

Routine laboratory testing before endoscopic procedures

This is a clinical update discussing the use of periendoscopic laboratory testing in common clinical situations. The Standards of Practice Committee of the American Society for Gastrointestinal Endoscopy (ASGE) prepared this document by using MEDLINE and PubMed databases to search for publications between January 1990 and December 2013 pertaining to this topic. The keywords “endoscopy” and “laboratory” were used with each of the following: “preanesthesia,” “preoperative,” “routine,” “screening,” and “testing.” The search was supplemented by accessing the “related articles” feature of PubMed with articles identified on MEDLINE and PubMed as the references. Additional references were obtained from the bibliographies of the identified articles and from recommendations of expert consultants. When few or no data were available from well-designed prospective trials, emphasis was given to results from large series and reports from recognized experts. Weaker recommendations are indicated by phrases such as “We suggest...,” whereas stronger recommendations are stated as “We recommend...” The strength of individual recommendations was based on both the aggregate evidence quality (Table 1)¹ and an assessment of the anticipated benefits and harms.

ASGE guidelines for appropriate use of endoscopy are based on a critical review of the available data and expert consensus at the time that the documents are drafted. Further controlled clinical studies may be needed to clarify aspects of this document. This document may be revised as necessary to account for changes in technology, new data, or other aspects of clinical practice and is solely intended to be an educational device to provide information that may assist endoscopists in providing care to patients. This document is not a rule and should not be construed as establishing a legal standard of care or as encouraging, advocating, requiring, or discouraging any particular treatment. Clinical decisions in any particular case involve a complex analysis of the patient’s condition and available courses of action. Therefore, clinical considerations may lead an endoscopist to take a course of action that varies from the recommendations and suggestions proposed in this document.

Routine preprocedure laboratory testing is the practice of ordering a set panel of tests for all patients undergoing a given procedure, irrespective of specific information obtained from the history and physical examination. There are insufficient data to determine the benefit of routine laboratory testing before endoscopic procedures, and therefore data must be extrapolated from surgical series and nonsurgical interventions. Most studies indicate that physicians overuse laboratory testing and that routine preoperative screening tests are usually unnecessary.²⁻⁸ In a study involving 2000 patients,⁹ only 40% of preoperative tests were done for a recognizable indication, and less than 1% of the tests revealed abnormalities that would have influenced perioperative management. Moreover, no adverse events were attributable to the identified laboratory abnormalities. Other studies have shown similar results and confirmed a lack of benefit from routine preoperative testing in both adult and pediatric patients.¹⁰⁻¹²

An evaluation of routine laboratory testing in the periendoscopic period should consider the frequency of abnormal test results within a given population, the accuracy of the tests, the risks of the planned procedure, the use of moderate sedation versus anesthesia, and whether an abnormal result will affect the decision to perform endoscopy or alter periprocedural management or outcome. Individual patient and procedure risks should be factored into the decision to perform periendoscopic laboratory tests. General risk estimates are available for common endoscopic procedures.¹³⁻¹⁶

The cost of screening and the expense of follow-up testing to evaluate often minor abnormalities that seldom improve patient care must also be considered. Furthermore, falsely abnormal test results may unnecessarily delay endoscopy and subject the patient to additional risks, with untoward health and economic consequences.¹⁷

COAGULATION TESTS

The definitions of coagulopathy and thrombocytopenia and the threshold laboratory values (international normalized ratio [INR], platelets) that are considered acceptable for endoscopy and surgery have not been clearly established. This document is designed to assist in the selection of patients for whom testing is performed, but it is not intended to determine how a health care professional applies these results to individual patients.

