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"ROUTINE" PREOPERATIVE STUDIES Which Studies in Which Patients?

Surgical Clinics of North America - Volume 76, Issue 1 (February 1996) - Copyright © 1996 W. B. Saunders Company

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COST EFFECTIVENESS IN SURGERY

"ROUTINE" PREOPERATIVE STUDIES Which Studies in Which Patients?

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As part of the preoperative evaluation, the majority of patients admitted for elective surgery undergo "routine" preoperative testing. The purpose of widespread testing is threefold: to evaluate a known clinical condition, to identify patients at high risk, and to screen patients for new disease that may affect perioperative morbidity. The cost of preoperative screening examinations is considerable. More than \$30 billion is spent annually on preoperative testing in the United States. [30] The need for such testing is controversial. Studies have shown that 60% of routine screening examinations could be eliminated without adversely affecting patient care. [16] [19] [39] In addition, unnecessary testing may cause harm to the patient in the further evaluation and treatment of borderline or false-positive results. We examine the results of mass screening and selective testing in the preoperative patient and discuss which laboratory tests are required to reduce perioperative morbidity and optimize the patient's preoperative condition.

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RESULTS OF MASS SCREENING

Numerous studies have evaluated the results of "routine" screening laboratory testing in the preoperative patient. • In a retrospective analysis,

*References [2] [15] [16] [18] [25] [26] [28] [30] [32] [38] [39]

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Kaplan et al [16] examined the results of 2785 screening tests in patients undergoing elective surgery. On the

basis of the patient's history, roughly 60% of the tests were unwarranted and ranged from 34% to 90% of requests for each individual test ordered. Overall, 96 abnormalities were detected, 86 of which were anticipated by the patient's history. Ten abnormalities were in the unindicated group (0.5%), with only four laboratory results of any potential surgical significance.

Similar results were noted in a study of 1010 patients undergoing elective cholecystectomy by Turnbull and Buck. [38] Of the 5003 preoperative screening tests, only four results were considered to be of conceivable benefit in addition to the patient's history and physical examination. Among these results were two patients with hypokalemia (3.2 and 3.4 mEq/L), an asymptomatic patient with a hemoglobin concentration of 9.9 gm/dL, and a fourth patient with emphysematous lungs detected only by chest radiography. All four patients received preoperative interventions, although it is unclear whether foregoing these interventions would have been life-threatening for any of the patients. Other studies have also confirmed that the majority of screening tests do not provide additional new information that prevents complications or alters perioperative management. The decision regarding the fitness of a patient for elective surgery can be accurately predicted in 96% of cases on the basis of a complete history and physical examination alone. [41]

POTENTIAL RISKS OF MASS SCREENING

When a large number of laboratory examinations are performed to screen patients preoperatively, it is not unusual for at least one of these to be flagged as abnormal. The "normal" range of values for many diagnostic tests is based on a bell-shaped curve of distribution, with values outside the 95% confidence interval (more than 2 standard deviations away) being reported as abnormal. Subsequently, 5% of *normal* values are classified as "abnormal." This is of great significance when multiple tests are ordered. A patient having 10 tests performed has a 40% chance that at least one will be "abnormal" when it truly is not. This leads to further unnecessary evaluation or treatment for an abnormality that has occurred simply by random chance.

The additional testing required to evaluate an abnormal result is not without risk. Further invasive testing can lead to iatrogenic injury. In a review of adverse outcomes from unnecessary chest radiography, Roizen [31] noted that in a group of 606 patients, 386 patients (64%) had a radiograph that was not indicated. Among these 386 patients, three lung shadows were found. Further invasive testing, including one thoracotomy, did not identify any pathology. These additional procedures resulted in one pneumothorax and a total of 4 months of disability for the patients.

