Preoperative patient evaluation*

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This refresher course has emerged in response to the problem that routine, preoperative laboratory tests, as customarily ordered by a physician to make medical assessments, are not the best means for generating information significant to perioperative management of the patient. These medical assessments provide an important opportunity for physicians to reduce perioperative morbidity by optmizing preoperative status and planning perioperative management. Because perioperative mortality and morbidity increase with the severity of preexisting disease,[1–7] careful evaluation and treatment should reduce their occurrence.[3,8,9] Consequently, physicians would benefit from a reliable, efficient, and effective method for assessing patients preoperatively and then ordering laboratory tests based on that assessment.

Preoperative evaluation – the current system

The primary problem with the current system of ordering laboratory tests is that many tests are ordered and obtained which do not contribute beneficially to patient care. Most studies estimate that approximately 60 per cent of preoperative testing could be eliminated without adversely affecting patient care. It has been further documented that unnecessary testing tends to cause extra risk to the patient, inefficient operating room schedules, and unnecessary costs. Unnecessary testing may be hazardous to patients because of the pursuit and treatment of borderline positive or false-positive results. In addition, extra testing may also increase medicolegal risk because the abnormalities that are discovered are usually not noted on the chart.

The benefits in quality of care and reduction of tests by decreasing the number of unproductive and possibly harmful tests – even excluding costs saved by avoiding iatrogenic disease – are considerable. Blue Cross/Blue Shield, estimating that $30 billion was spent on preoperative testing and evaluation in the United States in 1984, believes that $12 to $18 billion could be saved if only appropriate tests, i.e., those indicated by the patient's history and benefit-risk ratio, were performed. This course will stress ways that appropriate preoperative tests can be selected for the patients in your practice.

Routine laboratory testing is not the most effective way of evaluating patients preoperatively

Leonard *et al.*[10] reported that biochemical screening tests had no significant value in the preoperative screening of paediatric patients expected to be hospitalized for less than one week. In another study, Korvin *et al.*[11] reviewed biochemical tests given routinely to 1,000 patients on hospital admission. None of the tests produced a new diagnosis that was unequivocally beneficial to the patient. In an ambitious, controlled trial of multiphasic screening in 1,500 patients, Olsen *et al.*[12] found no difference in morbidity between control groups and groups having screening tests. Durbridge *et al.*[13] compared 1,500 patients who were randomly assigned to undergo or not to undergo screening tests on admission. No benefit resulted from the 8,363 tests that were performed with respect to length of hospital stay or patient outcome.

Although laboratory screening tests can aid in optimizing a patient's preoperative condition once a disease is suspected or diagnosed, they have several shortcomings: they frequently fail to uncover pathological conditions; they detect abnormalities, the discovery of which does not necessarily improve patient care or outcome; and they are inefficient in screening for asymptomatic diseases. Finally, most abnormalities discovered on preoperative screening, or even on admission screening for nonsurgical purposes, are not recorded (other than in the laboratory report) or appropriately pursued.

Domoto *et al.*[14] examined the yield and effectiveness of a battery of 19 screening laboratory tests performed routinely in 70 functionally intact elderly patients (average age, 82.6 years) who resided at a chronic care facility. The 70 patients underwent 3,903 screening tests. "New abnormal" results primarily occurred in five of the 19 screening tests; most of these "new abnormalities" were only minimally outside the normal range. Only four (0.1 per cent of all tests ordered) led to change in patient management, none of which, Domoto *et al.* concluded, benefited any patient in an important way.

