

# Practice Advisory for Preanesthesia Evaluation

## *An Updated Report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation*

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\* American Society of Anesthesiologists Task Force on Preanesthesia Evaluation: Practice advisory for preanesthesia evaluation: A report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation. *ANESTHESIOLOGY* 2002; 96:485–96. The Practice Advisory was amended by the ASA House of Delegates on October 15, 2003.

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- What other guideline statements are available on this topic?
  - This Practice Advisory updates the “Practice Advisory for Preanesthesia Evaluation,” adopted by the ASA in 2001 and published in 2002.\*
- Why was this Advisory developed?
  - In October 2010, the Committee on Standards and Practice Parameters elected to collect new evidence to determine whether recommendations in the existing Practice Advisory were supported by current evidence.
- How does this statement differ from existing guidelines?
  - New evidence presented includes an updated evaluation of scientific literature. The new findings did not necessitate a change in recommendations.
- Why does this statement differ from existing guidelines?
  - The ASA Advisory differs from the existing guidelines because it provides new evidence obtained from recent scientific literature.

vision as warranted by the evolution of medical knowledge, technology, and practice.

This document updates the “Practice Advisory for Preanesthesia Evaluation: A Report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation,” adopted by the ASA in 2001 and published in 2002.\*

### Methodology

#### *A. Definition of Preanesthesia Evaluation*

The literature does not provide a standard definition for preanesthesia evaluation. For this Practice Advisory, preanesthesia evaluation is defined as the process of clinical assessment that precedes the delivery of anesthesia care for surgery and for non-surgical procedures. For this Advisory, “perioperative” refers to the care surrounding operations and procedures. The preanesthetic evaluation is the responsibility of the anesthesiologist.

Preanesthesia evaluation consists of the consideration of information from multiple sources that may include the patient’s medical records, interview, physical examination, and findings from medical tests and evaluations. As part of the

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preanesthesia evaluation process, the anesthesiologist may choose to consult with other healthcare professionals to obtain information or services that are relevant to perioperative anesthetic care. Preoperative tests, as a component of the preanesthesia evaluation, may be indicated for various purposes, including but not limited to (1) discovery or identification of a disease or disorder that may affect perioperative anesthetic care; (2) verification or assessment of an already known disease, disorder, medical or alternative therapy that may affect perioperative anesthetic care; and (3) formulation of specific plans and alternatives for perioperative anesthetic care.

The assessments made in the process of preanesthetic evaluation may be used to educate the patient, organize resources for perioperative care, and formulate plans for intraoperative care, postoperative recovery, and perioperative pain management.

### **B. Purposes of the Advisory for Preanesthesia Evaluation**

The purposes of this Advisory are to (1) assess the currently available evidence pertaining to the healthcare benefits of preanesthesia evaluation, (2) offer a reference framework for the conduct of preanesthesia evaluation by anesthesiologists, and (3) stimulate research strategies that can assess the healthcare benefits of a preanesthesia evaluation.

### **C. Focus**

A preanesthesia evaluation is considered a basic element of anesthesia care. Therefore the focus of this Advisory is the assessment of evidence pertaining to the content and timing of a preanesthesia evaluation. The interactions between the preanesthesia evaluation, preoperative testing, and perioperative care are beyond the scope and mandate of the Advisory. Informed consent, often undertaken at the same time as the preanesthesia evaluation, is also beyond the scope of this Advisory.

### **D. Application**

This Advisory is intended for use by anesthesiologists and those who provide care under the direction of an anesthesiologist. The Advisory applies to patients of all ages who are scheduled to receive general anesthesia, regional anesthesia, and moderate or deep sedation for elective surgical and non-surgical procedures. The Advisory does not address the selection of anesthetic technique; nor does it address the preanesthetic evaluation of patients requiring urgent or emergency surgery or anesthetic management provided on an urgent basis in other locations, (*e.g.*, emergency rooms).

† Society for Ambulatory Anesthesia 11th Annual Meeting, Orlando, Florida, 1996; Society for Ambulatory Anesthesia 12th Annual Meeting, Orlando, Florida, 1997; Postgraduate Assembly in Anesthesiology 54th Annual Meeting, New York, New York, 2000.

### **E. Criteria for Anesthesia Intervention, Testing, and Consultation**

Any evaluations, tests, and consultations required for a patient are done with the reasonable expectation that such activities will result in benefits that exceed the potential adverse effects. Potential benefits may include a change in the content or timing of anesthetic management or perioperative resource use that may improve the safety and effectiveness of anesthetic processes involved with perioperative care. Potential adverse effects may include interventions that result in injury, discomfort, inconvenience, delays, or costs that are not commensurate with the anticipated benefits.

### **F. Task Force Members and Consultants**

The original Advisory was developed by an ASA-appointed task force of 12 members, consisting of anesthesiologists from various geographic areas of the United States and two methodologists from the ASA Committee on Standards and Practice Parameters.

The Task Force developed the original Advisory by means of a six-step process. First, they reached consensus on the criteria for evidence of effectiveness of preanesthesia evaluation. Second, original published articles from peer-reviewed journals relevant to preanesthesia evaluation were evaluated. Third, consultants who had expertise or interest in preanesthesia evaluation and who practiced or worked in various settings (*e.g.*, academic and private practice) were asked to (1) participate in opinion surveys on the effectiveness of various preanesthesia evaluation strategies, and (2) review and comment on a draft of the Advisory developed by the Task Force. Fourth, additional opinions were solicited from active members of the ASA. Fifth, the Task Force held several open forums at three major national anesthesia meetings<sup>†</sup> to solicit input on the draft Advisory. Sixth, all available information was used to build consensus within the Task Force to finalize the Advisory. A summary of recommendations may be found in appendix 1.

In 2009, the ASA Committee on Standards and Practice Parameters requested that scientific evidence for this Advisory be updated. The update consists of an evaluation of literature published after completion of the original Advisory. The draft of this updated document was made available for review on the ASA Web site.

### **G. Availability and Strength of Evidence**

Preparation of this update used the same methodological process as was used in the original Advisory to obtain new scientific evidence. Opinion-based evidence obtained from the original Advisory is reported in this update. The protocol for reporting each source of evidence is described.

### **Scientific Evidence**

Study findings from published scientific literature were aggregated and are reported in summary form by evidence category, as described below. All literature (*e.g.*, randomized

controlled trials, observational studies, case reports) relevant to each topic was considered when evaluating the findings. However, for reporting purposes in this document, only the highest level of evidence (*i.e.*, level 1, 2, or 3 identified below) within each category (*i.e.*, A, B, or C) is included in the summary.

### Category A: Supportive Literature

Randomized controlled trials report statistically significant ( $P < 0.01$ ) differences between clinical interventions for a specified clinical outcome.

- Level 1: The literature contains multiple randomized controlled trials, and the aggregated findings are supported by meta-analysis.‡
- Level 2: The literature contains multiple randomized controlled trials, but there is an insufficient number of studies to conduct a viable meta-analysis.
- Level 3: The literature contains a single randomized controlled trial.

### Category B: Suggestive Literature

Information from observational studies permits inference of beneficial or harmful relationships among clinical interventions and clinical outcomes.

- Level 1: The literature contains observational comparisons (*e.g.*, cohort, case-control research designs) of clinical interventions or conditions and indicates statistically significant differences between clinical interventions for a specified clinical outcome.
- Level 2: The literature contains noncomparative observational studies with associative (*e.g.*, relative risk, correlation) or descriptive statistics.
- Level 3: The literature contains case reports.

### Category C: Equivocal Literature

The literature cannot determine whether there are beneficial or harmful relationships among clinical interventions and clinical outcomes.

- Level 1: Meta-analysis did not find significant differences among groups or conditions.
- Level 2: The number of studies is insufficient to conduct meta-analysis, and (1) randomized controlled trials have not found significant differences among groups or conditions or (2) randomized controlled trials report inconsistent findings.
- Level 3: Observational studies report inconsistent findings or do *not* permit inference of beneficial or harmful relationships.

‡ Practice Advisories lack the support of a sufficient number of adequately controlled studies required to conduct an appropriate meta-analysis. Therefore, categories A1 and C1 evidence are not reported in this document.

### Category D: Insufficient Evidence from Literature

The lack of scientific evidence in the literature is described by the following terms.

**Inadequate.** The available literature cannot be used to assess relationships among clinical interventions and clinical outcomes. The literature either does not meet the criteria for content as defined in the “Focus” of the Advisory or does not permit a clear interpretation of findings due to methodological concerns (*e.g.*, confounding in study design or implementation).

**Silent.** No identified studies address the specified relationships among interventions and outcomes.

**Limitations of the Literature.** Numerous methodological concerns were encountered in the preanesthesia evaluation literature, including (1) lack of “no-test” controls, (2) failure to blind the practitioner to test results before and during the procedure, and (3) confounding of outcomes. These concerns limit the interpretability of published findings and are discussed in more detail in appendix 2.

### Opinion-based Evidence

The original Advisory contained formal survey information collected from expert consultants and random samples of active members of the ASA. Additional information was obtained from open forum presentations and other invited and public sources. All opinion-based evidence relevant to each topic (*e.g.*, survey data, open-forum testimony, Internet-based comments, letters, and editorials) was considered in the development of the original Advisory. However, only the findings obtained from formal surveys are reported.

Survey responses from Task Force-appointed expert consultants and specialty society members obtained during development of the original Advisory are summarized in the text and reported in appendix 2, tables 1–5.

### Advisories

#### I. Preanesthesia History and Physical Examination

**Impact.** A preanesthesia history and physical examination precedes the ordering, requiring, or performance of specific preanesthesia tests and consists of (1) evaluation of pertinent medical records, (2) patient interview(s), and (3) physical examination. No controlled trials of the clinical impact of performing a preanesthesia medical records review or physical examination were found (*Category D evidence*). Observational studies of asymptomatic or nonselected surgical patients reported associations between several preoperative patient characteristics (*e.g.*, age, health status) and postoperative morbidity and mortality (*Category B2 evidence*).<sup>1–14</sup> Several observational studies reported perioperative complications (*e.g.*, cardiac, respiratory, renal, hemorrhagic) associated with specific preexisting conditions (*e.g.*, diabetes, pulmonary disease, chronic hypertension, previous myocardial infarction, history of smoking, high body mass index, extremes of age) (*Category B2 evidence*).<sup>15–55</sup> These associations do not provide evidence

regarding the clinical impact of perioperative interventions that may be derived from preoperative knowledge of a patient's condition. Additional studies were examined that reported changes in resource management based on preexisting conditions (e.g., airway abnormalities, cardiopulmonary disorders) detected during a preanesthetic examination, interview, or questionnaire administration (Category B2 evidence).<sup>56–61</sup>

**Timing.** The activities encompassed by a preanesthetic history and physical examination occur over a variable period of time. The timing of an initial preanesthetic evaluation is guided by such factors as patient demographics, clinical conditions, type and invasiveness of procedure, and the nature of the healthcare system. Three options that practices use for the timing of an initial preanesthetic evaluation are: (1) always before the day of surgery, (2) either on or before the day of surgery, and (3) only on the day of surgery.

