bleeding. Similarly, note a patient's personal or family history of any clotting disorders or thrombotic events. If the patient is taking therapeutic anticoagulants, the preoperative clinician should work in collaboration with the surgical team to determine if and when anticoagulation should be stopped, and whether bridging therapy is needed.[28]

## CIRRHOSIS

A systematic review of 46 articles evaluating mortality and morbidity in patients with cirrhosis after nonhepatic surgery found worse outcomes than in patients without cirrhosis. The outcomes of patients with portal hypertension were even worse.[29] Although surgical risks vary depending on the type of procedure as well as the patient's overall health, Model for End-stage Liver Disease (MELD) scores predicted surgical risk in patients with hepatic disease.[29] This scoring system is calculated based on a patient's kidney function, International Normalized Ratio (INR), and sodium and bilirubin levels. The MELD score has historically been associated with liver transplantation procedures, but more recently has been used to assess risk of adverse postoperative reactions in patients with liver disease undergoing nonhepatic surgeries.[30] The Child-Turcotte-Pugh (CTP) score is another scoring system that estimates severity of liver disease and can predict nonhepatic surgical outcomes in patients with cirrhosis.[29] PAs play an important role in identifying these patients and directing optimum treatment for ascites, varices, and other complications; identification also allows informed discussion of severe bleeding and other risks.

## COMPROMISED IMMUNITY

Obtain a thorough medical history in patients with immunosuppression, including a careful review of medications, recent infections, previous surgical history with outcomes, and a summary of recent laboratory studies that reveal the acuity or stability of their condition. Guideline-driven recommendations are available for managing patients on immunosuppressive agents undergoing total joint arthroplasty.[31] Articles with recommendations for patients with inflammatory bowel disease provide guidance on specific perioperative complications, nutrition needs, and management of their immunosuppressant therapy.[32,33] In patients on specific immunotherapy, antiviral therapies, or antibiotic prophylaxis, the primary care clinician and the specialist must collaborate and communicate effectively with the patient's surgical team. Many conditions requiring immunosuppressive therapy depend on minimally interrupted dosing to achieve desired outcomes. Therefore, discuss with the patient how to continue the medication in the context of preoperative NPO instructions. Often, the patient can take oral medications on the day of surgery with a small sip of water.

## OTHER CONSIDERATIONS

Although many components of perioperative assessment can influence a patient's perioperative course, not all are

included in this article. In older adults, also consider nutrition, advance directives, cognitive impairment, and fall risk.[3,34] The use of prehabilitation, a program aimed at improving patients' functional status in the weeks leading up to surgery, has been beneficial in reducing overall, and especially pulmonary, complications in some surgical populations.[35] In the context of surgical risk, the significance of any particular patient-related characteristic or comorbid condition is too broad to be covered in one article. Even considering evidence-based guidelines for specific diseases, perioperative management continues to be dependent on evaluating the patient carefully, and using evidence and expert-guided practice to minimize harm.

## CONCLUSION

A thorough patient interview and physical examination are essential before any elective noncardiac surgery. They enable the clinician to assess the patient's existing health conditions and to uncover new ones that may put the patient at risk for complications. By identifying and evaluating these circumstances before surgery, the surgical and anesthesia teams can anticipate common perioperative complications and inform postoperative care. Although this article focuses on the preoperative assessment, other research provides in-depth guidelines for managing the conditions outlined herein. Clinicians should make important findings in the preoperative evaluation available to the perioperative care team as well as to any specialists involved in key decisions. Depending on the setting and the timing of surgery, this can be accomplished through electronic medical records or direct conversation with the anesthesia or surgical teams. Ideally, high-risk patients are evaluated weeks to months preoperatively, which allows ample time to include additional testing, arrange specialist input when needed, optimize medical conditions, and hold patient discussions. Communication with the perioperative team and coordination of care are essential for achieving the best outcomes for patients. **JAAPA**

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