

**KIM A. EAGLE, MD**

Dr. Eagle specializes in cardiac risk assessment at the University of Michigan Medical Center and is the chairman of the American College of Cardiology and American Heart Association Task Force that published guidelines on perioperative cardiovascular evaluation for noncardiac surgery. He is also the editor of the "Images in Clinical Medicine" section of the *New England Journal of Medicine*.

**MICHAEL S. LAUER, MD**

Dr. Lauer is a staff cardiologist in the Section of Heart Failure and Transplantation at the Cleveland Clinic.

**JAMES THOMAS, MD, EDITOR**

# Preoperative evaluation before noncardiac vascular surgery

This article is based on a discussion held at the Cleveland Clinic Heart Center's "Controversies in Cardiology" conference.

**T**he preoperative medical evaluation is a golden moment to identify cardiac risk factors and to initiate preventive measures, but it is not always clear what is the best, most cost-effective way to perform the evaluation. In this month's Cardiology Dialogue, Kim Eagle, MD, Director of Clinical Cardiology at the University of Michigan, and Michael S. Lauer, MD, from the Cleveland Clinic Department of Cardiology, discuss how to assess a patient's perioperative risk, outlining in which patients the use of clinical factors will suffice and those for whom pharmacologic stress testing is indicated. They also discuss the more important issue of how to treat high-risk patients identified before surgery, especially determining which patients need angioplasty before undergoing a noncardiac surgical procedure. Finally, they address the problem of how to bring risk assessment guidelines from the textbook to the bedside. Although their discussion specifically addresses screening in candidates for vascular surgery, the same principles apply to other high-risk procedures as well.

## ■ THE EVOLUTION OF CARDIAC RISK ASSESSMENT

**DR. EAGLE:** Twenty years ago, most candidates for vascular surgery first underwent coronary angiography, especially if they were at an academic medical center. In fact, the Cleveland Clinic pioneered this "cath-all" strategy. It was the standard of care.

Later, the development of pharmacologic stress testing gave physicians a way to screen patients noninvasively. In 1985 Boucher and colleagues<sup>1</sup> at Massachusetts General Hospital first reported using dipyridamole-thallium scanning to screen patients before vascular surgery, and concluded it is superior to clinical assessment. But all 54 patients in this study had known coronary artery disease to begin with, either myocardial infarction or angina.

The question then became: If dipyridamole-thallium scanning is so good, why do a clinical assessment at all? Why not just scan everybody?



TABLE

**PERCENT OF PATIENTS WHO DIED OR HAD A MYOCARDIAL INFARCTION AFTER VASCULAR SURGERY\***

Risk according to clinical factors†	Risk according to dipyridamole-thallium scan		
	Low	Moderate	High
Low	3	3	0
Moderate	3	9	19
High	12	7	24

\* Data from L'Italien et al, reference 5

† Risk factors were age > 70 years; history of angina, myocardial infarction, diabetes, or congestive heart failure; and previous bypass grafting

### ■ THE DEVELOPMENT OF A CLINICAL RATING SYSTEM

**DR. EAGLE:** I was a fellow working with Dr. Boucher at the time; to answer that question, we next studied a series of vascular surgery patients, looking at the relationship between five clinical risk markers (angina, previous myocardial infarction, congestive heart failure, diabetes, and Q waves on electrocardiography) and the risk of perioperative cardiac events. At the same time, all the patients also underwent dipyridamole-thallium scanning.<sup>2</sup> Of 111 patients, 52 had no risk markers, and only one of these 52 had a perioperative event (angina).<sup>2</sup>

#### Assessing risk clinically

We next examined the gradient of risk for patients with one, two, three, four, or five risk markers. In 200 patients undergoing aortic surgery, the multivariate clinical predictors of perioperative ischemic events were Q waves, advanced age, angina, history of ventricular arrhythmias (which correlated very well with a history of heart failure), and diabetes. Sixty-four patients had none of these markers, and only two (3%) of them suffered events, both unstable angina. There were 116 patients with one or two risk markers, and 18 (16%) of them had events. Twenty patients had three or more risk markers, and 10 (50%) of them suffered events.<sup>3</sup>

#### Assessing risk with dipyridamole-thallium scanning

Dipyridamole-thallium scanning results can also be quantified. In a blinded study, we read 62 stress thallium studies that had been read as positive for reversible ischemia before vascular surgery, and applied a semiquantitative scoring system. In this system, we divided each of the three standard views into five segments, and scored each as normal, showing redistribution, or showing a fixed defect. If multiple segments, two or three views, or two or three coronary territories showed ischemia, the risk of postoperative cardiac events was particularly elevated.<sup>4</sup>