TABLE 1. GRADE System for Rating the Quality of Evidence for Guidelines¹

Quality of evidence	Definition	Symbol
High quality	Further research is very unlikely to change our confidence in the estimate of effect	⊕⊕⊕⊕
Moderate quality	Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate	⊕⊕⊕○
Low quality	Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate	⊕⊕○○
Very low quality	Any estimate of effect is very uncertain	⊕○○○

Prothrombin time, INR, and partial thromboplastin time

In patients without evidence of a bleeding disorder or coagulopathy, the prothrombin time (PT), INR, and partial thromboplastin time (PTT) neither predict nor correlate with intraoperative or postoperative hemorrhage.¹⁸⁻²¹

Furthermore, when bleeding does occur, it typically does so in patients with normal coagulation parameters in the absence of clinical risk factors, as shown in studies evaluating patients who underwent bronchoscopy with biopsy or transjugular liver biopsy.^{20,22} In the absence of clinical suspicion of a bleeding diathesis, abnormal PT results are found in less than 1% of patients.^{23,24} Moreover, an abnormal PT result does not accurately predict bleeding, nor does a normal value ensure hemostasis.²⁵

Abnormal PTT results are encountered in approximately 6.5% of patients, with reports as high as 16.3%.²¹ One presumed justification for routine coagulation screening is to identify patients with undiagnosed hemophilia or von Willebrand disease²⁶ because mild cases of hemophilia may escape detection until early adulthood, when hemorrhage may complicate major trauma or surgery. The PTT is not sensitive for hemophilia and has a false-positive rate of approximately 2.3%.²⁷ Moreover, the calculated incidence of hemophilia in males without a family history of the disease or a history of major trauma or surgery is only 0.0025%.²⁸ Therefore, a screening PTT for hemophilia is not recommended in the absence of clinical suspicion.

An abnormal PTT result does not reliably predict perioperative hemorrhage. A study of 1000 patients found that all patients with a prolonged PTT had clinical risk factors for bleeding,²⁹ suggesting the need to determine testing on a directed history and physical examination. Similarly, a recent study evaluating the utility of routine coagulation testing in children undergoing endoscopic procedures found abnormal PT and/or PTT test results in 16.8% of patients. However, these results did not predict bleeding episodes.³⁰ The PT and INR do not predict bleeding risk in liver disease because it relies on thromboplastins and measures only the activity of procoagulants and not

anticoagulants, both of which may be depressed in patients with advanced liver disease.³¹⁻³³ Routine PT and PTT measurements are not clinically useful unless the patient has a history of abnormal bleeding or known bleeding disorder or malnutrition; is receiving prolonged therapy with antibiotics associated with clotting factor deficiencies; is receiving anticoagulant therapy; or has prolonged biliary obstruction.^{6,8,34-36}

Platelet count

Similar to coagulation studies, a platelet count is not routinely advised unless there is a suspicion of thrombocytopenia based on the history or physical examination. Such clues may include a history of excessive bleeding or easy bruisability, myeloproliferative disorder, or the use of medications that decrease the platelet count. Thrombocytopenia occurs in less than 1% and results in altered care in 0.3% or less of surgical patients.^{3,8,24}

Bleeding time

Multiple studies indicate that routine preoperative measurement of bleeding time is not useful in predicting hemorrhage.³⁷ Although newer techniques to assess platelet function are available,^{38,39} these tests have not been validated in terms of assessing the risk of perioperative bleeding.⁴⁰⁻⁴² Contradictory results have been reported between test results and clinical endpoints such as bleeding.^{40,43,44} It is unclear whether these tests are clinically useful in patients with renal failure⁴⁵ or in those receiving aspirin or other antiplatelet agents.