Wolf-Klein *et al.*[15] retrospectively studied the results of annual laboratory screening on a population of 500

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institutionalized and ambulatory elderly patients (average age, 80 years). From the 15,000 tests performed, 756 new abnormalities were discovered, 690 of which were ignored. Sixty-six of the new abnormalities were evaluated; 20 new diagnoses resulted, 12 of which were treated. Two patients of the 500 ultimately may have benefited from eradication of asymptomatic bacteriuria (although eradication of asymptomatic bacteriuria has not been shown to improve the quality of life, or extend life).[16–19]

Studies show that history and physical examination are the best measures for screening for disease. Delahunt and Turnbull[20] evaluated patients who were assessed preoperatively for varicose vein stripping or inguinal herniorrhaphy. For 803 patients who underwent 1,972 tests, only 63 abnormalities were uncovered in those patients whose history or physical findings had not indicated the need for tests; but in no instance did the discovery of these abnormalities influence patient management. Rossello and associates[21] retrospectively evaluated 690 admissions for elective paediatric surgical procedures. The history and physical examination indicated the probability of abnormalities in all 12 patients in whom an abnormality was found through laboratory testing. Clinical diagnosis, and not laboratory testing, was the apparent basis for any change in operative plans.

Several studies have compared outcome for groups of hospitalized patients who had routine laboratory screening tests performed to supplement the history and physical examination with those who did not have routine screening tests. Wood and Hoekelman[22] found that 28 of 1,924 children examined had changes in preoperative clinical courses (all had surgery postponed) because of abnormal history, physical examination, or laboratory examination results. Three of those 28 patients whose surgery was postponed had abnormal laboratory tests that were not indicated by the history or physical examination. Thus, the history or physical examination dictated appropriate laboratory testing for all but three of 1,924 patients. The abnormalities discovered for these three patients pertained to their chest radiographs. (These children were part of a study comparing perioperative outcome at two hospitals, one that required chest radiographs as a screening test for elective surgery in children, and one that did not.) There were no differences noted in anaesthetic or perioperative complications between the two groups. Therefore, Wood and Hoekelman recommended that chest radiographs not be obtained routinely for apparently healthy children.

Even in a referral population, history and physical examination determine more than 90 per cent of the clinical course when a patient is referred for consultation about cardiovascular, neurologic, or respiratory diseases.[23] Other studies also have demonstrated that the history and physical examination accurately indicate all areas in which subsequent laboratory testing proves beneficial to patients. For example, Rabkin and Horne[24,25] examined the records of 165 patients having "new" (i.e., a change from a previous tracing) abnormalities on electrocardiogram (ECG) that were potentially "surgically significant" (i.e., that might affect perioperative management or outcome). In only two instances were the anaesthetic or surgical plans altered by the discovery of new abnormalities on an ECG not indicated by history. Thus, for these 165 patients, for whom the benefits of a laboratory test should have been maximal (i.e., when a new abnormality is detected in the course of preoperative assessments), the history or physical examination determined case management most of the time. Even in one of the two instances of altered case management – a patient having atrial fibrillation – physical examination should have indicated that an ECG needed to be performed. A history or physical examination was not available for the other patient.

In summary, the studies cited above point to the inadequacy of routine laboratory tests as an independent means to assess patients preoperatively. It has been shown that many of these laboratory tests are considered superfluous to patient care management. History and physical examination are considered the most effective ways to screen for disease; laboratory tests can be used to screen for disease when such tests have proven effective but are better used to confirm clinical diagnoses or optimize a patient's condition prior to surgery.

Random testing without selectivity may not be beneficial and may even pose extra risk to the patient

Unnecessary testing may lead physicians to pursue and treat borderline and false-positive laboratory abnormalities. This does not imply that all standard screening tests should be discontinued – some are beneficial, such as the mammogram for every woman over the age of 40, the stool for occult blood test over the age of 40, the pap smear, etc. Few studies examine whether increased tests and the follow-up of false-positive tests adversely affect patients. Roizen[26] retrospectively examined adverse effects on patients who had chest *x*-rays. In this study population of 606 patients, 386 extra chest *x*-rays were ordered without being indicated. In those 386 patients, one elevated hemidiaphragm and probable phrenic nerve palsy was found that may have resulted in improved care for that patient. In addition, three lung shadows were found which resulted in three sets of invasive tests, including one thoracotomy, without discovery of any disease. These procedures caused considerable morbidity, including one pneumothorax and four months of disability for those patients.