Consultant and ASA member opinions regarding the timing of an initial assessment of pertinent medical records for high, medium, and low levels of surgical invasiveness, independent of medical condition, were obtained during development of the original Advisory and are reported in table 1 (appendix 2). The majority of consultants and ASA members agree that for high surgical invasiveness, the initial assessment of pertinent medical records should be done before the day of surgery by anesthesia staff. For medium surgical invasiveness, the majority of consultants indicate that the initial assessment of pertinent medical records should be done before the day of surgery by anesthesia staff, although the majority of ASA members indicate that the initial assessment may be done on or before the day of surgery. For low surgical invasiveness, the majority of consultants and ASA members agree that the initial assessment may be done on or before the day of surgery.

Consultant and ASA membership opinions regarding the timing of an initial preanesthetic interview and physical examination for high and low severities of disease are reported in table 2 (appendix 2). The majority of consultants and ASA members agree that, for patients with high severity of disease, it is preferable that the interview and physical examination be done before the day of surgery by anesthesia staff. For low severity of disease and high surgical invasiveness, consultants and ASA members agree that it is preferable that the interview and physical examination should be done before the day of surgery. For patients with low severity of disease and medium or low surgical invasiveness, consultants and ASA members agree that the interview and physical examination may be done on or before the day of surgery.

A majority of consultants and the ASA membership, respectively, agree that, *at a minimum*, a preanesthetic physical examination should include (1) an airway examination (100%, 100%), (2) a pulmonary examination to include auscultation of the lungs (88%, 85%), and (3) a cardiovascular examination (81%, 82%).

### Advisory for Preanesthetic History and Physical Examination

**Impact.** The assessment of anesthetic risks associated with the patient's medical conditions, therapies, alternative treatments, surgical and other procedures, and of options for anesthetic techniques is an essential component of basic anesthetic practice. Benefits may include, but are not limited to, the safety of perioperative care, optimal resource use, improved outcomes, and patient satisfaction.

**Timing.** An assessment of readily accessible, pertinent medical records with consultations, when appropriate, should be performed as part of the preanesthetic evaluation before the day of surgery for procedures with high surgical invasiveness. For procedures with low surgical invasiveness, the review and assessment of medical records may be done on or before the day of surgery by anesthesia staff. The information obtained may include, but should not be limited to, (1) a description of current diagnoses; (2) treatments, including medications and alternative therapies used; and (3) determination of the patient's medical condition(s). The Task Force cautions that the timing of such assessments may not be practical with the current limitation of resources provided in specific healthcare systems or practice environments.

An initial record review, patient interview, and physical examination should be performed before the day of surgery for patients with high severity of disease. For patients with low severity of disease and those undergoing procedures with high surgical invasiveness, the interview and physical exam should also be performed before the day of surgery. For patients with low severity of disease undergoing procedures with medium or low surgical invasiveness, the initial interview and physical exam may be performed on or before the day of surgery. *At a minimum*, a focused preanesthetic physical examination should include an assessment of the airway, lungs, and heart, with documentation of vital signs.

The Task Force believes it is the obligation of the healthcare system to, at a minimum, provide pertinent information to the anesthesiologist for the appropriate assessment of the severity of medical condition of the patient and invasiveness of the proposed surgical procedure well in advance of the anticipated day of procedure for all elective patients.

### II. Selection and Timing of Preoperative Tests

Literature regarding controlled trials and test findings regarding the incidence or frequency of commonly used preoperative tests are described below. For purposes of this Advisory, a *routine* test is defined as a test ordered in the absence of a specific clinical indication or purpose. Global designations such as "preop status" or "surgical screening" are not considered as specific clinical indications or purposes. An *indicated* test is defined as a test that is ordered for a specific clinical indication or purpose. For example, assessment of warfarin therapy effects would be considered an indication for specific coagulation studies.



**Electrocardiogram (ECG).** Observational studies report abnormal ECG findings for asymptomatic or nonselected patients ranging from 4.6 to 44.9% of patients (*Category B2 evidence*).<sup>62–72</sup> Abnormal findings led to cancellations of surgery or changes in management in 0.46–2.6% of cases (*Category B2 evidence*).<sup>64,67</sup>

Observational studies report abnormal findings for ECGs that were ordered as indicated tests in 11.0–78.8% of patients,<sup>15,35,57,62,68,73–87</sup> leading to postponement, cancellations, or changes in management in 2.0–20.0% of cases (*Category B2 evidence*).<sup>57,80,81</sup> One observational study with investigator and practitioner blinding found that preoperative ECG ischemic episodes were associated with intraoperative and postoperative myocardial infarction for older patients with severe coronary artery disease scheduled for elective coronary artery bypass surgery (*Category B2 evidence*).<sup>79</sup>

**Other Cardiac Evaluation.** An observational study reports abnormal transthoracic echocardiography findings in 25% of asymptomatic or nonselected patients (*Category B2 evidence*).<sup>88</sup> Another observational study reports abnormal stress test values in 24% of asymptomatic or nonselected patients, leading to a management change in 2% of the cases (*Category B2 evidence*).<sup>60</sup>

For patients with cardiac indications, observational studies report abnormal echocardiography findings in 7.5–25.2% of patients,<sup>89–92</sup> leading to cancellation of surgery in 0.8% of cases (*Category B2 evidence*).<sup>92</sup> In selected or indicated patients, abnormal stress or exercise test findings were reported for 15.2–61.9% of patients,<sup>74,93–96</sup> leading to additional cardiac testing in 39.5% of patients with abnormal findings (*Category B2 evidence*).<sup>96</sup> A retrospective non-blinded study of vascular surgery patients administered a preoperative stress test reports a reduced 30-day mortality compared with patients not administered a preoperative cardiac test (*Category B2 evidence*).<sup>97</sup> In selected coronary artery bypass patients, ventriculography findings indicated low ejection fraction values (*e.g.*, less than 40–50%) in 22.5–24.3% of patients (*Category B2 evidence*).<sup>98,99</sup>

**Chest Radiography.** Chest radiography findings were reported as abnormal in 0.3–60.1% of asymptomatic or nonselected patients,<sup>57,62,67,68,70,100–118</sup> and led to postponement, cancellations, or changes in management in 0.6–20.3% of cases found to be abnormal (*Category B2 evidence*).<sup>57,67,70,100,101,103,113,115,117,118</sup>

For selected or indicated patients, abnormal chest radiography findings were reported in 7.7–86.0% of patients,<sup>33,62,68,75,81,101,111,114,119–124</sup> and led to postponement, cancellations, or changes in management in 0.5–17.1% of the cases with abnormal findings (*Category B2 evidence*).<sup>81,101,120</sup>

**Pulmonary Evaluation (*i.e.*, Pulmonary Function Tests, Spirometry).** Spirometry studies reported abnormal findings in 14.0–51.7% of asymptomatic or nonselected patients

(*Category B2 evidence*).<sup>125–127</sup> Changes in clinical management were not reported.

For selected or indicated patients, abnormal pulmonary function test findings were reported in 27.1–65.6% of patients<sup>128–130</sup>; abnormal spirometry findings were reported in 42.0% of patients (*Category B2 evidence*).<sup>131</sup> Changes in clinical management were not reported.

**Hemoglobin/Hematocrit Measurement.** In asymptomatic or nonselected patients, abnormal hemoglobin findings were reported in 0.5% to 65.4% of patients<sup>8,70,107,114,132–140</sup> and led to cancellations or changes in management in 2.4–28.6% of cases with abnormal findings (*Category B2 evidence*).<sup>70,133,138,139</sup>

For selected or indicated patients, abnormal hemoglobin findings were reported in 54.0% of patients (*Category B2 evidence*).<sup>114</sup> Changes in clinical management were not reported.

In asymptomatic or nonselected patients, abnormal hematocrit findings were reported in 0.2–38.9% of patients<sup>110,134,141–143</sup> and led to delay of surgery in 20.0% of the cases with abnormal findings (*Category B2 evidence*).<sup>110</sup>

In asymptomatic or nonselected patients, abnormal complete blood counts (*i.e.*, individual test results not reported) were reported in 2.9–9.0% of patients<sup>59,62,67,144</sup> and led to changes in clinical management in 2.9% of cases with abnormal findings (*Category B2 evidence*).<sup>67</sup>

For selected or indicated patients, abnormal complete blood counts were reported in 6.3–60.8% of patients<sup>62,75,81</sup> and led to changes in clinical management in 14.9% of the cases with abnormal findings (*Category B2 evidence*).<sup>81</sup>

**Coagulation Studies.** In asymptomatic or nonselected patients, coagulation abnormalities (*i.e.*, bleeding time, prothrombin time, partial prothrombin time, or platelet count) were reported in 0.06–21.2% of patients<sup>8,110,134,137,144–157</sup> and led to cancellations or changes in management in 0.0–4.0% of cases with abnormal findings (*Category B2 evidence*).<sup>110,148,152</sup>

For selected or indicated patients, abnormal coagulation findings were reported in 3.4–29.1% of patients (*Category B2 evidence*).<sup>156,158–160</sup> Changes in clinical management were not reported.

**Serum Chemistries.** In asymptomatic or nonselected patients, abnormal sodium concentrations were reported in 1.9% of patients<sup>8</sup>; abnormal potassium concentrations were reported in 0.2–16.0% of patients<sup>8,107,114,134,137,161</sup>; abnormal glucose concentrations were reported in 0.9–40.4% of patients (*Category B2 evidence*).<sup>8,107,134,137,144,162–164</sup> Changes in clinical management were not reported.

For selected or indicated patients, abnormal potassium concentrations were reported in 2.9–71.0% of patients (*Category B2 evidence*).<sup>114,165,166</sup> One nonrandomized study compared preoperative serum potassium concentrations 3 days before surgery with serum potassium concentrations at induction, and found lower potassium concentrations (hypokalemia) at induction (*Category B2 evidence*).<sup>161</sup> Changes in clinical management were not reported.

**Urine Testing.** In asymptomatic or nonselected patients, abnormal findings for urinalysis, not including pregnancy testing, were reported in 0.7–42.0% of patients<sup>59,62,64,70,110,114,134,138,142,167–169</sup> and led to cancellations or changes in management in 2.3–75.0% of the cases with abnormal findings (*Category B2 evidence*).<sup>110,138,168</sup>

For selected or indicated patients, abnormal urinalysis findings, not including pregnancy testing, were reported in 4.6–90.0% of patients<sup>62,81,114,167,168</sup> and led to changes in clinical management in 23.1–42.8% of cases with abnormal findings (*Category B2 evidence*).<sup>81,168</sup>

**Pregnancy Testing.** In asymptomatic or nonselected patients (*i.e.*, premenopausal menstruating females, not excluding anyone on the basis of history) positive pregnancy test findings were reported in 0.3–1.3% of patients<sup>170–173</sup> and led to postponement, cancellations, or changes in management in 100.0% of the cases of pregnancy (*Category B2 evidence*).<sup>170–173</sup>

**Survey Responses for Selection and Timing of Preoperative Tests.** For the original Advisory, consultants and ASA members were asked to consider whether specific preoperative tests (1) should be conducted on a routine basis (*i.e.*, given to patients regardless of known or suspected diseases or disorders), (2) should be conducted for selected patients or for selected types of surgery, or (3) are not necessary. For the tests considered, consultant and ASA membership responses are reported in table 3 (appendix 2). Consultants and ASA members were also asked to identify specific patient characteristics that would favor a decision to order, require, or perform a preoperative test. For these specific patient characteristics, consultant and ASA membership responses are reported in table 4 (appendix 2).