In summary, in the absence of clinical suspicion, abnormalities of hemostasis are uncommon, and routine preoperative screening for coagulopathy with PT, INR, PTT, platelet count, or bleeding time, either alone or in combination, is not recommended.⁴⁶⁻⁴⁸

CHEST RADIOGRAPHY

Preoperative chest radiography is often recommended for patients 60 years of age or older, particularly those with a strong smoking history, recent respiratory infection,

or signs or symptoms suggestive of advanced cardiopulmonary disease.^{8,36,49} However, there is a high incidence of detecting incidental minor radiographic abnormalities that seldom alter patient care or clinical outcome.⁵⁰⁻⁵² In 1 meta-analysis, 10% of preoperative chest radiographs were abnormal and 1.3% of patients had unexpected findings; however, patient care was altered in only 0.1% of patients.⁵⁰ Therefore, routine chest radiography is not recommended before endoscopy.^{7,46,53-56} A chest radiograph should be considered in patients with new respiratory signs or symptoms or decompensated heart failure.¹⁷

ELECTROCARDIOGRAPHY

The value of a screening electrocardiogram (ECG) is limited by the high incidence of abnormalities, which is approximately 30%, and by the lack of influence on patient care.⁵⁷⁻⁶⁰ Although convincing data are not available to suggest a benefit, a preoperative ECG is often obtained in patients of advanced age.⁴⁶ However, there is no consensus regarding the minimum age for obtaining an ECG, and age alone is a poor indicator of who would benefit from screening.^{5,8,9,36,46} An ECG is often obtained in patients with comorbid illnesses (eg, heart disease, dysrhythmias, diabetes mellitus, hypertension, and electrolyte disturbances) undergoing surgery, particularly when symptomatic, and undergoing more complex or prolonged procedures.^{5,8,9,46} For patients with a normal history and physical examination findings undergoing a minor surgery, routine electrocardiography is unlikely to alter outcomes and can be deferred.⁶¹ Similarly, routine preoperative electrocardiography in patients undergoing endoscopic procedures is not recommended. The exception to this is when the use of droperidol for sedation is being considered because this drug is associated with prolongation of the QT interval and is contraindicated in those with a prolonged QT interval.^{62,63}

BLOOD TYPING AND CROSS-MATCHING

Blood typing and screening are unnecessary before most surgical procedures⁶⁴ unless it is anticipated that a blood transfusion may be necessary. The risk of bleeding after endoscopy is anticipated to be lower than that for surgery. Therefore, routine blood typing before elective endoscopy is not recommended. Blood typing, screening, and cross-matching should be considered in patients undergoing endoscopy for the evaluation and management of acute GI bleeding.

HEMOGLOBIN/HEMATOCRIT TESTING

Severe anemia is found in less than 1% of asymptomatic patients,⁹ whereas mild decreases in hemoglobin levels are

relatively common. The baseline hemoglobin level has been shown to predict the need for transfusion in patients undergoing surgical procedures associated with significant blood loss.⁶⁵ In addition, a hemoglobin level less than 8 mg/dL has been associated with cardiac morbidity and operative death.⁶⁶ Although determining a baseline hemoglobin or hematocrit level is recommended before major surgery in patients anticipated to have significant intraoperative blood loss, such testing is not recommended for patients undergoing minor surgeries in the absence of clinical findings suggestive of anemia.^{67,68} Measurement of hemoglobin should be considered for patients with preexisting anemia or risk factors for bleeding, a high risk of adverse events with significant bleeding, advanced liver disease, or a hematologic disorder when undergoing endoscopic procedures in which there is a high risk of bleeding adverse events.^{36,46,61}

URINALYSIS

The rationale for a preoperative urinalysis is primarily to detect urinary tract infections or unrecognized renal disease. The incidence of abnormal preoperative screening urinalysis is approximately 19%, but has been reported in as many as 39% of patients.^{8,69} However, abnormal urinalysis results rarely affect patient care,^{4,8,69} and there are no data to suggest that urinary tract infections affect endoscopic outcome.⁴⁶ Therefore, routine urinalysis is not recommended before endoscopy.^{5,7,8}