In another study, Turnbull and Buck[27] examined the

charts of 2,570 patients undergoing cholecystectomy to determine the value of preoperative tests. History and physical examinations successfully indicated all tests that ultimately benefited the patients, with four possible exceptions. But again, in those four patients it is doubtful if any benefit actually occurred. Among them was one patient who had his emphysema detected only by chest *x*-ray; he had preoperative physiotherapy without subsequent postoperative complication. Two patients had unsuspected hypokalaemia (3.2 and 3.4 $mEq \cdot L^{-1}$ respectively) and received treatment prior to operation. Data now in the literature[28–32] indicate no harm occurs to patients undergoing operation with this degree of hypokalaemia, and severe potential harm may be caused by treating such patients with oral or intravenous potassium. The fourth patient in whom possible benefit occurred received a blood transfusion prior to cholycystectomy for an asymptomatic haemoglobin concentration of 9.9 $g \cdot dL^{-1}$. Since cholycystectomy is not normally associated with major blood loss, it is concluded that this patient also received no benefit and only the risk of transfusion from that preoperative laboratory test and its pursuit. Thus, it is not clear that any patient in this study benefited from preoperative screening tests done without indication.

In another study,[33] only two patients at most (who had eradication of asymptomatic bacteriuria) benefited from the 9,270 screening tests that were obtained. At least one patient was seriously harmed from pursuit and treatment of abnormalities on screening tests; this woman developed atrial fibrillation and congestive heart failure after institution of thyroid therapy for borderline low thyroxine and free thyroxine index (FTI) tests. It is unclear if these investigators examined other patients for potential harm arising from pursuit and treatment of abnormalities on screening tests.

When batteries of laboratory tests yield abnormal results which are neither pursued nor noted, medicolegal risk for physicians increases

Extra testing – testing which is not warranted by findings on a medical history – does not serve as medicolegal protection against liability. A series of studies (Roizen,[26] Roizen *et al.*[34] review these) show that 30–95 per cent of all unexpected abnormalities found on preoperative laboratory tests are not noted on the chart preoperatively. Many reports of preoperative *x*-rays, for example, are not in charts before anaesthesia is administered. This lack of notation occurs not only at university medical centres, but in community hospitals also. Data show that failing to pursue an abnormality appropriately poses a greater risk to medicolegal liability than does failing to detect that abnormality.[35] In this way extra testing results in extra medicolegal risk to physicians.

Random preoperative testing is inefficient for operating room schedules

According to hospital administrators in the United States, surgeons say that they order preoperative tests to satisfy the anaesthetist: they find it easier just to order all the tests and let the anaesthetist sort them out. Surgeons also believe that it is much more efficient to order batteries of tests than to have the anaesthetist, who sees the patient the night before or the morning of surgery, try to get the tests on an emergency basis. These surgeons apparently do not realize that abnormalities arising from tests done in this battery fashion are not discovered until the night before or the morning of surgery, if at all. Then abnormal results on these tests delay or postpone schedules, as extra effort and time are wasted in obtaining consultant reviews of false-positive or slightly abnormal results.

Implementation of preoperative evaluation

There are at least three methods for determining the laboratory tests to be ordered for a patient. The surgeon or anaesthetist who sees the patient before the scheduled procedure can obtain the history and perform the physical. Second, a clinic can be set up in the outpatient facility to perform these two tasks early enough to ensure that the appropriate laboratory tests or consultations can be obtained without delaying schedules. Third, a questionnaire answered by the patient can be used to indicate appropriate laboratory tests.

Of the first method one might ask, "Can the appropriate testing be easily generated from the surgeon's preoperative visit?" One study found that it could. At the University of California, San Francisco, Kaplan *et al.*[36] found that even a partial history conveyed enough information to indicate correctly all but 22 abnormalities (none of which affected patient outcome) in over 2,785 preoperative blood tests obtained (counting the complete blood count and simultaneous multichannel analysis of six variables (SMA 6) as one test). Knowing only the admission diagnosis, previous discharge diagnoses, and scheduled operation, and using previously determined indications for laboratory testing, enabled detection of virtually all abnormalities that would have been detected by routine screening.