Consultants and ASA members were asked whether or not they agree that selected preoperative test results are acceptable if obtained from the patient's medical chart, assuming the patient's medical history has not changed substantially since the test result was obtained. The percentages of agreement of consultants and ASA members are reported, respectively, as follows: ECG (99%, 98%), other cardiac evaluation (94%, 98%), chest x-ray (97%, 92%), hemoglobin or hematocrit (99%, 96%), coagulation studies (86%, 98%), and serum chemistries (96%, 98%).

Respondents who agreed that test findings might be obtained from a patient's medical chart were asked how recent the findings should be to be acceptable. Opinions on how recent test findings should be are reported in table 5 (appendix 2).

### **Advisory for Selection and Timing of Preoperative Tests**

**Routine Preoperative Testing.** Preoperative tests should not be ordered routinely. Preoperative tests may be ordered, required, or performed *on a selective basis* for purposes of guiding or optimizing perioperative management. The indications for such testing should be documented and based on information obtained from medical records, patient inter-

view, physical examination, and type and invasiveness of the planned procedure.

### **Preoperative Testing in the Presence of Specific Clinical Characteristics**

The Task Force believes that there is insufficient evidence to identify explicit decision parameters or rules for ordering preoperative tests on the basis of specific clinical characteristics. However, consideration of selected clinical characteristics may assist the anesthesiologist when deciding to order, require, or perform preoperative tests. The following clinical characteristics may be of merit, although the anesthesiologist should not limit consideration to the characteristics suggested below.

**ECG.** Important clinical characteristics may include cardiovascular disease, respiratory disease, and type or invasiveness of surgery. The Task Force recognizes that ECG abnormalities may be more frequent in older patients and in patients with multiple cardiac risk factors. The Task Force did not reach consensus on a specific minimum age in those patients without specific risk factors. The Task Force recognizes that age alone may not be an indication for ECG. An ECG may be indicated for patients with known cardiovascular risk factors or for patients with risk factors identified in the course of a preanesthesia evaluation.

**Preanesthesia Cardiac Evaluation (Other than ECG).** Preanesthesia cardiac evaluation may include consultation with specialists and ordering, requiring, or performing tests that range from noninvasive passive or provocative screening tests (*e.g.*, stress testing) to noninvasive and invasive assessment of cardiac structure, function, and vascularity (*e.g.*, echocardiogram, radionuclide imaging, cardiac catheterization). Anesthesiologists should balance the risks and costs of these evaluations against their benefits. Clinical characteristics to consider include cardiovascular risk factors and type of surgery.

**Preanesthesia Chest Radiographs.** Clinical characteristics to consider include smoking, recent upper respiratory infection, chronic obstructive pulmonary disease (COPD), and cardiac disease. The Task Force recognizes that chest radiographic abnormalities may be higher in such patients but does not believe that extremes of age, smoking, stable COPD, stable cardiac disease, or resolved recent upper respiratory infection should be considered unequivocal indications for chest radiography.

**Preanesthesia Pulmonary Evaluation (Other than Chest X-ray).** Preanesthesia pulmonary evaluation other than chest x-ray may include consultation with specialists and tests that range from noninvasive passive or provocative screening tests (*e.g.*, pulmonary function tests, spirometry, pulse oximetry) to invasive assessment of pulmonary function (*e.g.*, arterial blood gas). Anesthesiologists should balance the risks and costs of these evaluations against their benefits. Clinical characteristics to consider include type and invasiveness of the surgical procedure, interval from previous evaluation, treated

or symptomatic asthma, symptomatic COPD, and scoliosis with restrictive function.

**Preanesthesia Hemoglobin or Hematocrit.** Routine hemoglobin or hematocrit is not indicated. Clinical characteristics to consider as indications for such tests include type and invasiveness of procedure, patients with liver disease, extremes of age, and history of anemia, bleeding, and other hematologic disorders.

**Preanesthesia Coagulation Studies.** Clinical characteristics to consider for ordering selected coagulation studies include bleeding disorders, renal dysfunction, liver dysfunction, and type and invasiveness of procedure. The Task Force recognizes that anticoagulant medications and alternative therapies may present an additional perioperative risk. The Task Force believes that there were not enough data to comment on the advisability of coagulation tests before regional anesthesia.

**Preanesthesia Serum Chemistries (i.e., Potassium, Glucose, Sodium, Renal and Liver Function Studies).** Clinical characteristics to consider before ordering such tests include likely perioperative therapies, endocrine disorders, risk of renal and liver dysfunction, and use of certain medications or alternative therapies. The Task Force recognizes that laboratory values may differ from normal values at extremes of age.

**Preanesthesia Urinalysis.** Urinalysis is not indicated except for specific procedures (e.g., prosthesis implantation, urologic procedures) or when urinary tract symptoms are present.

**Preanesthesia Pregnancy Testing.** Patients may present for anesthesia with early undetected pregnancy. The Task Force believes that the literature is inadequate to inform patients or physicians on whether anesthesia causes harmful effects on early pregnancy. Pregnancy testing may be offered to female patients of childbearing age and for whom the result would alter the patient's management.

**Timing of Preoperative Testing.** The current literature is not sufficiently rigorous to permit an unambiguous assessment of the clinical benefits or harms of the timing for preoperative tests. The Task Force believes that there is insufficient evidence to identify explicit decision parameters or "rules" for ordering preoperative tests on the basis of specific patient factors.

Test results obtained from the medical record within 6 months of surgery generally are acceptable if the patient's medical history has not changed substantially. More recent test results may be desirable when the medical history has changed or when a test results may play a role in the selection of a specific anesthetic technique (e.g., regional anesthesia in the setting of anticoagulation therapy).

### III. Summary and Conclusions

A *preanesthesia evaluation* involves the assessment of information from multiple sources, including medical records, patient interviews, physical examinations, and findings from preoperative tests.

The current scientific literature does not contain sufficiently rigorous information about the components of a preanesthesia evaluation to permit recommendations that are unambiguously based. Therefore, the Task Force has relied primarily upon observational literature, opinion surveys of consultants, and surveys of a random sample of members of the American Society of Anesthesiologists. The focus of opinion surveys has been threefold: (1) the content of the preanesthesia evaluation, (2) the timing of the preanesthesia evaluation, and (3) the indications for specific preoperative tests.

The following remarks represent a synthesis of the opinion surveys, literature, and Task Force consensus.

- *Content* of the preanesthetic evaluation includes but is not limited to (1) readily accessible medical records, (2) patient interview, (3) a directed preanesthesia examination, (4) preoperative tests when indicated, and (5) other consultations when appropriate. *At a minimum*, a directed preanesthetic physical examination should include an assessment of the airway, lungs, and heart.
- *Timing* of the preanesthetic evaluation can be guided by considering combinations of surgical invasiveness and severity of disease, as shown in table 2 (appendix 2).

The Task Force cautions that limitations in resources available to a specific healthcare system or practice environment may affect the timing of the preanesthetic evaluation. The healthcare system is obligated to provide pertinent information to the anesthesiologist for the appropriate assessment of the invasiveness of the proposed surgical procedure and the severity of the patient's medical condition well in advance of the anticipated day of procedure for all elective patients.

- *Routine preoperative tests* (i.e., tests intended to discover a disease or disorder in an asymptomatic patient) do not make an important contribution to the process of perioperative assessment and management of the patient by the anesthesiologist.
- *Selective preoperative tests* (i.e., tests ordered after consideration of specific information obtained from sources such as medical records, patient interview, physical examination, and the type or invasiveness of the planned procedure and anesthesia) may assist the anesthesiologist in making decisions about the process of perioperative assessment and management.
- *Decision-making parameters* for specific preoperative tests or for the timing of preoperative tests cannot be unequivocally determined from the available scientific literature. Further research is needed, preferably in the form of appropriately randomized clinical trials. Specific tests and their timing should be individualized and based upon information obtained from sources such as the patient's medical record, patient interview, physical examination, and the type and invasiveness of the planned procedure.



## Appendix 1: Summary of Advisory Statements

### I. Preanesthesia History and Physical Examination

- Impact
  - The assessment of anesthetic risks associated with the patient's medical conditions, therapies, alternative treatments, surgical and other procedures, and of options for anesthetic techniques is an essential component of basic anesthetic practice.
    - Benefits may include, but are not limited to, the safety of perioperative care, optimal resource use, improved outcomes, and patient satisfaction.
- Timing
  - An assessment of readily accessible, pertinent medical records with consultations, when appropriate, should be performed as part of the preanesthetic evaluation before the day of surgery for procedures with high surgical invasiveness.
    - For procedures with low surgical invasiveness, the review and assessment of medical records may be done on or before the day of surgery by anesthesia staff.
    - The information obtained may include, but should not be limited to, (1) a description of current diagnoses; (2) treatments, including medications and alternative therapies used; and (3) determination of the patient's medical condition(s).
    - The timing of such assessments may not be practical with the current limitation of resources provided in specific healthcare systems or practice environments.
  - An initial record review, patient interview, and physical examination should be performed before the day of surgery for patients with high severity of disease.
    - For patients with low severity of disease and undergoing procedures with high surgical invasiveness, the interview and physical exam should also be performed before the day of surgery.
    - For patients with low severity of disease undergoing procedures with medium or low surgical invasiveness, the initial interview and physical exam may be performed on or before the day of surgery.
    - At a minimum, a focused preanesthetic physical examination should include an assessment of the airway, lungs, and heart, with documentation of vital signs.
  - It is the obligation of the healthcare system to, at a minimum, provide pertinent information to the anesthesiologist for the appropriate assessment of the severity of medical condition of the patient and invasiveness of the proposed surgical procedure well in advance of the anticipated day of procedure for all elective patients.
    - There is insufficient evidence to identify explicit decision parameters or rules for ordering preoperative tests on the basis of specific clinical characteristics.
    - Consideration of selected clinical characteristics may assist the anesthesiologist when deciding to order, require, or perform preoperative tests. The following clinical characteristics may be of merit, although the anesthesiologist should not limit consideration to the characteristics suggested below.
      - Electrocardiogram
        - Important clinical characteristics may include cardiocirculatory disease, respiratory disease, and type or invasiveness of surgery.
        - The Task Force recognizes that ECG abnormalities may be higher in older patients and in patients with multiple cardiac risk factors.
        - An ECG may be indicated for patients with known cardiovascular risk factors or for patients with risk factors identified in the course of a preanesthesia evaluation. Age alone may not be an indication for ECG.
      - Preanesthesia Cardiac Evaluation Other than ECG
        - Preanesthesia cardiac evaluation may include consultation with specialists and ordering, requiring, or performing tests that range from noninvasive passive or provocative screening tests (*e.g.*, stress testing) to noninvasive and invasive assessment of cardiac structure, function, and vascularity (*e.g.*, echocardiogram, radionuclide imaging, cardiac catheterization).
        - Anesthesiologists should balance the risks and costs of these evaluations against their benefits.
        - Clinical characteristics to consider include cardiovascular risk factors and type of surgery.
      - Preanesthesia Chest Radiographs
        - Clinical characteristics to consider include smoking, recent upper respiratory infection, COPD, and cardiac disease.
          - The Task Force recognizes that chest radiographic abnormalities may be higher in such patients but does not believe that extremes of age, smoking, stable COPD, stable cardiac disease, or resolved recent upper respiratory infection should be considered unequivocal indications for chest radiography.
      - Preanesthesia Pulmonary Evaluation Other than Chest X-ray
        - Preanesthesia pulmonary evaluation other than chest x-ray may include consultation with specialists and tests that range from noninvasive passive or provocative screening tests (*e.g.*, pulmonary function tests, spirometry, pulse oximetry) to invasive assessment of pulmonary function (*e.g.*, arterial blood gas).
          - Anesthesiologists should balance the risks and costs of these evaluations against their benefits.
          - Clinical characteristics to consider include type and invasiveness of the surgical procedure, interval from previous evaluation, treated or symptomatic asthma, symptomatic COPD, and scoliosis with restrictive function.