PREGNANCY TESTING

Although pregnancy is not a contraindication to endoscopic procedures and the use of moderate sedation, there are situations when it is important to be aware of pregnancy status because it may affect certain procedural aspects such as use of fluoroscopy and choice of sedation agents.^{46,70-73} When possible, it is advisable to avoid or delay elective endoscopic procedures until after delivery or to take appropriate measures to lessen the potential risk to the unborn child when delaying the procedure is not possible. The American Society of Anesthesiologists (ASA) states that “the literature is inadequate to inform patients or physicians on whether anesthesia causes harmful effects on early pregnancy,” and β -human chorionic gonadotropin testing before surgery is recommended, but not mandated, by the ASA.^{36,46} Pregnancy testing may be considered in women of childbearing age who provide an uncertain pregnancy history or a history suggestive of current pregnancy, unless they have undergone a total hysterectomy or bilateral tubal ligation or have had absent menses for 1 year (menopause). The threshold for pregnancy testing should be lower when fluoroscopy use is planned.⁷³

SERUM CHEMISTRY TESTING

Serum electrolyte determinations, tests of renal function, and serum glucose levels are usually reported together as part of a “chemistry” panel. Outcomes data regarding the use of screening serum chemistry testing is largely derived from the surgical literature. Routine preoperative chemistry testing rarely yields an abnormality that influences perioperative management in a patient without a history to suggest abnormal test results.⁹ When laboratory studies are performed on the basis of clinical considerations, as many as 30% of the test results may be abnormal and identification of abnormalities by such selective testing may result in substantial changes in the surgical management of the patient.⁷⁴ Unsuspected abnormalities are found in only 0.2% to 1.0% of patients undergoing routine preoperative chemistry screening,^{9,75,76} and there is no evidence that these unexpected abnormalities alter anesthetic or surgical treatment or lead to an adverse outcome.^{4,23} Based on data from a literature review and 1 large study encompassing 2570 patients, it has been recommended that routine preoperative chemistry testing not be performed.^{67,77}

It has been suggested that a test of renal function be performed in surgical patients older than 40 years of age to adjust the dose of perioperative medications. In addition, renal dysfunction (creatinine > 1.9 mg/dL) has been shown to correlate with poor outcome in patients undergoing major surgery,^{78,79} and the American College of Cardiology and American Heart Association both classify renal insufficiency as an intermediate clinical risk predictor for an adverse outcome after major surgery.⁸⁰ However, there are no data to support this recommendation in patients undergoing endoscopy and mild impairment in renal function appears to have no bearing on the outcome with the use of moderate and deep sedation.

Considering the aggregate cost and lack of correlation between abnormal results and poor outcomes, routine performance of screening chemistry tests in an otherwise healthy patient undergoing endoscopy is not justified. Testing may be indicated for a subset of patients with a history of endocrine, renal, or hepatic dysfunction and those taking medications that may further impair function. In patients with known insulin-requiring diabetes mellitus, preprocedural evaluation of blood glucose levels may be warranted.

RECOMMENDATIONS

1. We recommend that endoscopists pursue preprocedure testing selectively based on the medical history, physical examination, and patient and procedural risk factors. (⊕⊕⊕⊕)
2. We recommend against routine testing with coagulation studies, chest radiography, electrocardiography, blood

typing or screening, hemoglobin or hematocrit levels, urinalysis, and chemistry tests before endoscopy in healthy patients. The use of these tests should be individualized based on patient and procedural risk factors.

- (⊕⊕⊕⊕)
3. We suggest that pregnancy testing be considered before endoscopy and fluoroscopy use in female patients of childbearing age with an uncertain pregnancy history or a history suggestive of current pregnancy in the absence of a previous total hysterectomy, bilateral tubal ligation, or absent menses for 1 year (menopause). (⊕⊕○○)
 4. We suggest that coagulation studies be performed before endoscopy in patients with active bleeding, a known or clinically suspected bleeding disorder, medication risk (eg, anticoagulant use, prolonged antibiotics), prolonged biliary obstruction, history of abnormal bleeding, malnutrition, or other conditions associated with acquired coagulopathies. (⊕⊕○○)
 5. We suggest obtaining a chest radiograph before endoscopy in patients with new respiratory symptoms or decompensated cardiac failure. (⊕⊕○○)
 6. We recommend blood typing and screening before endoscopy when a blood transfusion is considered likely in patients with active bleeding or anemia. (⊕⊕⊕⊕)
 7. We suggest testing the hemoglobin/hematocrit before endoscopy in patients with preexisting anemia or ongoing bleeding or when there is a high risk of significant blood loss during the procedure. (⊕⊕⊕○)
 8. We suggest selective chemistry testing before endoscopy in patients with significant endocrine, renal, or hepatic dysfunction before using medications that may further impair function. (⊕⊕○○)