The treatment of borderline results can also lead to potential injury. Potassium repletion in the hypokalemic patient can occasionally result

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in a serious complication. A life-threatening injury occurs in up to 1.7% of patients treated and death in 0.2% of patients. [32] Although these complications are rare, they must be considered when examining the results of abnormal screening tests.

Finally, most studies of mass screening tests have reported that 30% to 95% of unexpected laboratory abnormalities are never noted on the chart preoperatively, nor are they pursued by further evaluation. [2] [30] [32] This lack of documentation occurs at both university medical centers and community hospitals. The failure to pursue an abnormal result may pose a greater medicolegal risk than does the failure to detect the abnormality. The use of nonselective testing, therefore, poses a risk not only to the patient but to the physician as well.

RESULTS OF SELECTIVE TESTING

In a prospective study, Blery et al [3] and Charpak et al [5] evaluated a protocol for selective ordering of 12 preoperative tests over a 1-year period at a teaching hospital in Paris. Forty-four surgeons and anesthesiologists agreed upon the criteria for selective evaluation of the patient. Laboratory tests, electrocardiograms, and chest radiographs were ordered according to the patient's clinical status and type of surgery planned. Overall,

3866 patients undergoing 15,920 tests for 3849 procedures were evaluated. As a consequence of test results, 19 procedures were canceled or delayed and treatment was instituted or anesthetic management modified in 347 cases (9%). Abnormal results were noted in 30% of patients, and the anesthesiologist found the tests helpful in 24% of patients. In reviewing the events that occurred perioperatively, the authors concluded that only 0.2% to 0.4% of omitted tests would have been helpful. This study identified a high yield of clinically significant laboratory abnormalities using a selective evaluation based on a patient's history and physical examination. Although a cost analysis was not performed, on average, 34% of the complete battery of tests was performed in this study, compared with an 80% utilization rate at other teaching hospitals in France. [5] The magnitude of this reduction in preoperative testing was impressive and likely resulted in significant savings.

In a study by Billings et al, [2] the pattern of preoperative testing was evaluated in two phases at a British teaching hospital. During the first phase, over a 6-week period, the ordering of preoperative tests by the house officers was audited and the investigations were assessed as being "indicated" or "not indicated" on the basis of predetermined criteria. During this period, of the 272 tests obtained in 117 patients undergoing elective surgery, 143 (53%) were indicated, and the results of 218 (66%) were noted in the records. Prior to the next phase, the criteria for investigations were distributed and reviewed with the house officers. During the second phase, 305 tests were obtained in 139 patients. Of these investigations, 90% were indicated according to the protocol, and a significantly greater percentage (81%) were noted in the patient's

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record. Also, by use of selective testing, a significant savings was reported. Although the percentage of unwarranted tests dropped from 47% to 10% during the study, the house officers did not obtain an indicated electrocardiogram in 14% of patients during the second phase. This deviation from a selective protocol highlights one of the difficulties with its implementation--the issue of noncompliance. The benefits gained by the use of selective evaluation of the preoperative patient must be balanced against any possible injury resulting from the deletion of a warranted examination.

ERRORS WITH SELECTIVE TESTING

In the study by Blery et al [3] and Charpak et al, [5] a significant discrepancy was also noted between the actual ordering of tests and the protocol agreed upon by the investigators. Of all performed tests, 30% were not recommended by the protocol. More importantly, 24% of the tests recommended by the selection criteria were *not* obtained by the investigators. In a later report, Charpak et al [4] reported the results of the 1101 screening chest radiographs obtained during the trial. According to the protocol, 271 chest films were ordered although not recommended, and 596 were not ordered although they met criteria for the examination. The deviation from the study design may be the result of the clinical judgment of the ordering physician or simply an error in the ordering of these examinations.