### II. Selection and Timing of Preoperative Tests

- Routine Preoperative Testing
  - Preoperative tests should not be ordered routinely.
  - Preoperative tests may be ordered, required, or performed on a selective basis for purposes of guiding or optimizing perioperative management.
    - The indications for such testing should be documented and based on information obtained from medical records, patient interview, physical examination, and type and invasiveness of the planned procedure.
- Preoperative Testing in the Presence of Specific Clinical Characteristics
  - Preanesthesia Hemoglobin or Hematocrit
    - Routine hemoglobin or hematocrit is not indicated.
    - Clinical characteristics to consider as indications for hemoglobin or hematocrit include type and invasiveness of procedure, patients with liver disease, extremes of age, and history of anemia, bleeding, and other hematologic disorders.
  - Preanesthesia Coagulation Studies
    - Clinical characteristics to consider for ordering selected coagulation studies include bleeding disorders, renal dys-



function, liver dysfunction, and type and invasiveness of procedure.

- The Task Force recognizes that anticoagulant medications and alternative therapies may present an additional perioperative risk.
- The Task Force believes that there were not enough data to comment on the advisability of coagulation tests before regional anesthesia.
- Preanesthesia Serum Chemistries (*i.e.*, Potassium, Glucose, Sodium, Renal and Liver Function Studies)
  - Clinical characteristics to consider before ordering preanesthesia serum chemistries include likely perioperative therapies, endocrine disorders, risk of renal and liver dysfunction, and use of certain medications or alternative therapies.
    - The Task Force recognizes that laboratory values may differ from normal values at extremes of age.
- Preanesthesia Urinalysis
  - Urinalysis is not indicated except for specific procedures (*e.g.*, prosthesis implantation, urologic procedures) or when urinary tract symptoms are present.
- Preanesthesia Pregnancy Testing
  - Patients may present for anesthesia with early undetected pregnancy.
    - The Task Force believes that the literature is inadequate to inform patients or physicians on whether anesthesia causes harmful effects on early pregnancy.
    - Pregnancy testing may be offered to female patients of childbearing age and for whom the result would alter the patient's management.
- Timing of Preoperative Testing
  - The current literature is not sufficiently rigorous to permit an unambiguous assessment of the clinical benefits or harms of the timing for preoperative tests.
    - There is insufficient evidence to identify explicit decision parameters or "rules" for ordering preoperative tests on the basis of specific patient factors.
  - Test results obtained from the medical record within 6 months of surgery generally are acceptable if the patient's medical history has not changed substantially.
    - More recent test results may be desirable when the medical history has changed, or when a test results may play a role in the selection of a specific anesthetic technique (*e.g.*, regional anesthesia in the setting of anticoagulation therapy).

### III. Summary and Conclusions

- Content of the preanesthetic evaluation includes, but is not limited to, (1) readily accessible medical records, (2) patient interview, (3) a directed preanesthesia examination, (4) preoperative tests when indicated, and (5) other consultations when appropriate. At a minimum, a directed preanesthetic physical examination should include an assessment of the airway, lungs, and heart.
- Timing of the preanesthetic evaluation can be guided by considering combinations of surgical invasiveness and severity of disease, as shown in table 2 (appendix 2).
  - Limitations in resources available to a specific healthcare system or practice environment may affect the timing of the preanesthetic evaluation.
  - The healthcare system is obligated to provide pertinent information to the anesthesiologist for the appropriate assessment of the invasiveness of the proposed surgical procedure and the

severity of the patient's medical condition well in advance of the anticipated day of procedure for all elective patients.

- Routine preoperative tests (*i.e.*, tests intended to discover a disease or disorder in an asymptomatic patient) do not make an important contribution to the process of perioperative assessment and management of the patient by the anesthesiologist.
- Selective preoperative tests (*i.e.*, tests ordered after consideration of specific information obtained from sources such as medical records, patient interview, physical examination, and the type or invasiveness of the planned procedure and anesthesia) may assist the anesthesiologist in making decisions about the process of perioperative assessment and management.
- Decision-making parameters for specific preoperative tests or for the timing of preoperative tests cannot be unequivocally determined from the available scientific literature.
  - Specific tests and their timing should be individualized and based upon information obtained from sources such as the patient's medical record, patient interview, physical examination, and the type and invasiveness of the planned procedure.

## Appendix 2: Methods and Analyses

### A. State of the Literature

For this updated Advisory, a review of studies used in the development of the original Advisory was combined with a review of studies published subsequent to approval of the original Advisory. The updated literature review was based on evidence linkages, consisting of directional statements about relationships between specific preanesthesia evaluation activities and clinical outcomes. The evidence linkage interventions are listed below.

#### *Preanesthesia History and Physical Examination*

Preprocedure review of pertinent medical records  
 Patient interviewing for medical or anesthetic history  
 Preanesthesia patient examination

#### *Cardiac Evaluation*

Electrocardiogram  
 Other cardiac evaluation (*e.g.*, angiography, echocardiography, stress tests)  
 Cardiac function tests  
 Echocardiography (transesophageal, transthoracic)  
 Stress tests  
 Ventriculography

#### *Pulmonary Evaluation*

Chest radiography  
 Other pulmonary evaluation (*e.g.*, pulmonary function tests, spirometry)

#### *Blood Tests*

Hemoglobin  
 Hematocrit  
 Complete blood count  
 Coagulation studies  
 Serum chemistries (*i.e.*, sodium, potassium, glucose)  
 Potassium  
 Glucose  
 Urinalysis (as distinct from pregnancy testing)  
 Pregnancy evaluation

For purposes of literature review, potentially relevant clinical studies were identified via electronic and manual searches of the literature. The updated electronic search covered a 10-yr period from 2002 through 2011. The manual search covered a 15-yr period of time from 1997 through 2011. More than 300 new citations that addressed topics related to the evidence linkages were identified. These articles were reviewed, and studies that did not provide direct evidence were eliminated (combined total = 985). Articles that were accepted as containing direct linkage-related evidence were combined with pre-2002 articles accepted by the 2003 amended Advisory, resulting in a combined total of 245 articles.

No evidence linkage contained sufficient literature with well-defined experimental designs and statistical information to conduct an analysis of aggregated studies (*i.e.*, meta-analysis). A complete bibliography used to develop this updated Advisory, organized by section, is available as Supplemental Digital Content 2, <http://links.lww.com/ALN/A789>.

A study or report that appears in the published literature can be included as evidence in the development of an advisory if it meets four essential criteria. Failure to meet one or more of these criteria means that a study had features that did not make it suitable for analytic purposes. The four essential criteria are as follows: (1) the study must be related to one of the specified linkage statements; (2) the study must report a clinical finding or set of findings that can be tallied or quantified (This criterion eliminates reports that contain only opinion.); (3) the study must report a clinical finding or set of findings that can be identified as the product of an original investigation or report (This criterion eliminates the repetitive reporting and counting of the same results, such as may occur in review articles or follow-up studies that summarize previous findings.); and (4) the study must use sound research methods and analytical approaches that provide a clear test or indication of the relationship between the intervention and outcome of interest. Because none of the studies in this updated Advisory met all four criteria, the published literature could not be used as a source of quantitative support.

Although evidence linkages are designed to assess causality, the reviewed studies did not provide a clear indication of causality. However, many published studies were evaluated that provided the Task Force with important noncausal evidence. For example, descriptive literature (*i.e.*, reports of frequency or incidence) is often useful in providing an indication of the scope of a problem, and case reports may be useful in identifying the usefulness of preoperative tests for selected patients. In conclusion, the current literature has not been helpful in determining the efficacy of specific preanesthe-

sia evaluation activities in improving patient outcome. Until controlled studies are conducted, evidence from noncausal sources will need to be used, such as consensus-driven data and the opinion of practitioners and experts. It is recommended that future research on preanesthesia evaluation focus on the identification of preoperative tests or other evaluative activities in the context of prospective research designs when feasible.

### B. Consensus-based Evidence

For the original Advisory, consensus was obtained from multiple sources, including (1) survey opinion from consultants who were selected based on their knowledge or expertise regarding preanesthesia or preoperative evaluation, (2) survey opinions from a representative sample of ASA members (N = 360), (3) testimony from attendees of three publicly held open forums at national anesthesia meetings,<sup>†</sup> (4) Internet commentary, and (5) Task Force opinion and interpretation. Consultants and ASA members responded to three surveys addressing the following issues: (1) the appropriateness and completeness of topics selected for evidence review, (2) the appropriateness and need to include algorithm examples for timing of the preanesthesia evaluation, and (3) surveys regarding the timing and content of the preanesthesia evaluation and indications for testing. The survey rate of return for consultants was 55.8% (72 of 129). Of the 360 ASA members contacted, 234 (65%) responded. Survey responses for consultants and ASA members are presented in the text of the Advisory, and complete listings of survey responses are reported in tables 1–5.

In the original Advisory, consultants were asked to indicate which, if any, of the evidence linkages would change their clinical practices if the Advisory was instituted. The rate of return was 27.9% (36 of 129). The percentage of responding consultants expecting no change associated with each linkage were as follows: (1) review of medical records, charts, consultations, or other documentation = 88.6%, (2) preanesthesia patient examination = 91.4%, (3) patient interviewing for medical or anesthesia history = 91.4%, (4) timing of the preanesthesia evaluation = 82.9%, (5) ordering or performing preanesthesia ECGs = 77.1%, (6) ordering or performing other cardiac evaluations = 82.9%, (7) performing preanesthesia pulmonary function tests = 85.7%, (8) performing preanesthesia chest x-rays = 82.9%, (9) performing preanesthesia laboratory tests = 85.7%, and (10) performing preanesthesia urine pregnancy tests = 94.3%. Of the respondents, 94.3% indicated that the Advisory would have no effect on the amount of time spent on a typical case, and 5.7% indicated that there would be a decrease in the amount of time spent on a typical case with the implementation of this Advisory.