DISCLOSURE

The following authors disclosed financial relationships relevant to this publication: Dr. Khashab is a consultant to Boston Scientific and Olympus America and has received research support from Cook Medical. Dr. Chathadi is a consultant to Boston Scientific. V. Raman Muthusamy has a potential conflict with Boston Scientific (Consultant) and Covidien GI Solutions (Honorarium). All other authors disclosed no financial relationships relevant to this publication.

Abbreviations: ECG, electrocardiogram; INR, international normalized ratio; PTT, partial thromboplastin time; PT, protrombin time.

REFERENCES

1. Guyatt G, Oxman AD, Akl EA, et al. GRADE guidelines: Introduction—GRADE evidence profiles and summary of findings tables. *J Clin Epidemiol* 2011;64:383-94.

2. Coutre S. Preoperative assessment of hemostasis. UpToDate. Waltham (Mass); 2008.
3. Dzankic S, Pastor D, Gonzalez C, et al. The prevalence and predictive value of abnormal preoperative laboratory tests in elderly surgical patients. *Anesth Analg* 2001;93:301-8.
4. 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.
5. Pasternak LR. Preoperative laboratory testing: general issues and considerations. *Anesthesiol Clin North America* 2004;22:13-25.
6. Robinson TN, Biffl WL, Moore EE, et al. Routine preoperative laboratory analyses are unnecessary before elective laparoscopic cholecystectomy. *Surg Endosc* 2003;17:438-41.
7. Smetana GW. Preoperative medical evaluation of the healthy patient. UpToDate Waltham (Mass); 2008.
8. Smetana GW, Macpherson DS. The case against routine preoperative laboratory testing. *Med Clin North Am* 2003;87:7-40.
9. Kaplan EB, Sheiner LB, Boeckmann AJ, et al. The usefulness of preoperative laboratory screening. *JAMA* 1985;253:3576-81.
10. Benarroch-Gampel J, Sheffield KM, Duncan CB, et al. Preoperative laboratory testing in patients undergoing elective, low-risk ambulatory surgery. *Ann Surg* 2012;256:518-28.
11. Chung F, Yuan H, Yin L, et al. Elimination of preoperative testing in ambulatory surgery. *Anesth Analg* 2009;108:467-75.
12. Kumar A, Srivastava U. Role of routine laboratory investigations in preoperative evaluation. *J Anaesthesiol Clin Pharmacol* 2011;27:174-9.
13. Early DS, Acosta RD, Chandrasekhara V, et al. Adverse events associated with EUS and EUS with FNA. *Gastrointest Endosc* 2013;77:839-43.
14. Ben-Menachem T, Decker GA, Early DS, et al. Adverse events of upper GI endoscopy. *Gastrointest Endosc* 2012;76:707-18.
15. Fisher DA, Maple JT, Ben-Menachem T, et al. Complications of colonoscopy. *Gastrointest Endosc* 2011;74:745-52.
16. Anderson MA, Fisher L, Jain R, et al. Complications of ERCP. *Gastrointest Endosc* 2012;75:467-73.
17. Richman DC. Ambulatory surgery: how much testing do we need? *Anesthesiol Clin* 2010;28:185-97.
18. Dzik WH. Predicting hemorrhage using preoperative coagulation screening assays. *Curr Hematol Rep* 2004;3:324-30.
19. Eika C, Havig O, Godal HC. The value of preoperative haemostatic screening. *Scand J Haematol* 1978;21:349-54.
20. Segal JB, Dzik WH. Paucity of studies to support that abnormal coagulation test results predict bleeding in the setting of invasive procedures: an evidence-based review. *Transfusion* 2005;45:1413-25.
21. Suchman AL, Mushlin AI. How well does the activated partial thromboplastin time predict postoperative hemorrhage? *JAMA* 1986;256:750-3.
22. Kozak EA, Brath LK. Do "screening" coagulation tests predict bleeding in patients undergoing fiberoptic bronchoscopy with biopsy? *Chest* 1994;106:703-5.
23. Perez A, Planell J, Bacardaz C, et al. Value of routine preoperative tests: a multicentre study in four general hospitals. *Br J Anaesth* 1995;74:250-6.
24. Rohrer MJ, Michelotti MC, Nahrwold DL. A prospective evaluation of the efficacy of preoperative coagulation testing. *Ann Surg* 1988;208:554-7.
25. 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.
26. Rutgeerts P, Wang TH, Llorens PS. Gastrointestinal endoscopy and the patient with the risk of bleeding disorder. *Gastrointest Endosc* 1999;49:134-6.
27. Lowe GD, Forbes CD. Laboratory diagnosis of congenital coagulation defects. *Clin Haematol* 1979;8:79-94.