The omission of justified testing has been documented not only in selected trials but also in clinical practice. Macario et al [19] reported the preoperative test-ordering patterns of physicians at three major teaching institutions from 1979 to 1987. In reviewing the records of 2093 patients having four surgical procedures, the authors noted that the percentage of unwarranted preoperative tests decreased from 66.9% in 1979 to 60.1% in 1987, with an estimated savings of 320 million dollars. The preoperative ordering of medically indicated examinations also dropped from 92.9% in 1979 to 80.9% in 1987. Clinicians at these three institutions were attempting to selectively reduce the number of preoperative tests. However, in doing so, the authors concluded that the benefit of avoiding unwarranted testing was outweighed by the omission of justified examinations. Clearly, if a selective protocol is to be beneficial, a better system of test ordering must be implemented. To assist in this, Rozien [32] and Rozien et al, [33] have designed a portable computerized program to accurately obtain a patient's health status and then provide the clinician with an automated list of recommended screening examinations. Such a system would likely prevent the exclusion of necessary preoperative investigations and warrants further evaluation.

UTILITY OF PREVIOUS TEST RESULTS

The trend over the past decade has been to reduce the number of preoperative examinations performed. Several reports have also advocated

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the use of previous tests to substitute for preoperative screening examinations, thus limiting further the number of required tests. Patients often have had prior laboratory investigations, leading to the need for surgery. In a study by Macpherson et al, [20] the laboratory results of 1109 patients having elective surgery were examined. Forty-seven percent of the 7549 preoperative tests were duplicated results, which had been performed in the previous year (median interval, 2 months). Of the 3096 previous tests that were normal, only 13 (0.4%) of the repeated values were abnormal. The majority of these (69%) were predicted by the patient's history: a leukocytosis in a patient on corticosteroids; an elevated potassium in a patient with end-stage renal disease; an elevated prothrombin time in three patients, one with cirrhosis, one on warfarin, and a third with a history of abnormal bleeding; and an elevated creatinine in four patients with obstructive uropathy. The authors concluded that unless obviously indicated, prior laboratory tests obtained within 4 months of surgery could safely be substituted for screening examinations. We agree with this conclusion and question whether the time interval could safely be extended to 6 months or more.

RECOMMENDATIONS FOR ROUTINE TESTING

The following are our current recommendations for "routine" preoperative examinations and are summarized in Table 1 .

Chest Radiography

Historically, the ordering of a screening chest radiograph in patients admitted to the hospital was popularized after World War II, when tuberculosis was prevalent. With a declining prevalence of tuberculosis over the next several decades, the chest radiograph was later used as a screening examination for lung cancer. Several studies, however, have shown no significant survival advantage in those patients in whom lung cancer was diagnosed by a screening radiograph compared with other methods, and it is no longer recommended by the American Cancer Society. The cost of screening chest radiographs is considerable. More than 50 million chest radiography procedures are performed yearly in the United States, of which more than 30 million are ordered for routine screening at a cost of at least 1.5 billion dollars. [11] Are all these screening radiographs necessary?

Numerous studies have examined the impact of screening chest radiographs. • The largest study came from the Royal College of Radiologists in 1979 when they reported the results of a multicenter study of 10,619 patients, of whom 29% had a preoperative chest radiograph. [34] The authors noted a wide variation in the use of screening chest radiographs

*References [4] [8] [11] [23] [27] [29] [34] [35] [37] [40]

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TABLE 1 -- RECOMMENDED PREOPERATIVE TESTING FOR ELECTIVE SURGERY

Patient Status	Hemoglobin	PT/PTT	PLT	T/S	K +	BUN/Creat	Glucose	CXR	EKG	Additional Tests
Age	X									
<6 months	X									
<40 years	Female only								Males > 40 years	

40-60 years	Female only						Females > 50 years	
>60 years	X				X	X	X	X
Procedure with blood loss	X		X					
Associated conditions								
Cardiovascular disease	X				X		X	? Stress test
Pulmonary disease	X						X	? PFT/ABG
Smoker (>20 pack-years)	X						X	? PFT/ABG
Hepatic disease		X						AST
Renal disease	X			X	X			
Diabetes				X	X	X		X
Bleeding disorder		X	X					
Malignancy	X						X	
Morbid obesity	X							X
Medications								
Anticoagulant	X	X						
Digoxin				X	X	X		X
Diuretic				X	X			
Corticosteroid				X		X		