**Table 1.** Consultant and ASA Member Survey Responses: Timing of the Initial Assessment of Pertinent Medical Records\*

	High		Medium		Low	
	Consultants (N = 72)	Members (N = 234)	Consultants (N = 72)	Members (N = 231)	Consultants (N = 72)	Members (N = 233)
Surgical Invasiveness						
Before day of surgery	89%	75%	58%	33%	17%	11%
On or before day of surgery	11%	24%	39%	61%	69%	59%
Only on day of surgery	0%	1%	3%	6%	14%	30%

\* N = number of consultants or American Society of Anesthesiologists (ASA) members who responded to each item.

**Table 2.** Consultant and ASA Member Survey Responses: Timing of the Preanesthetic Interview and Physical Examination\*

High Severity of Disease	Surgical Invasiveness					
	High		Medium		Low	
	Consultants (N = 72)	Members (N = 232)	Consultants (N = 72)	Members (N = 232)	Consultants (N = 72)	Members (N = 232)
Before day of surgery	96%	89%	94%	69%	71%	53%
On or before day of surgery	4%	9%	4%	28%	24%	32%
Only on day of surgery	0%	2%	1%	3%	5%	15%

  

Low Severity of Disease	Surgical Invasiveness					
	High		Medium		Low	
	Consultants (N = 72)	Members (N = 229)	Consultants (N = 72)	Members (N = 229)	Consultants (N = 72)	Members (N = 229)
Before day of surgery	72%	53%	29%	21%	13%	25%
On or before day of surgery	11%	20%	49%	46%	39%	34%
Only on day of surgery	15%	11%	21%	34%	47%	56%

\* N = number of consultants or American Society of Anesthesiologists (ASA) members who responded to each item.

**Table 3.** Consultant and ASA Member Survey Responses: Routine or Selective Preoperative Testing\*

Preoperative Test	All Patients (Routine) Percent Agreement*	Selected Patients Percent Agreement	Test Not Necessary Percent Agreement
ECG			
Consultants (N = 72)	0%	100%	0%
ASA members (N = 233)	1%	98%	1%
Cardiac tests other than ECG			
Consultants (N = 72)	0%	97%	0%
ASA members (N = 233)	1%	99%	0%
Chest x-rays			
Consultants (N = 72)	3%	90%	7%
ASA members (N = 233)	1%	92%	6%
Pulmonary function tests			
Consultants (N = 42)	0%	98%	2%
ASA members (N = 234)	0%	96%	3%
Office spirometry			
Consultants (N = 42)	0%	88%	10%
ASA members (N = 234)	1%	63%	20%
Hemoglobin/Hematocrit			
Consultants (N = 72)	3%	96%	1%
ASA members (N = 234)	4%	95%	1%
Coagulation studies			
Consultants (N = 72)	3%	94%	1%
ASA members (N = 234)	1%	98%	1%
Serum chemistries			
Consultants (N = 72)	1%	99%	0%
ASA members (N = 234)	1%	99%	0%
Urinalysis			
Consultants (N = 72)	1%	53%	46%
ASA members (N = 233)	2%	47%	49%
Pregnancy test			
Consultants (N = 72)	7%	88%	5%
ASA members (N = 232)	17%	78%	3%

Row percentages do not include "don't know" responses, so row totals may not sum to 100%.

\* N = number of consultants or American Society of Anesthesiologists (ASA) members who responded to each item.

ECG = electrocardiogram.

**Table 4.** Consultant and ASA Member Survey Responses: Patient Characteristics for Selected Preoperative Testing\*

Preoperative Test	Patient Characteristics (N = 72)	Consultants (N = 234)	ASA Members
Electrocardiogram	Advanced age	93%	94%
	Cardiocirculatory disease	97%	98%
	Respiratory disease	74%	74%
Other cardiac evaluation (e.g., stress test)	Cardiovascular compromise	88%	95%
	Chest radiograph	Recent upper respiratory infection	45%
Smoking		42%	60%
COPD		71%	76%
Cardiac disease		62%	75%
Reactive airway disease		68%	71%
Pulmonary function tests	COPD	80%	89%
	Scoliosis	53%	60%
	Reactive airway disease	83%	86%
Office spirometry (i.e., portable spirometer)	COPD	77%	90%
	Scoliosis	51%	52%
	Hemoglobin/hematocrit	Advanced age	57%
Very young age		52%	56%
Anemia		96%	99%
Bleeding disorders		93%	94%
Other hematologic disorders		74%	84%
Coagulation studies		Bleeding disorders	99%
	Renal dysfunction	40%	52%
	Liver dysfunction	97%	91%
	Anticoagulants	97%	96%
Serum chemistries (Na, K, CO <sub>2</sub> , Cl, glucose)	Endocrine disorders	93%	95%
	Renal dysfunction	96%	98%
	Medications	87%	89%
Pregnancy test	Uncertain pregnancy history	84%	91%
	History suggestive of current pregnancy	94%	96%

\* N = number of consultants or American Society of Anesthesiologists (ASA) members who responded to each item.  
COPD = chronic obstructive pulmonary disease.

**Table 5.** Consultant and ASA Member Survey Responses: Timing of Test Findings\*

Preoperative Test	24 h	48 h	1 wk	2 wk	1 mo	3 mo	6 mo	1 yr	>1 yr	
Electrocardiogram	Consultants (N = 72)	0%	0%	4%	0%	31%	0%	46%	19%	0%
	ASA members (N = 218)	1%	0%	6%	0%	34%	0%	45%	12%	2%
Other cardiac tests	Consultants (N = 72)	0%	0%	5%	0%	33%	0%	27%	26%	10%
	ASA members (N = 217)	0%	0%	7%	0%	33%	0%	40%	18%	4%
Chest x-ray	Consultants (N = 72)	0%	5%	5%	0%	25%	23%	19%	23%	0%
	ASA members (N = 206)	0%	2%	8%	0%	27%	9%	31%	23%	0%
Hemoglobin/Hematocrit	Consultants (N = 72)	0%	0%	14%	8%	42%	23%	8%	5%	0%
	ASA members (N = 213)	0%	0%	13%	11%	46%	17%	11%	1%	0%
Coagulation studies	Consultants (N = 42)	28%	11%	30%	6%	19%	6%	0%	0%	0%
	ASA members (N = 194)	33%	16%	26%	6%	16%	4%	0%	0%	0%
Serum Chemistries	Consultants (N = 72)	15%	7%	27%	17%	27%	7%	0%	0%	0%
	ASA members (N = 203)	11%	12%	26%	9%	34%	7%	0%	0%	0%

\* N = number of consultants or American Society of Anesthesiologists (ASA) members who responded to each item.