28. Clarke JR, Eisenberg JM. A theoretical assessment of the value of the PTT as a preoperative screening test in adults. *Med Decis Making* 1981;1:40-3.
29. Robbins JA, Rose SD. Partial thromboplastin time as a screening test. *Ann Intern Med* 1979;90:796-7.
30. Giles E, Walton-Salih E, Shah N, et al. Routine coagulation screening in children undergoing gastrointestinal endoscopy does not predict those at risk of bleeding. *Endoscopy* 2006;38:508-10.
31. Tripodi A, Caldwell SH, Hoffman M, et al. Review article: the prothrombin time test as a measure of bleeding risk and prognosis in liver disease. *Aliment Pharmacol Ther* 2007;141-8.
32. Kovacs MJ, Wong A, MacKinnon K, et al. Assessment of the validity of the INR system for patients with liver impairment. *Thromb Haemost* 1994;71:727-30.
33. Deitcher SR. Interpretation of the international normalised ratio in patients with liver disease. *Lancet* 2002;359:47-8.
34. Eisenberg JM, Goldfarb S. Clinical usefulness of measuring prothrombin time as a routine admission test. *Clin Chem* 1976;22:1644-7.
35. Chee YL, Crawford JC, Watson HG, et al. Guidelines on the assessment of bleeding risk prior to surgery or invasive procedures. British Committee for Standards in Haematology. *Br J Haematol* 2008;140:496-504.
36. Apfelbaum JL, Connis RT, Nickinovich DG, et al. Practice advisory for preanesthesia evaluation: an updated report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation. *Anesthesiology* 2012;116:522-38.
37. Rodgers RP, Levin J. A critical reappraisal of the bleeding time. *Semin Thromb Hemost* 1990;16:1-20.
38. Bracey AW, Grigore AM, Nussmeier NA. Impact of platelet testing on presurgical screening and implications for cardiac and noncardiac surgical procedures. *Am J Cardiol* 2006;98:25N-32N.
39. Lordkipanidze M, Pharand C, Schampaert E, et al. A comparison of six major platelet function tests to determine the prevalence of aspirin resistance in patients with stable coronary artery disease. *Eur Heart J* 2007;28:1702-8.
40. Carroll RC, Chavez JJ, Snider CC, et al. Correlation of perioperative platelet function and coagulation tests with bleeding after cardiopulmonary bypass surgery. *J Lab Clin Med* 2006;147:197-204.
41. Kikura M, Sato S. Effects of preemptive therapy with milrinone or amrinone on perioperative platelet function and haemostasis in patients undergoing coronary bypass grafting. *Platelets* 2003;14:277-82.
42. Lennon MJ, Gibbs NM, Weightman WM, et al. A comparison of Plateletworks and platelet aggregometry for the assessment of aspirin-related platelet dysfunction in cardiac surgical patients. *J Cardiothorac Vasc Anesth* 2004;18:136-40.
43. Chen L, Bracey AW, Radovancevic R, et al. Clopidogrel and bleeding in patients undergoing elective coronary artery bypass grafting. *J Thorac Cardiovasc Surg* 2004;128:425-31.
44. Lasne D, Fiemeyer A, Chatellier G, et al. A study of platelet functions with a new analyzer using high shear stress (PFA 100) in patients undergoing coronary artery bypass graft. *Thromb Haemost* 2000;84:794-9.
45. Pawa S, Ehrinpreis M, Mutchnick M, et al. Percutaneous liver biopsy is safe in chronic hepatitis C patients with end-stage renal disease. *Clin Gastroenterol Hepatol* 2007;5:1316-20.
46. Practice advisory for preanesthesia evaluation: a report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation. *Anesthesiology* 2002;96:485-96.
47. Practice guidelines for perioperative blood transfusion and adjuvant therapies: an updated report by the American Society of Anesthesiologists Task Force on Perioperative Blood Transfusion and Adjuvant Therapies. *Anesthesiology* 2006;105:198-208.
48. Barber A, Green D, Galluzzo T, et al. The bleeding time as a preoperative screening test. *Am J Med* 1985;78:761-4.
49. Mendelson DS, Khilnani N, Wagner LD, et al. Preoperative chest radiography: value as a baseline examination for comparison. *Radiology* 1987;165:341-3.
50. Archer C, Levy AR, McGregor M. Value of routine preoperative chest x-rays: a meta-analysis. *Can J Anaesth* 1993;40:1022-7.
51. Lim EH, Liu EH. The usefulness of routine preoperative chest X-rays and ECGs: a prospective audit. *Singapore Med J* 2003;44:340-3.