*PT/PTT indicates prothrombin time and partial thromboplastin time; T/S, blood typing and screening; PLT, platelet count; K⁺, potassium; BUN/Creat, blood urea nitrogen and creatinine; CXR, chest x-ray; ECG, electrocardiogram; PFT, pulmonary function tests; ABG, arterial blood gas; AST, aspartate aminotransferase; and WBC, white blood cell count.

A stress test (including exercise tolerance test, dipyridamole-thallium scintigraphy, or dobutamine echocardiography) and PFT/ABG should be individualized to the patient and procedure planned.

among the eight institutions (11% to 54%). This variability could not be explained by differences in severity of illness or type of case and was related to institutional and departmental utilization of screening examinations. Ninety-six percent of patients with normal findings had surgery, compared with 92% of patients with abnormal findings. In 26% of patients with preoperative radiographs, the formal reading was not noted prior to surgery. They concluded that the screening radiographs did not influence the decision to operate or the choice of anesthetic used, nor were they needed as a baseline evaluation for comparison with postoperative films. However, owing to the study design, the authors could not conclude that preoperative chest radiographs were unjustified.

The likelihood of an abnormal chest radiographic finding is related to both the patient's age and the associated illness. In patients under the age of 50 the likelihood of an abnormality on a chest film ranges from 0 to 20% and increases to 20% to 60% in patients over 50 years. [32] The majority of radiographic abnormalities, however, can be predicted by the patient's history and physical examination and only rarely have altered the operative plan. The benefit of identifying a significant radiographic finding must be balanced

against a potential false-positive result, which either delays surgery, results in further unnecessary evaluation, or incurs a potential iatrogenic injury, as described earlier.

In the prospective evaluation of selective ordering of preoperative chest radiographs by Charpak et al, [4] the outcome of 3866 patients undergoing noncardiothoracic surgical procedures was examined. Using defined selection criteria (patients with any lung or cardiovascular disease, known malignancy, a major surgical emergency, a current smoker more than 50 years old, history of immunosuppression, and immigrants without prior health evaluation), 1101 patients (28%) had preoperative radiographs. The radiograph was considered helpful by the anesthetist in 166 (15%) and altered the surgical plan or anesthetic technique in 5%. In 2765 procedures performed without a preoperative chest radiograph, only one patient, a 72 year-old male with chronic obstructive pulmonary disease, who developed a postoperative pneumonia, may have benefited from a preoperative chest radiograph. This patient should have had a preoperative film by the study guidelines. No mortalities or pulmonary complications could be directly related to the lack of a preoperative radiograph. Several other reports of selective ordering of chest radiographs have found similar results. [22] [35] [38] [40] Based on these studies, our recommendations for screening chest radiographs are listed in Table 2 . Patients who have had a chest radiograph within 6 months of the planned procedure need not have it repeated unless clinically indicated because the likelihood of a new abnormality being identified is exceedingly low. [27]

Electrocardiogram

Abnormalities on routine electrocardiograms (ECG) are relatively common, and the incidence increases with age. [3] [9] [14] [15] [22] [24] [32] [38] Averaging

TABLE 2 -- GUIDELINES FOR SELECTIVE PREOPERATIVE CHEST RADIOGRAPHS ·

1. Intrathoracic procedure
2. Age greater than 65 years
3. History of cardiovascular disease
4. History of pulmonary disease
5. Current smoker with more than 20 pack-year history or than 50 years
6. agegreater History of prior malignancy

*Patients who had a chest radiograph within 6 months of the planned procedure need not have it repeated unless clinically indicated.

these studies, the incidence of ECG abnormalities is more than 10% by 40 and 25% by 60 years of age. Many of the studies, however, do not clarify what percentage of the abnormalities could have been predicted by a patient's history and physical examination or have been recognized on a standard monitor applied prior to the induction of anesthesia. Those studies that obtained elective ECGs in asymptomatic patients noted an even lower incidence of abnormalities. In the study by Blery et al, [3] only 14 of 2256 ECGs (0.6%) obtained in patients under 40 years of age with no cardiac or pulmonary complaints had an abnormality.