## References

- Boersma E, Kertai MD, Schouten O, Bax JJ, Noordzij P, Steyerberg EW, Schinkel AF, van Santen M, Simoons ML, Thomson IR, Klein J, van Urk H, Poldermans D: Perioperative cardiovascular mortality in noncardiac surgery: Validation of the Lee cardiac risk index. *Am J Med* 2005; 118: 1134-41
- Canet J, Gallart L, Gomar C, Paluzie G, Vallès J, Castillo J, Sabaté S, Mazo V, Briones Z, Sanchis J, ARISCAT Group: Prediction of postoperative pulmonary complications in a population-based surgical cohort. *ANESTHESIOLOGY* 2010; 113: 1338-50
- Cohen MM, Duncan PG: Physical status score and trends in anesthetic complications. *J Clin Epidemiol* 1988; 41:83-90
- Correll DJ, Hepner DL, Chang C, Tsen L, Hevelone ND, Bader AM: Preoperative electrocardiograms: Patient factors predictive of abnormalities. *ANESTHESIOLOGY* 2009; 110: 1217-22
- Cullen DJ, Apolone G, Greenfield S, Guadagnoli E, Cleary P: ASA Physical Status and age predict morbidity after three surgical procedures. *Ann Surg* 1994; 220:3-9
- Dripps RD, Lamont A, Eckenhoff JE: The role of anesthesia in surgical mortality. *JAMA* 1961; 178:261-6
- Dudley JC, Brandenburg JA, Hartley LH, Harris S, Lee TH: Last-minute preoperative cardiology consultations: Epidemiology and impact. *Am Heart J* 1996; 131:245-9
- Dzankic S, Pastor D, Gonzalez C, Leung JM: The prevalence and predictive value of abnormal preoperative laboratory tests in elderly surgical patients. *Anesth Analg* 2001; 93: 301-8
- Gibbs J, Cull W, Henderson W, Daley J, Hur K, Khuri SF: Preoperative serum albumin level as a predictor of operative mortality and morbidity: Results from the National VA Surgical Risk Study. *Arch Surg* 1999; 134:36-42
- McAlister FA, Bertsch K, Man J, Bradley J, Jacka M: Incidence of and risk factors for pulmonary complications after nonthoracic surgery. *Am J Respir Crit Care Med* 2005; 171:514-7
- Michelson JD, Lotke PA, Steinberg ME: Urinary-bladder management after total joint-replacement surgery. *N Engl J Med* 1988; 319:321-6
- Olsson GL: Bronchospasm during anaesthesia. A computer-aided incidence study of 136,929 patients. *Acta Anaesth Scand* 1987; 31:244-52
- Pedersen T, Eliassen K, Henriksen E: A prospective study of risk factors and cardiopulmonary complications associated with anaesthesia and surgery: Risk indicators of cardiopulmonary morbidity. *Acta Anaesth Scand* 1990; 34:144-55
- Pedersen T, Viby-Mogensen J, Ringsted C: Anaesthetic practice and postoperative pulmonary complications. *Acta Anaesth Scand* 1992; 36:812-8
- Açil T, Cölkesen Y, Türköz R, Sezgin AT, Baltali M, Gülcan O, Demircan S, Yildirim A, Ozin B, Müderrisoğlu H: Value of preoperative echocardiography in the prediction of postoperative atrial fibrillation following isolated coronary artery bypass grafting. *Am J Cardiol* 2007; 100:1383-6
- Bando K, Sun K, Binford RS, Sharp TG: Determinants of longer duration of endotracheal intubation after adult cardiac operations. *Ann Thorac Surg* 1997; 63:1026-33
- Biavati MJ, Manning SC, Phillips DL: Predictive factors for respiratory complications after tonsillectomy and adenoidectomy in children. *Arch Otolaryngol Head Neck Surg* 1997; 123:517-21
- Blake DW, McGrath BP, Donnan GB, Smart S, Way D, Myers KA, Fullerton M: Influence of cardiac failure on atrial natriuretic peptide responses in patients undergoing vascular surgery. *Eur J Anaesthesiol* 1991; 8:365-71
- Brooks-Brunn JA: Predictors of postoperative pulmonary complications following abdominal surgery. *Chest* 1997; 111:564-71
- Burgos LG, Ebert TJ, Asiddao C, Turner LA, Pattison CZ, Wang-Cheng R, Kampine JP: Increased intraoperative cardiovascular morbidity in diabetics with autonomic neuropathy. *ANESTHESIOLOGY* 1989; 70:591-7
- Cohen MM, Cameron CB: Should you cancel the operation when a child has an upper respiratory tract infection? *Anesth Analg* 1991; 72:282-8
- Datema FR, Poldermans D, Baatenburg de Jong RJ: Incidence and prediction of major cardiovascular complications in head and neck surgery. *Head Neck* 2010; 32: 1485-93
- Duncan PG, Cohen MM: Postoperative complications: Factors of significance to anaesthetic practice. *Can J Anaesth* 1987; 34:2-8
- Duncan PG, Cohen MM, Tweed WA, Biehl D, Pope WD, Merchant RN, DeBoer D: The Canadian four-centre study of anaesthetic outcomes: III. Are anaesthetic complications predictable in day surgical practice? *Can J Anaesth* 1992; 39:440-8
- Forrest JB, Rehder K, Cahalan MK, Goldsmith CH: Multi-center study of general anesthesia. III. Predictors of severe perioperative adverse outcomes [published erratum appears in *ANESTHESIOLOGY* 1992; 77:222]. *ANESTHESIOLOGY* 1992; 76:3-15
- Fouad TR, Abdel-Razek WM, Burak KW, Bain VG, Lee SS: Prediction of cardiac complications after liver transplantation. *Transplantation* 2009; 87:763-70
- Gang Y, Hnatkova K, Mandal K, Ghuran A, Malik M: Preoperative electrocardiographic risk assessment of atrial fibrillation after coronary artery bypass grafting. *J Cardiovasc Electrophysiol* 2004; 15:1379-86
- Garibaldi RA, Britt MR, Coleman ML, Reading JC, Pace NL: Risk factors for postoperative pneumonia. *Am J Med* 1981; 70:677-80
- Goldman L, Caldera DL, Southwick FS, Nussbaum SR, Murray B, O'Malley TA, Goroll AH, Caplan CH, Nolan J, Burke DS, Krogstad D, Carabello B, Slater EE: Cardiac risk factors and complications in non-cardiac surgery. *Medicine* 1978; 57:357-70
- Greaves SC, Rutherford JD, Aranki SF, Cohn LH, Couper GS, Adams DH, Rizzo RJ, Collins JJ Jr, Antman EM: Current incidence and determinants of perioperative myocardial infarction in coronary artery surgery. *Am Heart J* 1996; 132:572-8
- Hovagim AR, Vitkun SA, Manecke GR, Reiner R: Arterial oxygen desaturation in adult dental patients receiving conscious sedation. *J Oral Maxillofac Surg* 1989; 47:936-9
- Karkos CD, Thomson GJ, Hughes R, Joshi M, Baguneid MS, Hill JC, Mukhopadhyay US: Prediction of cardiac risk prior to elective abdominal aortic surgery: Role of multiple gated acquisition scan. *World J Surg* 2003; 27:1085-92
- Kroenke K, Lawrence VA, Theroux JF, Tuley MR, Hilsenbeck S: Postoperative complications after thoracic and major abdominal surgery in patients with and without obstructive lung disease. *Chest* 1993; 104:1445-51
- Lawrence VA, Dhanda R, Hilsenbeck SG, Page CP: Risk of pulmonary complications after elective abdominal surgery. *Chest* 1996; 110:744-50
- Liu LL, Dzankic S, Leung JM: Preoperative electrocardiogram abnormalities do not predict postoperative cardiac complications in geriatric surgical patients. *J Am Geriatr Soc* 2002; 50:1186-91
- Mamode N, Docherty G, Lowe GD, Macfarlane PW, Martin W, Pollock JG, Cobbe SM: The role of myocardial perfusion scanning, heart rate variability and D-dimers in predicting the risk of perioperative cardiac complications after peripheral

- eral vascular surgery. *Eur J Vasc Endovasc Surg* 2001; 22:499-508
37. Mantia AM, Brinkmeyer SD, D'Amico F, Ingram M, Ammon J, Canose J: An epidemiologic approach to predictors of elective coronary artery bypass mortality in a non-university hospital population. *J Cardiothorac Vasc Anesth* 1994; 8:263-8
  38. Naef RW 3rd, Chauhan SP, Chevalier SP, Roberts WE, Meydrech EF, Morrison JC: Prediction of hemorrhage at cesarean delivery. *Obstet Gynecol* 1994; 83:923-6
  39. Ombrellaro MP, Freeman MB, Stevens SL, Goldman MH: Effect of anesthetic technique on cardiac morbidity following carotid artery surgery. *Am J Surg* 1996; 171:387-90
  40. Rao MK, Reilley TE, Schuller DE, Young DC: Analysis of risk factors for postoperative pulmonary complications in head and neck surgery. *Laryngoscope* 1992; 102:45-7
  41. Royster RL, Butterworth JF 4th, Prough DS, Johnston WE, Thomas JL, Hogan PE, Case LD, Gravlee GP: Preoperative and intraoperative predictors of inotropic support and long-term outcome in patients having coronary artery bypass grafting. *Anesth Analg* 1991; 72:729-36
  42. Shah KB, Kleinman BS, Rao TL, Jacobs HK, Mestan K, Schaafsma M: Angina and other risk factors in patients with cardiac diseases undergoing noncardiac operations. *Anesth Analg* 1990; 70:240-7
  43. Skolnick ET, Vomvolakis MA, Buck KA, Mannino SF, Sun LS: Exposure to environmental tobacco smoke and the risk of adverse respiratory events in children receiving general anesthesia. *ANESTHESIOLOGY* 1998; 88:1144-53
  44. Steen PA, Tinker JH, Tarhan S: Myocardial reinfarction after anesthesia and surgery. *JAMA* 1978; 239:2566-70
  45. Svensson LG, Hess KR, Coselli JS, Safi HJ, Crawford ES: A prospective study of respiratory failure after high-risk surgery on the thoracoabdominal aorta. *J Vasc Surg* 1991; 14:271-82
  46. Tait AR, Knight PR: The effects of general anesthesia on upper respiratory tract infections in children. *ANESTHESIOLOGY* 1987; 67:930-5
  47. Torres MR, Short L, Baglin T, Case C, Gibbs H, Marwick TH: Usefulness of clinical risk markers and ischemic threshold to stratify risk in patients undergoing major noncardiac surgery. *Am J Cardiol* 2002; 90:238-42
  48. Tseuda K, Debrand M, Bivins BA, Wright BD, Griffen WO: Pulmonary complications in the morbidly obese following jejunoileal bypass surgery under narcotic anesthesia. *Int Surg* 1980; 65:123-9
  49. van Klei WA, Bryson GL, Yang H, Kalkman CJ, Wells GA, Beattie WS: The value of routine preoperative electrocardiography in predicting myocardial infarction after noncardiac surgery. *Ann Surg* 2007; 246:165-70
  50. Vanzetto G, Machecourt J, Blendea D, Fagret D, Borrel E, Magne JL, Gattaz F, Guidicelli H: Additive value of thallium single-photon emission computed tomography myocardial imaging for prediction of perioperative events in clinically selected high cardiac risk patients having abdominal aortic surgery. *Am J Cardiol* 1996; 77:143-8
  51. Varela G, Novoa N, Ballesteros E, Oliveira R, Jiménez MF, Esteban PA, Aranda JL: Results of a simple exercise test performed routinely to predict postoperative morbidity after anatomical lung resection. *Eur J Cardiothorac Surg* 2010; 37:521-4
  52. von Knorring J: Postoperative myocardial infarction: A prospective study in a risk group of surgical patients. *Surgery* 1981; 90:55-60
  53. Warner MA, Offord KP, Warner ME, Lennon RL, Conover MA, Jansson-Schumacher U: Role of preoperative cessation of smoking and other factors in postoperative pulmonary complications: A blinded prospective study of coronary artery bypass patients. *Mayo Clin Proc* 1989; 64:609-16
  54. Wightman JA: A prospective survey of the incidence of postoperative pulmonary complications. *Br J Surg* 1968; 55:85-91
  55. Wong DH, Weber EC, Schell MJ, Wong AB, Anderson CT, Barker SJ: Factors associated with postoperative pulmonary complications in patients with severe chronic obstructive pulmonary disease. *Anesth Analg* 1995; 80:276-84
  56. Patel RI, Hannallah RS: Preoperative screening for pediatric ambulatory surgery: Evaluation of a telephone questionnaire method. *Anesth Analg* 1992; 75:258-61
  57. McKee RF, Scott EM: The value of routine preoperative investigations. *Ann R Coll Surg Engl* 1987; 69:160-2
  58. Burman AL: A pre-anaesthetic clinic. *S Afr Med J* 1968; 42:315-7
  59. Johnson H Jr, Knee-Ioli S, Butler TA, Munoz E, Wise L: Are routine preoperative laboratory screening tests necessary to evaluate ambulatory surgical patients? *Surgery* 1988; 104:639-45
  60. Sandler G: Costs of unnecessary tests. *Br Med J* 1979; 2:21-4
  61. Wittmann FW, Ring PA: Anaesthesia for hip replacement in ankylosing spondylitis. *J R Soc Med* 1986; 79:457-9
  62. Adams JG Jr, Weigelt JA, Poulos E: Usefulness of preoperative laboratory assessment of patients undergoing elective herniorrhaphy. *Arch Surg* 1992; 127:801-4; discussion 804-5
  63. Callaghan LC, Edwards ND, Reilly CS: Utilisation of the pre-operative ECG. *Anaesthesia* 1995; 50:488-90
  64. Golub R, Cantu R, Sorrento JJ, Stein HD: Efficacy of preadmission testing in ambulatory surgical patients. *Am J Surg* 1992; 163:565-70; discussion 571
  65. Liu S, Paul GE, Carpenter RL, Stephenson C, Wu R: Prolonged PR interval is a risk factor for bradycardia during spinal anesthesia. *Reg Anesth* 1995; 20:41-4
  66. Noordzij PG, Boersma E, Bax JJ, Feringa HH, Schreiner F, Schouten O, Kertai MD, Klein J, van Urk H, Elhendy A, Poldermans D: Prognostic value of routine preoperative electrocardiography in patients undergoing noncardiac surgery. *Am J Cardiol* 2006; 97:1103-6
  67. Perez A, Planell J, Bacardaz C, Hounie A, Franci J, Brotons C, Congost L, Bolibar I: Value of routine preoperative tests: A multicentre study in four general hospitals. *Br J Anaesth* 1995; 74:250-6
  68. Sommerville TE, Murray WB: Information yield from routine pre-operative chest radiography and electrocardiography. *S Afr Med J* 1992; 81:190-6
  69. Tait AR, Parr HG, Tremper KK: Evaluation of the efficacy of routine preoperative electrocardiograms. *J Cardiothorac Vasc Anesth* 1997; 11:752-5
  70. Turnbull JM, Buck C: The value of preoperative screening investigations in otherwise healthy individuals. *Arch Intern Med* 1987; 147:1101-5
  71. van Klei WA, Bryson GL, Yang H, Kalkman CJ, Wells GA, Beattie WS: The value of routine preoperative electrocardiography in predicting myocardial infarction after noncardiac surgery. *Ann Surg* 2007; 246:165-70
  72. Walton HJ, Cross P, Pollak EW: Ventricular cardiac arrhythmias during anesthesia: Feasibility of preoperative recognition. *South Med J* 1982; 75:27-9, 32
  73. Bhuripanyo K, Prasertchuang C, Viwathanatepa M, Khumsuk K, Sorpanya N: The impact of routine preoperative electrocardiogram in patients age > or = 40 years in Srinagarind Hospital. *J Med Assoc Thai* 1992; 75:399-406
  74. Carliner NH, Fisher ML, Plotnick GD, Garbart H, Rapoport A, Kelemen MH, Moran GW, Gadacz T, Peters RW: Routine preoperative exercise testing in patients undergoing major noncardiac surgery. *Am J Cardiol* 1985; 56:51-8
  75. Catchlove BR, Wilson RM, Spring S, Hall J: Routine investigations in elective surgical patients. Their use and cost