#### A strategy for scanning: the meaning of low, medium, and high clinical risk

We began to see how to apply decision rules to patients with a spectrum of clinical markers. Patients with no markers before vascular surgery are at low clinical risk, patients with three or more are at high risk, and patients with one or two are in the intermediate range. Dipyridamole-thallium scanning of low-risk or high-risk patients may not be valuable, because a positive test in a low-risk patient is likely to be falsely positive, and a negative test in a high-risk patient may be falsely negative. Its value seems to be greatest in those at intermediate risk.

To further refine this method of risk assessment, 1081 patients at seven centers underwent preoperative cardiac assessment and stress testing before vascular surgery. In the low clinical risk group, the overall rate of myocardial infarction or death was 3%. However, patients with low clinical risk but who had high-risk thallium scans did not have higher risk, in fact, they had no events (TABLE).<sup>5</sup> As we had shown previously, stress testing was most helpful in the medium clinical risk group.

#### Clinical factors more important than type of surgery

The type of vascular surgery also influences cardiac risk, but not as much as do clinical risk factors. One might think aortic surgery poses higher risk than infrainguinal or carotid



surgery, but it does not. In fact, we found that infrarenal surgery has more than double the rate of myocardial infarction than does aortic or carotid surgery. However, the death rates are similar. Further, after adjusting for clinical risk factors, we found that the difference in MI risk was reduced to insignificant levels.<sup>6</sup> In other words, the clinical risk profile had much more to do with perioperative cardiac risk than the type of vascular surgery.

## ■ DO HIGH-RISK PATIENTS NEED TREATMENT BEFORE SURGERY?

**DR. LAUER:** Bodenheimer<sup>7</sup> said in an editorial that we are very good at identifying people at high risk, but questioned what to do with the results. There is very little literature to tell us whether we should perform angioplasty or surgical revascularization before surgery in high-risk patients, whether surgical revascularization should wait until after surgery, or whether any treatment is needed at all. Also, when high-risk patients are identified, should we change their medical therapy, and if so, how?

Bodenheimer argued that the real function of the cardiologist is to identify people who, on the basis of clinical criteria alone, are at very high risk, such as patients with decompensated heart failure, who might have critical aortic stenosis, other severe valvular disease that has not been previously recognized, or unstable angina. These are the patients in whom we need to intervene. Everybody else — patients who are either mildly asymptomatic or relatively asymptomatic — we should leave alone.

**DR. EAGLE:** We may not have a large body of evidence for perioperative management of coronary disease, but we do have evidence for how to manage coronary disease in general. We use the clinical history and examination, functional status, and certain tests to find high-risk patients who may benefit from certain types of treatment.

Often, we can easily tell if a patient is at high risk, but more worrisome are patients with hidden disease, whom the stress of surgery might push over the line. Such a patient is typically sedentary in everyday life, has only subtle signs of coronary disease, and has an unknown burden of coronary disease, left ventricular dysfunction, or both.

Such patients are common in vascular

surgery, because there is a correlation between peripheral vascular disease or aneurysmal disease and coronary disease. Vascular surgery poses the highest risk of a cardiac event, followed by thoracic, abdominal, and major head-and-neck surgery. Many of the latter operations are for cancer caused by smoking, and smokers often have vascular disease that is not well recognized.

