Preoperative screening: What tests are necessary?

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SUMMARY The preoperative evaluation often includes more tests than are necessary. This article reviews the usefulness of and indications for nine commonly ordered preoperative tests.

KEY POINTS Physicians must consider the history, physical findings, and type of surgery in deciding which tests are needed before surgery in the individual patient. Patients undergoing minor surgery usually need minimal testing, even if they have established chronic medical conditions. Excessive testing carries potential morbidity and increases the cost of medical care. In general, coagulation testing, measurements of serum hemoglobin, potassium, creatinine, and glucose concentrations, liver function tests, urinalysis, chest radiography, and electrocardiography can be reserved for patients likely to have abnormal findings, or about to undergo surgery that may lead to abnormalities in these parameters.

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PREOPERATIVE screening tests complement the history and physical examination in assessing the risk posed by an operative procedure. When performing a preoperative evaluation, clinicians can choose from a multitude of tests, often with a simple check on an order form. This leads to too many tests being ordered in many patients seen for preoperative evaluation. Perez and colleagues[1] found that in asymptomatic patients undergoing elective surgery, routine testing led to a change in perioperative management in less than 1% of 3131 cases. Such indiscriminate testing carries potential morbidity, as false-positive results can unnecessarily delay surgery, lead to more invasive tests, or both. Further, unnecessary testing increases the cost of medical care.

How can the clinician select which tests a patient truly needs? The medical history and physical examination are relevant. In addition, certain procedures, such as cataract surgery, pose such a low risk that extensive preoperative screening is not necessary, even in patients with complex medical problems. Thus, one needs to indi-

vidualize testing on the basis of the patient *and* the procedure. This paper examines the evidence regarding nine common preoperative tests: coagulation studies; serum concentrations of hemoglobin, potassium, creatinine, and glucose; liver function tests; urinalysis; chest radiography; and electrocardiography. We also offer recommendations for testing, based on other reviews of this topic.[2–4]

COAGULATION STUDIES

Several studies have shown that few patients have a prolonged prothrombin time (PT) or partial thromboplastin time (PTT) who do not have a clinical indication for these tests.[5–7] Bushick et al,[5] in a retrospective study of 640 patients undergoing elective orthopedic surgery who were in class 1 or 2 in the American Society of Anesthesiologists rating system (see *Table 2* in "Postoperative pulmonary complications: risk assessment, prevention, and treatment" on page 402), found that only 0.3% of PT results and 0.9% of PTT results were outside the "action limits" (ie, beyond which some action would normally be taken because of the result—13.0 seconds for the PT or 40.0 seconds for the PTT). Similar results were seen in a study of medical patients by Erban et al,[6] and in a study by Rohrer et al[7] of general surgical patients.

In addition, coagulation studies have not been shown useful in predicting hemorrhage. Suchman and Mushlin,[8] in a prospective study, showed that prolonged PTTs predicted hemorrhage in a group of high-risk patients, but not in low-risk patients. Gewirtz and colleagues[9] reviewed the literature and their own data concerning the bleeding time test and concluded that it has a low predictive value as a preoperative screening test and should only be used in patients with a history of hemorrhagic disorders.

Therefore, not all patients need routine coagulation testing before surgery—only those with an increased likelihood of having an abnormal result, and those for whom a history cannot be obtained.

Coagulation testing: recommended indications

- Liver disease
- Malnutrition or malabsorption
- Anticoagulant therapy
- Recent history of or current active bleeding
- Inability to provide a history

HEMOGLOBIN TESTING

As many as 9% of patients may have low hemoglobin or hematocrit levels, using hemoglobin lower limits of 14 g/dL for men and 12.5 g/dL for women, and hematocrit lower limits of 42% and 36%, respectively.[10] The number of abnormal results falls to 0.7% when lower limits of 8 mg/dL for hemoglobin or 18% for hematocrit are applied for both men and women.[11] In a case-control study of 125 general surgery patients, those with preoperative hemoglobin concentrations of less than 8.0 mg/dL were 16.2 times more likely to suffer complications, including death, myocardial infarction, congestive heart failure, or cardiac arrhythmias.[12] In this study, the lower the preoperative hemoglobin concentration and the more blood lost during surgery, the greater the mortality rate ($P < .005$). Velanovich[13] found that abnormal hemograms (white blood cell counts or hematocrits) were significantly more common in patients over age 60 ($P < .0001$), in ASA class 3 or 4 ($P < .0001$), with kidney disease ($P < .0003$), with malignant diseases ($P < .0005$), or with diabetes mellitus ($P < .0001$).