- effectiveness in a teaching hospital. *Med J Aust* 1979; 2:107-10
76. Catheline JM, Bihan H, Le Quang T, Sadoun D, Charniot JC, Onnen I, Fournier JL, Bénichou J, Cohen R: Preoperative cardiac and pulmonary assessment in bariatric surgery. *Obes Surg* 2008; 18:271-7
  77. Gold BS, Young ML, Kinman JL, Kitz DS, Berlin J, Schwartz JS: The utility of preoperative electrocardiograms in the ambulatory surgical patient. *Arch Intern Med* 1992; 152:301-5
  78. Jeger RV, Probst C, Arsenic R, Lippuner T, Pfisterer ME, Seeberger MD, Filipovic M: Long-term prognostic value of the preoperative 12-lead electrocardiogram before major noncardiac surgery in coronary artery disease. *Am Heart J* 2006; 151:508-13
  79. Knight AA, Hollenberg M, London MJ, Tubau J, Verrier E, Browner W, Mangano DT: Perioperative myocardial ischemia: Importance of the preoperative ischemic pattern. *ANESTHESIOLOGY* 1988; 68:681-8
  80. Murdoch CJ, Murdoch DR, McIntyre P, Hosie H, Clark C: The pre-operative ECG in day surgery: A habit? *Anaesthesia* 1999; 54:907-8
  81. Muskett AD, McGreevy JM: Rational preoperative evaluation. *Postgrad Med J* 1986; 62:925-8
  82. Rabkin SW, Horne JM: Preoperative electrocardiography: Its cost-effectiveness in detecting abnormalities when a previous tracing exists. *Can Med Assoc J* 1979; 121:301-6
  83. Raby KE, Goldman L, Creager MA, Cook EF, Weisberg MC, Whittemore AD, Selwyn AP: Correlation between preoperative ischemia and major cardiac events after peripheral vascular surgery. *N Engl J Med* 1989; 321:1296-300
  84. Rettke SR, Shub C, Naessens JM, Marsh HM, O'Brien JF: Significance of mildly elevated creatine kinase (myocardial band) activity after elective abdominal aortic aneurysmectomy. *J Cardiothorac Vasc Anesth* 1991; 5:425-30
  85. Seymour DG, Pringle R, MacLennan WJ: The role of the routine pre-operative electrocardiogram in the elderly surgical patient. *Age Ageing* 1983; 12:97-104
  86. Woodward MN, Earnshaw JJ, Heather BP: The value of QTC dispersion in assessment of cardiac risk in elective aortic aneurysm surgery. *Eur J Vasc Endovasc Surg* 1998; 15:267-9
  87. Wyatt WJ, Reed DN Jr, Apelgren KN: Pitfalls in the role of standardized preadmission laboratory screening for ambulatory surgery. *Am Surg* 1989; 55:343-6
  88. Rohde LE, Polanczyk CA, Goldman L, Cook EF, Lee RT, Lee TH: Usefulness of transthoracic echocardiography as a tool for risk stratification of patients undergoing major noncardiac surgery. *Am J Cardiol* 2001; 87:505-9
  89. Plotkin JS, Benitez RM, Kuo PC, Njoku MJ, Ridge LA, Lim JW, Howell CD, Laurin JM, Johnson LB: Dobutamine stress echocardiography for preoperative cardiac risk stratification in patients undergoing orthotopic liver transplantation. *Liver Transpl Surg* 1998; 4:253-7
  90. Poldermans D, Arnese M, Fioretti PM, Salustri A, Boersma E, Thomson IR, Roelandt JR, van Urk H: Improved cardiac risk stratification in major vascular surgery with dobutamine-atropine stress echocardiography. *J Am Coll Cardiol* 1995; 26:648-53
  91. Rossi E, Citterio F, Vescio MF, Pennestri F, Lombardo A, Loperfido F, Maseri A: Risk stratification of patients undergoing peripheral vascular revascularization by combined resting and dipyridamole echocardiography. *Am J Cardiol* 1998; 82:306-10
  92. Van Damme H, Piéard L, Gillain D, Benoit T, Rigo P, Limet R: Cardiac risk assessment before vascular surgery: A prospective study comparing clinical evaluation, dobutamine stress echocardiography, and dobutamine Tc-99m sestamibi tomoscintigraphy. *Cardiovasc Surg* 1997; 5:54-64
  93. Erickson CA, Carballo RE, Freischlag JA, Seabrook GR, Farooq MM, Cambria RA, Towne JB: Using dipyridamole-thallium imaging to reduce cardiac risk in aortic reconstruction. *J Surg Res* 1996; 60:422-8
  94. Gerson MC, Hurst JM, Hertzberg VS, Baughman R, Rouan GW, Ellis K: Prediction of cardiac and pulmonary complications related to elective abdominal and noncardiac thoracic surgery in geriatric patients. *Am J Med* 1990; 88:101-7
  95. Therre T, Ribal JP, Motreff P, Lussion JR, Espeut JB, Cassagnes J, Glanddier G: Assessment of cardiac risk before aortic reconstruction: Noninvasive work-up using clinical examination, exercise testing, and dobutamine stress echocardiography *versus* routine coronary arteriography. *Ann Vasc Surg* 1999; 13:501-8
  96. Troisi N, Dorigo W, Lo Sapio P, Pratesi G, Pulli R, Gensini GF, Pratesi C: Preoperative cardiac assessment in patients undergoing aortic surgery: Analysis of factors affecting the cardiac outcomes. *Ann Vasc Surg* 2010; 24:733-40
  97. Fleisher LA, Eagle KA, Shaffer T, Anderson GF: Perioperative- and long-term mortality rates after major vascular surgery: The relationship to preoperative testing in the Medicare population. *Anesth Analg* 1999; 89:849-55
  98. Chiolero R, Borgeat A, Fisher A: Postoperative arrhythmias and risk factors after open heart surgery. *Thorac Cardiovasc Surg* 1991; 39:81-4
  99. Christakis GT, Weisel RD, Fremes SE, Ivanov J, David TE, Goldman BS, Salerno TA: Coronary artery bypass grafting in patients with poor ventricular function. *J Thorac Cardiovasc Surg* 1992; 103:1083-91; discussion 1091-2
  100. Bhuripanyo K, Prasertchuang C, Chamadol N, Laopaiboon M, Bhuripanyo P: The impact of routine preoperative chest X-ray in Srinagarind Hospital, Khon Kaen. *J Med Assoc Thai* 1990; 73:21-8
  101. Bouillot JL, Fingerhut A, Paquet JC, Hay JM, Coggia M: Are routine preoperative chest radiographs useful in general surgery? A prospective, multicentre study in 3959 patients. *Association des Chirurgiens de l'Assistance Publique pour les Evaluations médicales. Eur J Surg* 1996; 162:597-604
  102. Farnsworth PB, Steiner E, Klein RM, SanFilippo JA: The value of routine preoperative chest roentgenograms in infants and children. *JAMA* 1980; 244:582-3
  103. Lim EH, Liu EH: The usefulness of routine preoperative chest X-rays and ECGs: A prospective audit. *Singapore Med J* 2003; 44:340-3
  104. Loder RE: Routine pre-operative chest radiography: 1977 compared with 1955 at Peterborough District General Hospital. *Anaesthesia* 1978; 33:972-4
  105. Mendelson DS, Khilnani N, Wagner LD, Rabinowitz JG: Preoperative chest radiography: Value as a baseline examination for comparison. *Radiology* 1987; 165:341-3
  106. Ogunseyinde AO: Routine pre-operative chest radiographs in non-cardiopulmonary surgery. *Afr J Med Med Sci* 1988; 17:157-61
  107. Pal KM, Khan IA, Safdar B: Preoperative work up: Are the requirements different in a developing country? *J Pak Med Assoc* 1998; 48:339-41
  108. Petterson SR, Janower ML: Is the routine preoperative chest film of value? *Applied Radiology* 1977; Jan-Feb: 70
  109. Rees AM, Roberts CJ, Bligh AS, Evans KT: Routine preoperative chest radiography in non-cardiopulmonary surgery. *Br Med J* 1976; 1(6021):1333-5
  110. Rosselló PJ, Ramos Cruz A, Mayol PM: Routine laboratory tests for elective surgery in pediatric patients: Are they necessary? *Bol Asoc Med P R* 1980; 72:614-23
  111. Rucker L, Frye EB, Staten MA: Usefulness of screening chest roentgenograms in preoperative patients. *JAMA* 1983; 250:3209-11