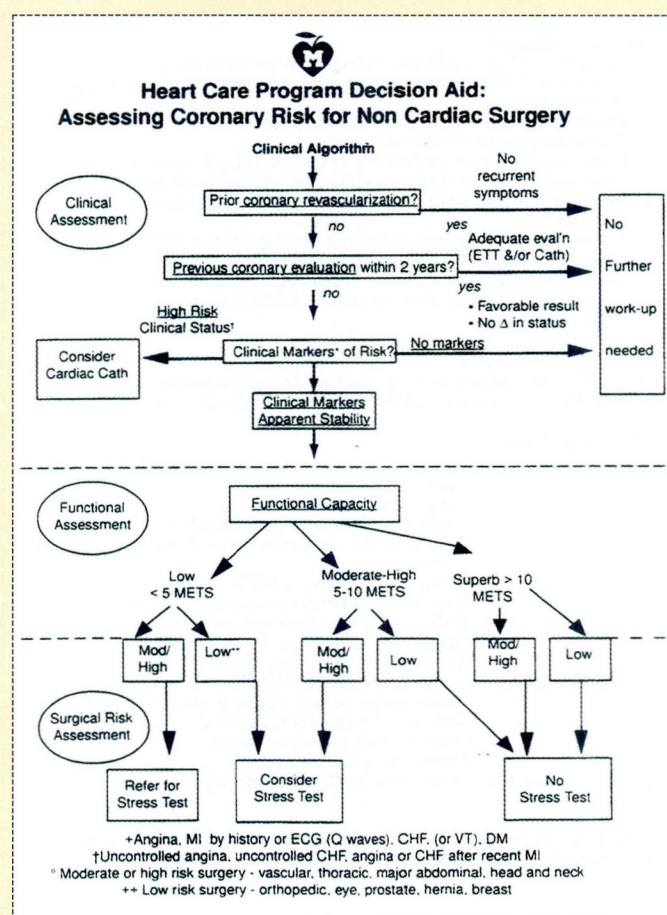
## When to perform preoperative angioplasty

**AUDIENCE:** What do you think about preoperative angioplasty? Let us say the patient has an angiogram and has one significant lesion, say over 70%, and some unclear symptom.

**DR. EAGLE:** Three trials, all observational, looked at this issue.<sup>8–10</sup> The angioplasty complication rates were high, and the procedure still did not eliminate all perioperative infarctions or deaths. I worry most about patients

A laminated, pocket-sized risk assessment guideline card is used at the University of Michigan<sup>15</sup>

**FIGURE (front)**







with left main or three-vessel disease. I would hesitate to take a stable patient with triple-vessel disease, dilate all three arteries, and then put him into the prothrombotic environment of surgery. I would hesitate even more to insert a stent. Also, which artery should you dilate? Dilating the most severely occluded artery does not preclude an event in another artery.

Therefore, the indications for angioplasty are the same as in other patients: angina that is not adequately controlled, or a very positive stress test in a proved zone of severe stenosis.<sup>11</sup>

This is especially relevant in elderly patients, who often have calcified triple-vessel disease. Unfortunately, many will have poor outcomes no matter what you do. If you dilate

a number of lesions in a stable elderly patient, I am not sure you will help him or her.

### Medical management of perioperative risk

**DR. EAGLE:** Several measures may lower perioperative risk, but they have not been proved conclusively.

**Beta blockers.** Observational studies suggested that beta blockers reduce perioperative ischemia,<sup>12</sup> probably because beta blockers blunt the tissue effects of the increase in catecholamines that surgery induces.

**Pain control.** Adequate pain control should also reduce the risk, because patients who have inadequate pain control have higher levels of catecholamines than do patients who have excellent pain control.

**Antianginal drugs.** If patients need drugs to control ischemia before surgery, they certainly need them during and after surgery, when the stresses are greater than in day-to-day living. We should therefore *not* discontinue calcium channel blockers, nitrates, or beta blockers (especially since discontinuing beta blockers can cause rebound hypertension, as can discontinuing clonidine).

### Long-term follow-up of coronary patients identified during a consultation

**DR. EAGLE:** Perioperative coronary management should be based upon our knowledge of coronary disease *in general*. For instance, beta blockers reduce the infarction rate and the mortality rate for patients who have had an MI or have stable ischemic symptoms. Aspirin reduces infarction rates with known coronary artery disease. Lipid lowering is beneficial. Better control of hypertension and other risk factor modifications are proven therapies.

**DR. LAUER:** That is an exceedingly important point. For many patients, it is the preoperative consult with the cardiologist that leads to proper coronary management, which they had not been receiving before. Only a minori-

## FIGURE

(back)

### Stepwise Approach

1. Determine if the patient has undergone prior coronary revascularization.
2. Determine if the patient has had a prior coronary eval. over the past several years.
3. Assess preoperative clinical risk of the patient.
4. Assess the patient's functional capacity.\*
5. Determine the pretest probability of cardiac complications for a patient based on the type of surgery and the institutional experience.
6. Assess whether the pretest probability is likely to be altered based on stress testing.
7. For truly elective surgery, weigh the benefits (of the operation) against the post test probability of cardiac complications after surgery.
8. Determine if there are opportunities to reduce the posttest probability of cardiac complications after surgery by modifying preoperative or intraoperative care.