These studies suggest that in patients without symptoms, screening hemoglobin concentrations of less than 8 or 10 mg/dL are uncommon but predictive of increased morbidity and mortality. Patients with known coronary disease or congestive heart failure should have a preoperative hemoglobin determination because of the propensity of these conditions to worsen with anemia.

Hemoglobin testing: recommended indications

- Any procedure commonly associated with major blood loss
- As a test of health maintenance in patients with no medical care
- Pregnancy
- Historical or physical findings suggestive of anemia
- Renal insufficiency
- History of any malignant disease
- Recent immigrants
- Institutionalized patients older than 75 years
- Diabetes mellitus
- Cardiac disease

SERUM POTASSIUM CONCENTRATION

Preoperative potassium screening is done primarily because of concerns about hypokalemia and car-

diac complications. Most of the concerns about hypokalemia are based on either in vitro experiments[14] or electrocardiographic surveys in nonsurgical patients.[15,16] Some studies have not found hypokalemia to be associated with increased cardiac risk,[17,18] although it is counted as a minor risk factor in the Goldman multifactorial cardiac risk factor index (see *Table 1* in "Evaluating cardiac risk in noncardiac surgery patients" on page 394).[19] Vitez et al[17] found, in a prospective study of 447 patients, that hypokalemia was not associated with a higher incidence of either preoperative or intraoperative arrhythmias; the only significant risk factor for intraoperative arrhythmias was the presence of arrhythmias before surgery. Most of the patients in this study were generally healthy. In contrast, a study by Hirsch et al[18] included more patients with known cardiac risk factors, who were receiving digoxin, or who underwent surgeries associated with a high incidence of cardiac complications. Neither benign nor complex ventricular arrhythmias were more common in patients with hypokalemia.

Further studies are needed to examine the relationship between hypokalemia and adverse outcomes, especially with respect to the degree of hypokalemia. In view of this, a serum potassium measurement is recommended in patients who have an increased likelihood of potassium abnormalities and in patients over the age of 60.[2]

Potassium testing: recommended indications

- Diuretic therapy
- Diarrhea
- Diabetes mellitus
- Renal disease
- Inability to provide a history
- Patients older than 60 years

SERUM CREATININE CONCENTRATION

Hou et al[20] retrospectively studied 2216 medical and surgical inpatients and found the risk of acute renal insufficiency to be significantly higher in patients with a baseline serum creatinine concentration greater than 1.2 mg/dL ($P < .001$). In a separate study, Velanovich[13] determined that risk factors associated with a high serum creatinine concentration included age greater than 50 years ($P < .0001$), male sex ($P < .0001$), ASA class greater than 3 ($P < .0001$), coronary artery disease ($P < .0001$), heart disease ($P < .0003$), hypertension ($P < .0001$), and diabetes mellitus ($P < .0003$).

Creatinine testing: recommended indications

- Patients older than 50 years
- Diabetes mellitus
- Hypertension
- Cardiac disease
- Severe liver disease
- Syndrome of inappropriate antidiuretic hormone (SIADH) or diabetes insipidus
- Known renal disease

SERUM GLUCOSE CONCENTRATION

The serum glucose concentration is often measured before surgery, in part because of evidence from large retrospective studies in the 1970s that suggested an increased operative risk for patients with diabetes mellitus.[21,22] These older studies did not control for the type of surgical procedure performed or for coexisting disease. More recently, Narr et al[23] reviewed 3782 surgical patients in ASA class 1 and found that only 70 had abnormal screening glucose concentrations. Only one patient required treatment. In a retrospective study, Hartup et al[24] controlled for operative procedure, sex, age, weight, and coexistent cardiovascular disease in a comparison of 224 diabetic and 224 nondiabetic patients. There was no significant difference in the rate of complications, and in the diabetic group, the complications were evenly distributed among patients treated with insulin, oral agents, and diet.

This evidence indicates that preoperative glucose testing is not warranted for all patients. Testing should focus on those at risk for hyperglycemia on the basis of the medical history.