52. Silvestri L, Maffessanti M, Gregori D, et al. Usefulness of routine pre-operative chest radiography for anaesthetic management: a prospective multicentre pilot study. *Eur J Anaesthesiol* 1999;16: 749-60.
53. Preoperative chest radiology. National study by the Royal College of Radiologists. *Lancet* 1979;2:83-6.
54. Fowkes FG, Davies ER, Evans KT, et al. Multicentre trial of four strategies to reduce use of a radiological test. *Lancet* 1986;1:367-70.
55. Roberts CJ, Fowkes FG, Ennis WP, et al. Possible impact of audit on chest X-ray requests from surgical wards. *Lancet* 1983;2:446-8.
56. Rucker L, Frye EB, Staten MA. Usefulness of screening chest roentgenograms in preoperative patients. *JAMA* 1983;250:3209-11.
57. Gold BS, Young ML, Kinman JL, et al. The utility of preoperative electrocardiograms in the ambulatory surgical patient. *Arch Intern Med* 1992;152:301-5.
58. 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.
59. Noordzij PG, Boersma E, Bax JJ, et al. Prognostic value of routine preoperative electrocardiography in patients undergoing noncardiac surgery. *Am J Cardiol* 2006;97:1103-6.
60. Tait AR, Parr HG, Tremper KK. Evaluation of the efficacy of routine preoperative electrocardiograms. *J Cardiothorac Vasc Anesth* 1997;11:752-5.
61. Laine C, Williams SV, Wilson JF. In the clinic. Preoperative evaluation. *Ann Intern Med* 2009;151:ITC1-15.
62. Vargo JJ, DeLegge MH, Feld AD, et al. Multisociety sedation curriculum for gastrointestinal endoscopy. *Gastrointest Endosc* 2012;76:e1-25.
63. Lichtenstein DR, Jagannath S, Baron TH, et al. Sedation and anesthesia in GI endoscopy. *Gastrointest Endosc* 2008;68:815-26.
64. Smallwood JA. Use of blood in elective general surgery: an area of wasted resources. *Br Med J (Clin Res Ed)* 1983;286:868-70.
65. Faris PM, Spence RK, Larholt KM, et al. The predictive power of baseline hemoglobin for transfusion risk in surgery patients. *Orthopedics* 1999;22:s135-40.
66. Carson JL, Poses RM, Spence RK, et al. Severity of anaemia and operative mortality and morbidity. *Lancet* 1988;1:727-9.
67. Campbell IT, Gosling P. Preoperative biochemical screening. *BMJ* 1988;297:803-4.
68. Robbins JA, Mushlin AI. Preoperative evaluation of the healthy patient. *Med Clin North Am* 1979;63:1145-56.
69. Johnson H Jr, Knee-Ioli S, Butler TA, et al. Are routine preoperative laboratory screening tests necessary to evaluate ambulatory surgical patients? *Surgery* 1988;104:639-45.