### Key Clinical Variables

Age > 70 years, Angina or its equivalent, Prior Myocardial Infarction (By history, By ECG-Q wave), Diabetes mellitus, Congestive heart failure

### \*Functional Capacity

- |     |  |
|-----|--|
| I   | Activity requiring $\geq 7$ metabolic equivalents (METS)<br>Carry 24 lb up 8 steps<br>Carry objects that weigh 80 lb<br>Outdoor work (shovel snow, spade soil)<br>Recreation (ski, basketball, squash, handball, jog/walk 5 mph) |
| II  | Activity requiring $\geq 5$ (but not $\geq 7$ METS)<br>Have sexual intercourse without stopping<br>Walk at 4 mph on level ground<br>Outdoor work (garden, rake, weed)<br>Recreation (roller skate, dance fox trot)               |
| III | Activity requiring $\geq 2$ (but not $\geq 5$ METS)<br>Shower/dress without stopping, strip and make bed<br>Walk at 2.5 mph on level ground<br>Outdoor work (clean windows)<br>Recreation (play golf, bowl)                      |
| IV  | No activity requiring $\geq 2$ METS (cannot carry out activities listed above)   |

Sumita PD, Eagle KA, A Stepwise Strategy for Coronary Risk Assessment for Noncardiac Surgery, Med Clin North America, 1995;79:1241-1262



ty of patients with left ventricular failure and known systolic dysfunction are on angiotensin converting enzyme (ACE) inhibitors. Or patients come in with coronary disease and known hypercholesterolemia who are not receiving lipid-lowering drugs and never received dietary counseling.

Many cardiac consultants may drop the ball, because they do not see the patient again, or they do not communicate their long-term recommendations to whomever is responsible for the patient's long-term care. I often tell patients I want to see them back after surgery in about 2 to 3 months.

## ■ APPLYING RISK ASSESSMENT GUIDELINES IN THE REAL WORLD

**DR. LAUER:** Dr. Eagle and the ACC/AHA Task Force have produced some excellent risk assessment guidelines for patients undergoing preoperative evaluation.<sup>13</sup> The algorithm emphasizes combining patient characteristics, predictors of risk, and surgical considerations to guide the clinician in the appropriate use of diagnostic tests. I have a copy of it, and I bring it into the examination room whenever I see these patients. But I am probably an exception.

### High-tech options

The way to bring guidelines into the clinical sphere is to use computers and information science. Pestonik and colleagues<sup>14</sup> used their hospital-wide computer system to implement guidelines for using antibiotics, with excellent results: patient care improved, and money was saved.

In cardiology, there is an enormous amount of variability in practice, which may have had some bad effects. We may be doing a lot of unnecessary tests and subjecting patients

to unnecessary risks. I believe firmly that we have to not only establish guidelines, but actually use them. If we do not, we have no way of measuring whether the guidelines are effective. As new technology is introduced and new knowledge is gained, we must continue to evaluate the guidelines as they are modified.

Bringing the information to the physician when he or she actually needs it (that is, when the physicians are seeing patients), will make it possible to effectively use these guidelines and dramatically improve the quality of care that we provide. Further, it will enable us to measure what we are doing in real practice, so that physicians can work together to develop guidelines, test them, and appropriately change them.

### Low-tech options

**DR. EAGLE:** A low-tech solution can also work. We condensed our perioperative management guidelines to a 4 by 5-inch laminated card, which we give to all the residents, fellows, and faculty (**FIGURE**).<sup>15</sup> We have another card for anticoagulation guidelines. I discuss the guidelines for our perioperative consultation group at the beginning of every month. We also have the guidelines on our hospital computer system, so they are available on the hospital wards.

Before we started using the guidelines we did a retrospective study of how we were managing vascular preoperative consults and internal medicine consults; now we are measuring prospectively the influence of the guidelines on test ordering, outcomes, and costs.

So you are right, we have to put the guidelines in your pocket or on your video screen, or it will not be used. It will be reference material, and the gap between practice and knowledge will continue.