Some authors believe that the major utility of a preoperative ECG is to identify a previously unrecognized myocardial infarction. This, however, is only rarely noted in the preoperative patient. Goldberger and O'Konski [9] noted that even in the highest risk group, men 75 or more years old, the estimated incidence of unrecognized Q-wave infarction within the preceding 6 months was less than 0.5%. Several groups have concluded that the risk of obtaining a preoperative electrocardiogram and subsequent testing of false-positive results exceeds the possible benefit in asymptomatic males under the age of 40 to 45 years and females under 50 to 55 years. [9] [22] [32] We agree with this recommendation. Clearly, patients with any risk factor for coronary artery disease (diabetes, smoking, hypertension, hyperlipidemia) should have a screening

examination regardless of age.

Additional cardiac evaluation may be necessary, depending on the patient's comorbidity and the procedure planned. Patients with peripheral vascular disease requiring operative intervention are at high risk for concomitant cardiac disease and death from cardiac complications. Examinations such as dipyridamole-thallium scintigraphy, exercise tolerance testing, and dobutamine stress echocardiography have been successfully used for preoperative cardiac risk assessment.

Urinalysis

The preoperative urinalysis has been used primarily to detect an unsuspected urinary tract infection (UTI) or as a screening examination for diabetes and renal disease. Patients with untreated urinary tract infections have been shown to have a higher incidence of surgical wound

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infection. [6] [12] These and other previous reports, however, have several flaws in study design. Most are retrospective analyses, lack control groups, use only univariate analysis, and fail to comment on the patient's symptomatology.

In a more recent review of 995 urinalyses obtained prior to elective cholecystectomy, Turnbull and Buck [38] noted 43 cases of pyuria (4%). One symptomatic patient was treated preoperatively; the remaining 42 patients were not. Postoperatively, UTIs were documented in 47 patients, only five of whom had preoperative pyuria. The authors did not identify preoperative pyuria as a risk factor for postoperative wound infection. They also did not find the urinalysis helpful in screening for glycosuria, proteinuria, red blood cells, or casts. Similar conclusions were noted in a retrospective analysis of 200 preoperative urinalyses by Lawrence and Kroenke [17] and a multivariate analysis of 520 patients by Velanovich. [39] Although urinalysis is a relatively inexpensive screening test, the additional cost of evaluating "abnormal" results quickly increases the overall expense of the examination. A fasting blood glucose, blood urea nitrogen, and creatinine are considered a more appropriate screening evaluation in the preoperative patient. [17] [32] [38]

We recommend the use of a screening urinalysis in patients with symptoms of a urinary infection and, until further evaluation, in patients whose procedure involves the use of prosthetic material. This is to exclude the possibility of an asymptomatic urinary infection that could potentially result in foreign body infection. [17]

Hemoglobin

With the advent of automated instrumentation, when a hemoglobin measurement is ordered, the clinician is often provided with a complete blood cell count, including white blood cell and platelet counts. The likelihood of an asymptomatic abnormality in white blood cell count or platelet count is extremely low in the preoperative patient, and abnormal results are often ignored. [15] [16] [25] [28] [32] [38] [39] Patients with a prior history of radiation, chemotherapy, or leukemia should have a white blood cell count done. Patients with a history of abnormal bleeding that has not been previously investigated need a platelet count and coagulation studies.