The third suggestion for implementing preoperative evaluation involves the use of a patient questionnaire. Several groups have tested the effects and sensitivity of orally administered or written questionnaires as a means of linking the selection of laboratory tests with a patient's medical history (Roizen *et al*;[37] Roizen[26]). Blery *et al.*[38] examined such a protocol in 3,866 surgical patients in

France. They found that even after education of indications, 30 per cent of tests ordered were not indicated, and that another 22 per cent of tests that were indicated were not obtained. Thus, by ordering tests in the usual way, surgeons and anaesthetists both increased costs and did not obtain possibly valuable information. The 4,762 tests not recommended might have been informative in perioperative management for perhaps 0.2 per cent of the time. Blery did not examine how many times such data might have led to pursuits which harmed patients.

In 1987, McKee and Scott[39] used an orally administered group of 17 questions and patient demographics to select preoperative tests for 400 patients. They found that age was the best predictor of abnormalities on preoperative tests. Complications occurred most commonly in patients who reported positive symptoms on the questionnaire and who were older.

A recent study determined that the responses of patients to written questions can predict all laboratory tests that will have abnormal results in those patients. After the patient answers the questionnaire, a plastic overlay reveals what tests are indicated. If the patient cannot answer the questions, a standard group of tests is ordered. Even in a tertiary care hospital that admits very sick patients, over 60 per cent of those laboratory tests now routinely obtained could be eliminated. The elimination of such tests could result in 93–97 per cent reduction in patient charges and hospital costs (Finkler[40] and personal communication, S.N. Cohen). Blery *et al.*[38] confirmed these findings. Using a protocol based on suspected disease to order preoperative tests selectively for 3,866 consecutive surgical patients, he subsequently questioned anaesthetists to assess whether management of the patient suffered from omission of one or more preoperative tests. Only 0.2 per cent of omitted tests would have possibly been useful. A protocol similar to that used by Blery and our group to indicate abnormalities based on suspected disease is summarized in the Table.

The protocol outlined in the Table is a minimum guideline for using clinical judgment in ordering laboratory tests. It requires a careful history and physical examination of the patient with special attention to testing whenever indicators of disease entities in the Table are discovered. With the goal of optimizing the patient's preoperative condition, this protocol clearly places the burden on whoever takes the history to do so accurately. At the University of Chicago, tests that have been requested are noted in the front of the Progress Notes section of a chart so that the anaesthetists preoperatively evaluating a patient know which tests have been ordered and can order additional ones if necessary.

But there is a problem with this system. *Errors are made in ordering tests when physicians attempt to selectively choose tests based on the patient's history and/or physical examination of the patient.* Even when surgeons and anaesthetists agree on indications for testing, 30–40 per cent of patients who should have tests do not get them, and 20–40 per cent of patients who should not have tests get them. For instance, Blery *et al.*[38] examined 3,866 surgical patients in France and found that even after education of indications, 30 per cent of tests ordered were not indicated and another 22 per cent of tests that were indicated were not obtained. Thus by ordering tests in the usual way, surgeons and anaesthetists both increased costs and failed to obtain possibly valuable information.

Charpak *et al.*[41] examined the value of preoperative screening chest *x*-rays (CXR) in 3,849 patients. Surgeons and anaesthetists agreed that any lung or cardiovascular disease, malignant disease, current smoking history in patients more than 50 years old, major surgical emergencies, immunodepression, or lack of prior health examination in immigrants were indications for ordering a CXR. The surgeons ordered or did not order the CXR after seeing the patient. Even with this agreement on indications, 271 chest *x*-rays were ordered although they were not recommended, and 596 chest *x*-rays were not ordered although they were recommended, of a total of 1,426 CXRs that should have been ordered in this group of 3,849 patients. While clinical judgments may account for some of these recommendations, it is presumed that many extra CXRs ordered or not ordered were simply errors. If there are so many errors in a single test trial, more laboratory tests are likely to generate more errors. Preliminary data, from studies by the author to be presented at this meeting attest to this error rate. Thus, a problem is how to order tests that are appropriate to each patient without decreasing efficiency. We believe that selective ordering strategies are better than previous nonselective methods of ordering tests, but an even easier, more efficient method exists.