## ■ REFERENCES

1. Boucher CA, Brewster DC, Darling RC, Okada RD, Strauss HW, Pohost GM. Determination of cardiac risk by dipyridamole-thallium imaging before peripheral vascular surgery. *N Engl J Med* 1985; 312:389-394.
2. Eagle KA, Singer DE, Brewster DC, Darling RC, Muley AG, Boucher CA. Dipyridamole-thallium scanning in patients undergoing vascular surgery. *JAMA* 1987; 257:2185-2189.
3. Eagle KA, Coley CM, Newell JB, et al. Combining clinical and thallium data optimizes preoperative assessment of cardiac risk before major vascular surgery. *Ann Intern Med* 1989; 110:859-966.
4. Levinson JR, Boucher CA, Coley CM, Guiney TE, Strauss HW, Eagle KA. Usefulness of semiquantitative analysis of dipyridamole-thallium-201 redistribution for improving risk stratification before vascular surgery. *Am J Cardiol* 1990; 66:406-410.
5. L'Italien GJ, Paul SD, Hendel RC, et al. Development and validation of a Bayesian model for perioperative cardiac risk assessment in a cohort of 1,081 vascular surgical candidates. *J Am Coll Cardiol* 1996; 27:779-786.
6. L'Italien GJ, Cambria RP, Cutler BS, et al. Comparative early and late cardiac morbidity among patients requiring different vascular surgery procedures. *J Vasc Surg* 1995; 21:935-944.
7. Bodenheimer MM. Noncardiac surgery in the cardiac patient: What is the question? *Ann Intern Med* 1996; 124:763-766.
8. Huber KC, Evans MA, Bresnahan JF, Gibbons RJ, Holmes DR Jr. Outcome of noncardiac operations in patients with severe coronary artery disease successfully treated preoperatively with coronary angioplasty. *Mayo Clin Proc* 1992; 67:15-21.
9. Ellmore JR, Hallett JW Jr, Gibbons JR, et al. Myocardial revascularization before abdominal aortic aneurysmorrhaphy: effect of coronary angioplasty. *Mayo Clin Proc* 1993; 68:637-641.

THE CLEVELAND CLINIC  
FOUNDATION INTRODUCES:

## CLINICAL PRACTICE GUIDELINES FOR ASTHMA

Between 10 and 20 million Americans in all age groups have asthma and are generally treated by their primary care physicians.

This self-instruction program is available for two hours of Category I CME credit. Produced by the Continuing Education Department at The Cleveland Clinic Foundation, this video program features Dr. Mani S. Kavuru, Director of the Pulmonary Function Lab, discussing current information based on the consensus of the National Asthma Education Program's Guidelines for the Diagnosis and Management of Asthma.

Along with the 20-minute video, you will receive:

- A current, concise, and comprehensive monograph
- Additional references from guideline documents
- Pre/post-tests, registration and evaluation forms

After viewing this video and reading the accompanying written material, the participant will be able to:

- Discuss recent epidemiologic trends and predisposing risk factors associated with asthma;
- Review clinical evaluation procedures for the asthmatic patient;
- Explain the clinical practice guidelines for the diagnosis and management of asthmatic patient;
- Recognize situations warranting patient referral to a specialist.

Cost of the program is \$84.95. All major credit cards are accepted. Shipping and handling is included. Ohio residents add 7 percent sales tax.

To order the clinical practice guidelines video package, or for more information on this or other clinical practice guidelines videos, please call 800/238-6750.

THE CLEVELAND CLINIC  
FOUNDATION 



10. Allen JR, Helling TS, Hartzler GO. Operative procedures not involving the heart after percutaneous transluminal coronary angioplasty. *Surg Gynecol Obstet* 1991; 173:285-288.
11. Guidelines for percutaneous transluminal coronary angioplasty: a report of the American College of Cardiology/American Heart Association Task Force on Assessment of Diagnostic and Therapeutic Cardiovascular Procedures. *J Am Coll Cardiol* 1993; 22:2033-2054.
12. Pasternak PF, Grossi EA, Baumann FG, et al. Beta blockade to decrease silent myocardial ischemia during peripheral vascular surgery. *Am J Surg* 1989; 158:113-116.
13. Eagle KA, Brundage BH, Chaitman BR, et al. Guidelines for perioperative cardiovascular evaluation of the noncardiac surgery. A report of the American Heart Association/American College of Cardiology Task Force on Assessment of Diagnostic and Therapeutic Cardiovascular Procedures. *J Am Coll Cardiol* 1996; 27:910-948.
14. Pestonik SL, Classen DC, Evans RS, Burke JP. Implementing antibiotic practice guidelines through computer-assisted decision support: Clinical and financial outcomes. *Ann Intern Med* 1996; 124: 884-890.
15. Paul SD, Eagle KA. A stepwise strategy for coronary risk assessment for noncardiac surgery. *Med Clin North Am* 1995; 79:1241-1262.