112. Sagel SS, Evens RG, Forrest JV, Bramson RT: Efficacy of routine screening and lateral chest radiographs in a hospital-based population. *N Engl J Med* 1974; 291:1001-4
113. Sane SM, Worsing RA Jr, Wiens CW, Sharma RK: Value of preoperative chest X-ray examinations in children. *Pediatrics* 1977; 60:669-72
114. Sewell JM, Spooner LL, Dixon AK, Rubenstein D: Screening investigations in the elderly. *Age Ageing* 1981; 10:165-8
115. Silvestri L, Maffessanti M, Gregori D, Berlot G, Gullo A: Usefulness of routine pre-operative chest radiography for anaesthetic management: A prospective multicentre pilot study. *Eur J Anaesthesiol* 1999; 16:749-60
116. Törnebrandt K, Fletcher R: Pre-operative chest x-rays in elderly patients. *Anaesthesia* 1982; 37:901-2
117. Wiencek RG, Weaver DW, Bouwman DL, Sachs RJ: Usefulness of selective preoperative chest x-ray films: A prospective study. *Am Surg* 1987; 53:396-8
118. Wood RA, Hoekelman RA: Value of the chest X-ray as a screening test for elective surgery in children. *Pediatrics* 1981; 67:447-52
119. Boghosian SG, Mooradian AD: Usefulness of routine preoperative chest roentgenograms in elderly patients. *J Am Geriatr Soc* 1987; 35:142-6
120. Charpak Y, Blerly C, Chastang C, Szatan M, Fourgeaux B: Prospective assessment of a protocol for selective ordering of preoperative chest x-rays. *Can J Anaesth* 1988; 35: 259-64
121. Ishaq M, Kamal RS, Aqil M: Value of routine pre-operative chest X-ray in patients over the age of 40 years. *J Pak Med Assoc* 1997; 47:279-81
122. Seymour DG, Pringle R, Shaw JW: The role of the routine pre-operative chest X-ray in the elderly general surgical patient. *Postgrad Med J* 1982; 58:741-5
123. Tape TG, Mushlin AI: How useful are routine chest x-rays of preoperative patients at risk for postoperative chest disease? *J Gen Intern Med* 1988; 3:15-20
124. Umbach GE, Zubek S, Deck HJ, Buhl R, Bender HG, Jungblut RM: The value of preoperative chest X-rays in gynecological patients. *Arch Gynecol Obstet* 1988; 243:179-85
125. Appleberg M, Gordon L, Fatti LP: Preoperative pulmonary evaluation of surgical patients using the vitalograph. *Br J Surg* 1974; 61:57-9
126. Kocabas A, Kara K, Ozgur G, Sonmez H, Burgut R: Value of preoperative spirometry to predict postoperative pulmonary complications. *Respir Med* 1996; 90:25-33
127. Pereira ED, Fernandes AL, da Silva Anção M, de Araújo Pereres C, Atallah AN, Faresin SM: Prospective assessment of the risk of postoperative pulmonary complications in patients submitted to upper abdominal surgery. *Sao Paulo Med J* 1999; 117:151-60
128. Durand M, Combes P, Eisele JH, Contet A, Blin D, Girardet P: Pulmonary function tests predict outcome after cardiac surgery. *Acta Anaesth Belg* 1993; 44:17-23
129. Jacob B, Amoateng-Adjepong Y, Rasakulasurir S, Manthous CA, Haddad R: Preoperative pulmonary function tests do not predict outcome after coronary artery bypass. *Conn Med* 1997; 61:327-32
130. Vedantam R, Crawford AH: The role of preoperative pulmonary function tests in patients with adolescent idiopathic scoliosis undergoing posterior spinal fusion. *Spine* 1997; 22:2731-4
131. Kispert JF, Kazmers A, Roitman L: Preoperative spirometry predicts perioperative pulmonary complications after major vascular surgery. *Am Surg* 1992; 58:491-5
132. Beattie WS, Karkouti K, Wijeyesundera DN, Tait G: Risk associated with preoperative anemia in noncardiac surgery: A single-center cohort study. *ANESTHESIOLOGY* 2009; 110: 574-81
133. Hackmann T, Steward DJ, Sheps SB: Anemia in pediatric day-surgery patients: Prevalence and detection. *ANESTHESIOLOGY* 1991; 75:27-31
134. Harris EJ: Usefulness of preoperative testing in pediatric podiatric surgery. Does it influence clinical decisions? *Clin Podiatr Med Surg* 1997; 14:149-78
135. Jones MW, Harvey IA, Owen R: Do children need routine preoperative blood tests and blood cross matching in orthopaedic practice? *Ann R Coll Surg Engl* 1989; 71:1-3
136. Keating EM, Meding JB, Faris PM, Ritter MA: Predictors of transfusion risk in elective knee surgery. *Clin Orthop* 1998; 357:50-9
137. Narr BJ, Hansen TR, Warner MA: Preoperative laboratory screening in healthy Mayo patients: Cost-effective elimination of tests and unchanged outcomes. *Mayo Clin Proc* 1991; 66:155-9
138. O'Connor ME, Drasner K: Preoperative laboratory testing of children undergoing elective surgery. *Anesth Analg* 1990; 70:176-80
139. Roy WL, Lerman J, McIntyre BG: Is preoperative haemoglobin testing justified in children undergoing minor elective surgery? *Can J Anaesth* 1991; 38:700-3
140. Swetech SM, Conlon JW, Messana AS: Common features associated with spinal-anesthesia-induced hypotension: A retrospective study. *J Am Osteopath Assoc* 1991; 91: 1195-8, 1201-2, 1205-8
141. Baron MJ, Gunter J, White P: Is the pediatric preoperative hematocrit determination necessary? *South Med J* 1992; 85:1187-9
142. Gold BD, Wolfersberger WH: Findings from routine urinalysis and hematocrit on ambulatory oral and maxillofacial surgery patients. *J Oral Surg* 1980; 38:677-8
143. Haug RH, Reifeis RL: A prospective evaluation of the value of preoperative laboratory testing for office anesthesia and sedation. *J Oral Maxillofac Surg* 1999; 57:16-20; discussion 21-2
144. Kaplan EB, Sheiner LB, Boeckmann AJ, Roizen MF, Beal SL, Cohen SN, Nicoll CD: The usefulness of preoperative laboratory screening. *JAMA* 1985; 253:3576-81
145. Aghajanian A, Grimes DA: Routine prothrombin time determination before elective gynecologic operations. *Obstet Gynecol* 1991; 78:837-9
146. Bolger WE, Parsons DS, Potempa L: Preoperative hemostatic assessment of the adenotonsillectomy patient. *Otolaryngol Head Neck Surg* 1990; 103:396-405
147. Burk CD, Miller L, Handler SD, Cohen AR: Preoperative history and coagulation screening in children undergoing tonsillectomy. *Pediatrics* 1992; 89:691-5
148. Close HL, Kryzer TC, Nowlin JH, Alving BM: Hemostatic assessment of patients before tonsillectomy: A prospective study. *Otolaryngol Head Neck Surg* 1994; 111:733-8
149. Eisenberg JM, Clarke JR, Sussman SA: Prothrombin and partial thromboplastin times as preoperative screening tests. *Arch Surg* 1982; 117:48-51
150. Eisenberg JM, Goldfarb S: Clinical usefulness of measuring prothrombin time as a routine admission test. *Clin Chem* 1976; 22:1644-7
151. Erban SB, Kinman JL, Schwartz JS: Routine use of the prothrombin and partial thromboplastin times. *JAMA* 1989; 262:2428-32
152. Houry S, Georgeac C, Hay JM, Fingerhut A, Boudet MJ: A prospective multicenter evaluation of preoperative hemostatic screening tests: The French Associations for Surgical Research. *Am J Surg* 1995; 170:19-23
153. Howells RC 2nd, Wax MK, Ramadan HH: Value of preoperative prothrombin time/partial thromboplastin time as a predictor of postoperative hemorrhage in pediatric patients undergoing tonsillectomy. *Otolaryngol Head Neck Surg* 1997; 117:628-32



154. Kozak EA, Brath LK: Do "screening" coagulation tests predict bleeding in patients undergoing fiberoptic bronchoscopy with biopsy? *Chest* 1994; 106:703-5
155. Robbins JA, Rose SD: Partial thromboplastin time as a screening test. *Ann Int Med* 1979; 90:796-7
156. Rohrer MJ, Michelotti MC, Nahrwold DL: A prospective evaluation of the efficacy of preoperative coagulation testing. *Ann Surg* 1988; 208:554-7
157. Tami TA, Parker GS, Taylor RE: Post-tonsillectomy bleeding: An evaluation of risk factors. *Laryngoscope* 1987; 97: 1307-11
158. Myers ER, Clarke-Pearson DL, Olt GJ, Soper JT, Berchuck A: Preoperative coagulation testing on a gynecologic oncology service. *Obstet Gynecol* 1994; 83:438-44
159. Rader ES: Hematologic screening tests in patients with operative prostatic disease. *Urology* 1978; 11:243-6
160. Wojtkowski TA, Rutledge JC, Matthews DC: The clinical impact of increased sensitivity PT and APTT coagulation assays. *Am J Clin Pathol* 1999; 112:225-32
161. Kharasch ED, Bowdle TA: Hypokalemia before induction of anesthesia and prevention by beta 2 adrenoceptor antagonism. *Anesth Analg* 1991; 72:216-20
162. Bochicchio GV, Salzano L, Joshi M, Bochicchio K, Scalea TM: Admission preoperative glucose is predictive of morbidity and mortality in trauma patients who require immediate operative intervention. *Am Surg* 2005; 71:171-4
163. Dunkelgrun M, Schreiner F, Schockman DB, Hoeks SE, Feringa HH, Goei D, Schouten O, Welten GM, Vidakovic R, Noordzij PG, Boersma E, Poldermans D: Usefulness of preoperative oral glucose tolerance testing for perioperative risk stratification in patients scheduled for elective vascular surgery. *Am J Cardiol* 2008; 101:526-9
164. Lankisch M, Füh R, Schotes D, Rose B, Lapp H, Rathmann W, Haastert B, Gülker H, Scherbaum WA, Martin S: High prevalence of undiagnosed impaired glucose regulation and diabetes mellitus in patients scheduled for an elective coronary angiography. *Clin Res Cardiol* 2006; 95:80-7
165. Hirsch IA, Tomlinson DL, Slogoff S, Keats AS: The overstated risk of preoperative hypokalemia. *Anesth Analg* 1988; 67:131-6
166. Wahr JA, Parks R, Boisvert D, Comunale M, Fabian J, Ramsay J, Mangano DT: Preoperative serum potassium levels and perioperative outcomes in cardiac surgery patients. Multicenter Study of Perioperative Ischemia Research Group. *JAMA* 1999; 281:2203-10
167. Akin BV, Hubbell FA, Frye EB, Rucker L, Friis R: Efficacy of the routine admission urinalysis. *Am J Med* 1987; 82: 719-22
168. Lawrence VA, Kroenke K: The unproven utility of the preoperative urinalysis: Clinical use. *Arch Intern Med* 1988; 148:1370-3
169. Sanders DP, McKinney FW, Harris WH: Clinical evaluation and cost effectiveness of preoperative laboratory assessment on patients undergoing total hip arthroplasty. *Orthopedics* 1989; 12:1449-53
170. Azzam FJ, Padda GS, DeBoard JW, Krock JL, Kolterman SM: Preoperative pregnancy testing in adolescents. *Anesth Analg* 1996; 82:4-7
171. Manley S, de Kelaita G, Joseph NJ, Salem MR, Heyman HJ: Preoperative pregnancy testing in ambulatory surgery: Incidence and impact of positive results. *ANESTHESIOLOGY* 1995; 83:690-3
172. Pierre N, Moy LK, Redd S, Emans SJ, Laufer MR: Evaluation of a pregnancy-testing protocol in adolescents undergoing surgery. *J Pediatr Adolesc Gynecol* 1998; 11:139-41
173. Wheeler M, Coté CJ: Preoperative pregnancy testing in a tertiary care children's hospital: A medico-legal conundrum. *J Clin Anesth* 1999; 11:56-63