The smart tech* solution to efficient, less expensive, quality care

At the University of Chicago and at least 13 other

*Smart technology is the use of new configurations of chips, microprocessors, circuit boards, memory banks, and software to allow us to practice inexpensively more efficient, less costly, and higher quality medicine. As the hardware becomes smaller and more powerful and the software becomes more versatile, the age of "high-tech" is being replaced by the age of "smart tech" just as the relatively expensive "horseless carriages" were replaced by today's cars. We can embrace smart-tech solutions such as this as we have embraced oximeters to reduce costs and improve quality.

TABLE Simplified strategy for preoperative testing

Preoperative conditions suspected	Test to be obtained: HGB M	HGB F	WBC	PT/ PTT	PLT, BT	Elect	Creat/ BUN	Blood Gluc	SGOT/ALK PTASE	x-ray	ECG	Preg	T/S
Surgical procedure													
– with blood loss	X	X											X
– without blood loss													
Neonates	X	X											
Age <40		X											
Age 40–59		X									±		
Age ≥60	X	X								X	X		
Cardiovascular disease							X			X	X		
Pulmonary disease										X	X		
Malignancy	X	X	*	*						X			
Radiation therapy			X							X	X		
Hepatic disease				X					X				
Exposure to hepatitis									X				
Renal disease	X	X				X	X						
Bleeding disorder				X	X								
Diabetes						X	X	X			X		
Smoking ≥20 pk-yrs	X	X								X			
Possible pregnancy												X	
Diuretic use						X	X						
Digoxin use						X	X				X		
Steroid use						X		X					
Anticoagulant use	X	X		X									

Modified from Kaplan *et al.*,[42] and Blery *et al.*[38]

Note: Not all diseases are included in this table. Please use your judgment on patients with diseases not included.

± = maybe; * = leukemias only; X = obtain; HGB = haemoglobin; WBC = white blood count; PT = prothrombin time; PTT = partial thromboplastin time; PLT = platelet count; BT = bleeding time; Elect = Na^+, K^+, Cl^-, CO_2, proteins; Creat/BUN = creatinine or blood urea nitrogen; SGOT/Alk PTASE = serum glutamic oxaloacetic transaminase phosphatase; T/S = blood typing and screen for unexpected antibodies. Adapted from Roizen *et al.*,[34] and Blery *et al.*[38]

institutions, a health-quiz is given to patients on a four-button computer machine, similar to the child's game "Donkey-Kong, Jr." Improvements in technology, graphics, and voice properties make it relatively inexpensive to display clearly (or read clearly) questions about a patient's health on a portable 8 inch × 6 inch × 1 inch hand-held box. The surgeon or anaesthetist can have this box in his/her office and, after both have agreed upon indications, it can be used by the patient to suggest the tests needed. The "smart-tech" box simply asks patients yes/no questions. It then generates a printout of the answers to the questions and a symptom summary, as well as suggested laboratory tests based on agreed upon indications and the patient's answers. It also gives reminders about items in history important to anaesthetic care, such as allergies and capped teeth. It doesn't save me much time when I see patients, but it improves the quality of time I spend with them. And it suggests tests that would be appropriate for each patient based on that patient's medical history and accepted indications for testing. The physician, surgeon, or anaesthetist then can override or add to suggested tests before preoperative testing is ordered. The "HealthQuiz" and its printout take less than ten minutes for the patient to complete.

Summary

Screening laboratory testing seemed logical: if you could spot abnormalities before overt disease occurred, you could prevent disability. But it has not worked out that way for the majority of preoperative tests. We are now spending over $40 billion a year in the United States on preoperative testing and evaluation; 60 per cent of it is wasted. This is like saying, "If a little epinephrine is good, more is better." That is wrong in the use of epinephrine and it can be wrong with too much testing. Worse than wasteful, I believe this extra testing is causing iatrogenic disease by pursuit and treatment of borderline and false-positive test results. It is increasing our medicolegal risk and decreasing the efficiency of practice. Fortunately, this history of too much testing can now be turned to our advantage. It provides an arena where we can demonstrate to our constituency, the patient, and our watchdog, the bureaucrat, that we can use inexpensive technology to reduce costs substantially and improve the quality of care.

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