70. Axelrad AM, Fleischer DE, Strack LL, et al. Performance of ERCP for symptomatic choledocholithiasis during pregnancy: techniques to increase safety and improve patient management. *Am J Gastroenterol* 1994;89:109-12.
71. Jamidar PA, Beck GJ, Hoffman BJ, et al. Endoscopic retrograde cholangiopancreatography in pregnancy. *Am J Gastroenterol* 1995;90:1263-7.
72. Qureshi WA, Rajan E, Adler DG, et al. ASGE Guideline: Guidelines for endoscopy in pregnant and lactating women. *Gastrointest Endosc* 2005;61:357-62.
73. Shergill AK, Ben-Menachem T, Chandrasekhara V, et al. Guidelines for endoscopy in pregnant and lactating women. *Gastrointest Endosc* 2012;76:18-24.
74. Charpak Y, Blery C, Chastang C, et al. Usefulness of selectively ordered preoperative tests. *Med Care* 1988;26:95-104.
75. Blery C, Charpak Y, Szatan M, et al. Evaluation of a protocol for selective ordering of preoperative tests. *Lancet* 1986;1:139-41.
76. McKee RF, Scott EM. The value of routine preoperative investigations. *Ann R Coll Surg Engl* 1987;69:160-2.
77. Turnbull JM, Buck C. The value of preoperative screening investigations in otherwise healthy individuals. *Arch Intern Med* 1987;147:1101-5.
78. Anderson RJ, O'Brien M, MaWhinney S, et al. Mild renal failure is associated with adverse outcome after cardiac valve surgery. *Am J Kidney Dis* 2000;35:1127-34.
79. Becquemin JP, Chemla E, Chatellier G, et al. Perioperative factors influencing the outcome of elective abdominal aorta aneurysm repair. *Eur J Vasc Endovasc Surg* 2000;20:84-9.
80. Eagle KA, Berger PB, Calkins H, et al. ACC/AHA guideline update for perioperative cardiovascular evaluation for noncardiac surgery—executive summary a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1996 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery). *Circulation* 2002;105:1257-67.

Prepared by:

ASGE STANDARDS OF PRACTICE COMMITTEE

Shabana F. Pasha, MD

Ruben Acosta, MD

Vinay Chandrasekhara, MD

Krishnavel V. Chathadi, MD

Mohamad A. Eloubeidi, MD

Robert Fanelli, MD, SAGES Representative

Ashley L. Faulx, MD

Lisa Fonkalsrud, BSN, RN, CGRN, SGNA Representative

Mouen A. Khashab, MD

Jenifer R. Lightdale, MD, MPH

V. Raman Muthusamy, MD

John R. Saltzman, MD

Aasma Shaukat, MD

Amy Wang, MD

Brooks Cash, MD, Committee Chair

This document is a product of the Standards of Practice Committee. This document was reviewed and approved by the Governing Board of the American Society for Gastrointestinal Endoscopy.