Glucose testing: recommended indications

- Diabetes mellitus
- Steroid therapy
- Pancreatic, hypothalamic, or adrenal disease

LIVER FUNCTION TESTS

Biochemical profiles have been available in hospitals since the advent of automated simultaneous multiple analysis (SMA). These typically include 12 to 20 independent chemical determinations. Because of the high rate of false-positive results, these profiles cannot be justified as routine preoperative screening tests. Cebul and others[25] have found that

routine preadmission screening with biochemical profiles yields abnormal results in up to 40% of patients, but leads to a new diagnosis in fewer than 10%. Up to 80% of the abnormalities remain unexplained, often after extensive and expensive investigation. However, liver function tests (serum concentrations of albumin, bilirubin, and aminotransferases) do have a role in preoperative evaluation in the situations listed below.

Liver function testing: recommended indications

- Known liver disease
- Remote history of hepatitis
- Known malignant disease

URINALYSIS

A screening urinalysis is often performed before surgery because of the possible relationship between remote infection and surgical wound infection. Lawrence et al[26] retrospectively studied 200 patients who underwent elective knee procedures, all of whom had a preoperative urinalysis. The test was not medically indicated in 90%. Fifteen percent of patients had abnormal results, and 70% of these suggested infection. However, there were no wound infections in patients with abnormal urinalysis results. Fraser et al[27] found that of 2600 urinalyses that were not indicated, only 13 led to a change in diagnosis or therapy. Thus, routine preoperative urinalysis is rarely indicated.

Urinalysis: recommended indications

- Any surgical procedure in which urinary tract instrumentation is expected

CHEST RADIOGRAPHY

The value of preoperative chest radiography is controversial. Studies have found that abnormal findings on screening chest radiographs are rarely investigated further and tend not to alter overall care.[28,29] In a study by the Royal College of Radiologists of more than 10 000 patients undergoing noncardiopulmonary surgery, chest radiographs did not appear to influence patient management before or after surgery.[28] Rucker et al[30] found that risk factors that predicted chest radiographic abnormalities included a history of cancer at any site, smoking, and exposure to toxic chemicals. In this study, there was a highly significant difference in the rate of radiographic abnormalities between the high-risk and low-risk groups.

Tape and Mushlin[31] found that clinical characteristics (age greater than 75 years, previous myocardial infarction, and history of typical angina) were much more predictive of postoperative chest complications than were abnormalities on screening chest radiographs. In this retrospective study, a strategy of performing chest radiography only in patients with signs or symptoms of chest disease would not have missed any patients who derived clinical benefit.

Boghosian and Mooradian[32] found a 49% prevalence of abnormal chest radiographs and a 17% incidence of postoperative pulmonary complications in a group of patients over the age of 70, and concluded that all patients in this age group should have routine preoperative chest radiographs. Others have also argued that most elderly patients have clinical indications for chest radiography.[33,34] However, the impact of a preoperative chest radiograph on clinical outcome in elderly patients is unclear. There is general consensus that a baseline preoperative chest radiograph is useful in patients undergoing thoracic surgery.

Chest radiography: recommended indications

- Intrathoracic surgical procedures
- Signs and symptoms of active chest disease
- Candidates for major surgery older than 70 years (possibly)

ELECTROCARDIOGRAPHY

Screening electrocardiograms are often abnormal. There is a direct association between age and electrocardiographic abnormalities,[35–37] and an increased prevalence of abnormalities in patients in ASA class 2 or higher.[35] The strength of the association between common electrocardiographic abnormalities and perioperative complications is not clearly defined.[19,35,38] There is, however, a clear association between recent Q-wave myocardial infarction and increased perioperative cardiac morbidity and mortality.[19] Further, up to 25% of Q-wave myocardial infarctions may be silent.[39] There is also evidence that clinically silent arrhythmias are markers of increased cardiac risk.[19] Thus, the history alone cannot be used to guide cardiac risk assessment. In view of the morbidity and mortality associated with cardiac complications, as well as the frequency of electrocardiographic abnormalities in elderly patients, screening preoperative electrocardiograms are rec-

ommended in men older than 45 years and women older than 55 years, as well as in the other conditions listed below.

Electrocardiography: recommended indications

- Men older than 45 years
- Women older than 55 years
- Systemic disease associated with unrecognized cardiac conditions, including hypertension, peripheral vascular disease, and diabetes mellitus
- Certain cardiotoxic medications, including doxorubicin, phenothiazines, and tricyclic antidepressants
- Intrathoracic, intraperitoneal, aortic, or emergency surgery

CONCLUSION

The preoperative evaluation often includes more testing than is necessary. The clinician must individualize testing on the basis of the patient's medical history, physical findings, and type of surgery. At the same time, preoperative testing practices need to be studied further, to refine these guidelines and provide optimal, cost-effective medical care for patients undergoing surgical procedures.

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