The prevalence of preoperative anemia varies from 0% to 30% of patients and depends on the patient's age, gender, diagnosis, and concurrent illnesses. [32] The risk of perioperative complications among patients with a normovolemic anemia is unknown. Treatment of such anemia must be individualized to the patient and procedure planned. An asymptomatic anemia in a 30-year-old woman requiring a cholecystectomy could likely be managed differently from a 70-year-old man with diabetes requiring resection of an abdominal aortic aneurysm.

We recommend obtaining a hemoglobin or hematocrit in patients

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who are at risk for abnormalities, who require procedures with significant blood loss, or who have considerable

comorbidity (see Table 1) .

Blood Chemistries

Patients with a history of hepatic or renal impairment may require alterations in the type and dose of anesthetics and adjuvant medications. The likelihood of an asymptomatic patient harboring hepatitis is approximately 1 in 700. [36] In multiple studies of preoperative testing, the finding of occult hepatitis has appeared much less frequently. Unsuspected laboratory abnormalities that are clinically significant arise in 2% to 5% of patients, the majority of which are related to blood glucose and blood urea nitrogen (BUN) levels in the elderly. [13] [21] [32] [38] We therefore recommend obtaining a BUN, creatinine, and blood glucose level in all patients over 60 years of age. Other criteria for obtaining blood chemistries are listed in Table 1 . If there is any question of pregnancy, female patients of childbearing age should have a pregnancy test performed.

Coagulation Studies

The routine screening for abnormalities in prothrombin time (PT) and partial thromboplastin time (PTT) has been abandoned by most authors because of the low yield of abnormal results among asymptomatic patients. In a review of 750 preoperative patients by Eisenberg et al, [7] 13 of 480 patients (2.7%) without a history of a bleeding disorder had an abnormal PT or PTT. Of these 13 patients, 8 patients underwent uneventful surgery without repeated testing, repeated values were normal in 4 patients, and 1 patient required re-exploration for arterial hemorrhage following an emergency cesarean section. Other studies have shown no benefit in obtaining routine screening coagulation studies. [32] The need for preoperative PT and PTT is reserved for patients who have a personal or family history of a bleeding disorder or a history of hepatic disease or who are currently taking anticoagulants. Patients with end-stage renal disease may develop a platelet dysfunction which, if necessary, is best evaluated by a bleeding time.

Pediatric Procedures

Previously, the pediatric patient was subjected to the same series of preoperative screening examinations as the adult patient. Over the past decade, numerous reports have narrowed the evaluation to a preoperative hemoglobin and urinalysis for elective surgery. [1] [10] [18] [26] [42] O'Conner and Drasner, [26] in a study of 486 patients, found a screening urinalysis to be of little help, leaving only a screening hemoglobin to be performed. Should all pediatric patients undergoing elective surgery have this test?

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The prevalence of anemia among pediatric patients ranges from 0.5% to 1.5% and appears to be highest among the neonatal and infant population. [1] [10] Anemia detected in the first 3 to 6 months may indicate a congenital disorder of hemoglobin structure or synthesis. The use of a preoperative hemoglobin may represent the first opportunity for screening of such disorders. We believe this proactive screening is warranted provided that appropriate referral for patient/parent counseling and treatment is provided. A screening hemoglobin is also recommended in any child with a history of concurrent disease, known hematologic disease, or family history of hematologic disorders.

SUMMARY

The utility of mass screening of preoperative patients has never been demonstrated for the majority of tests. Although screening patients to uncover occult disease appears logical, in reality it has resulted in excessive expenditure of our health care dollars with limited benefit. More than \$30 billion is spent annually on preoperative examinations, 60% of which are unnecessary. In addition, iatrogenic injury has resulted from the further evaluation and treatment of false-positive results. A selective utilization of routine examinations can accurately supplement the clinician's evaluation, providing the patient with a complete preoperative assessment. The benefits of selective testing must be balanced against the possible omission of warranted examinations, highlighting the need for a more reliable system for test ordering.

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