Circulation

ARTICLES

Cardiac Risk of Noncardiac Surgery

Influence of Coronary Disease and Type of Surgery in 3368 Operations

Kim A. Eagle, Charanjit S. Rihal, Mary C. Mickel, David R. Holmes, Eric D. Foster, Bernard J. Gersh, for the CASS Investigators, University of Michigan Heart Care Program

DOI https://doi.org/10.1161/01.CIR.96.6.1882
Circulation. 1997;96:1882-1887
Originally published September 16, 1997

Jump to

Abstract

Background The influence of prior coronary artery bypass surgery (CABG) versus medical therapy for reducing the risk of postoperative cardiac complications after noncardiac surgery continues to be debated. To further clarify this controversy we studied 24 959 participants in the Coronary Artery Surgery Study (CASS) database with suspected coronary disease by identifying those who required noncardiac surgery during more than 10 years of follow-up.

Methods and Results CASS registry enrollees were either treated with CABG or medical therapy after initial entry. During follow-up, patients who required noncardiac operations were evaluated for hospital death or out-of-hospital death within 30 days of noncardiac surgery and nonfatal postoperative myocardial infarction (MI). At a mean follow-up of 4.1 years, 3368 patients underwent noncardiac surgery, with abdominal (36%), urologic (21%), orthopedic (15%), and vascular being most common. Abdominal, vascular, thoracic, and head and neck surgery each had a combined MI/death rate among patients with nonrevascularized coronary disease >4%. Among 1961 patients undergoing higher-risk surgery, prior CABG was associated with fewer postoperative deaths (1.7% versus 3.3%, P=.03) and MIs (0.8% versus 2.7%, P=.002) compared with medically managed coronary disease. Contrariwise, 1297 patients undergoing urologic, orthopedic, breast, and skin operations had mortality of <1% regardless of prior coronary treatment. Prior CABG was most protective in patients with advanced angina and/or multivessel coronary artery disease.

Conclusions In patients with known coronary artery disease, noncardiac surgeries involving the thorax, abdomen, vasculature, and head and neck are associated with the highest cardiac risk, which is reduced among patients with prior CABG.

surgery revascularization myocardial infarction

Noncardiac surgery rates continue to rise as the US population increases in age.[1 2] Cardiac complications, such as myocardial infarction or congestive heart failure, represent the single most common cause of death in postoperative patients.[3] A number of studies have identified an elevated cardiac risk in certain surgical types such as vascular surgery.[4 5 6 7 8 9] However, few if any studies to date have included a large number of patients from a broad group of noncardiac procedures so that surgery-specific risk could be considered among the full range of noncardiac procedures performed. A true assessment of surgery-specific risk is further clouded by the fact that coronary artery anatomy is infrequently defined before most procedures except when dictated by advanced clinical signs or symptoms. Thus, the interaction between extent of coronary disease and procedure-related stresses on the heart to produce untoward postoperative outcomes is rarely clear.

The CASS registry represents a unique database for asking questions related to these interactions. Since all CASS patients had careful clinical and angiographic profiling at entry, and since a large subset required noncardiac surgery in the years after enrollment, the database allows an assessment of the association

between well-defined coronary disease and postoperative death or myocardial infarction after various types of noncardiac operations and whether prior coronary revascularization is protective. The goal of this analysis was to further clarify these relationships.

Methods

Patient Selection

The patient population for the CASS registry of the National Heart, Lung, and Blood Institute has been described previously.[10 11] A total of 24 959 patients were enrolled at 15 different clinical sites between 1974 and 1979. Patient enrollment was based on a primary indication for coronary angiography of suspected or proven coronary disease. During annual follow-up of patients enrolled in the CASS registry, 3368 patients were identified who had undergone at least one noncardiac operation. For the purposes of this analysis, the patients were further divided into those with no evidence of coronary artery disease, those with documented coronary disease at cardiac catheterization who did not undergo coronary bypass surgery before noncardiac operations, and those who had coronary artery bypass surgery preceding their noncardiac surgery. In this large randomized registry, medical versus surgical treatment for underlying coronary disease was dictated not by randomization but rather by physician and patient preference. The definitions for coronary artery disease for CASS have been published previously.[11]

End points of interest were operative mortality or myocardial infarction. Perioperative deaths included all deaths occurring within 30 days of the procedure. For the analysis of cardiac risk of noncardiac surgery, all deaths were included that were defined as death during hospitalization or death occurring after hospitalization but within 30 days of the noncardiac procedure. Perioperative myocardial infarction was defined by a combination of enzyme elevation and electrographic abnormalities that were either strongly suggestive or diagnostic for myocardial infarction.

The type of noncardiac operation was further defined as higher or lower risk on the basis of a post hoc analysis of the combined myocardial infarction and/or death rate. There appeared to be a clear break point among types of procedures, with a combined myocardial infarction and death rate among medically treated patients of ≥4% (higher risk) or <4% (lower risk).

Data Analysis

Univariate comparisons of patients with and without myocardial infarction and/or perioperative death were stratified by clinical features, prior coronary artery bypass surgery, extent of coronary artery disease, and type of nonsurgical procedure performed. For two-way comparisons of binary variables, the χ^2 statistic was used. For three-way comparisons of binary information, a three-way χ^2 statistic was performed. For multivariate analysis, stepwise logistic regression was used to select covariates that were independently associated with the outcome of interest. Then, the variable that defined whether or not the patient had prior coronary bypass surgery was allowed to enter the model to see if it provided additional independent predictive power.

Results

Table 1⇓ describes the major categories and subcategories of noncardiac surgery identified during follow-up as well as the total number of patients having each particular type of operation. Abdominal, urologic, orthopedic, vascular, and head and neck operations accounted for the vast majority, with abdominal and

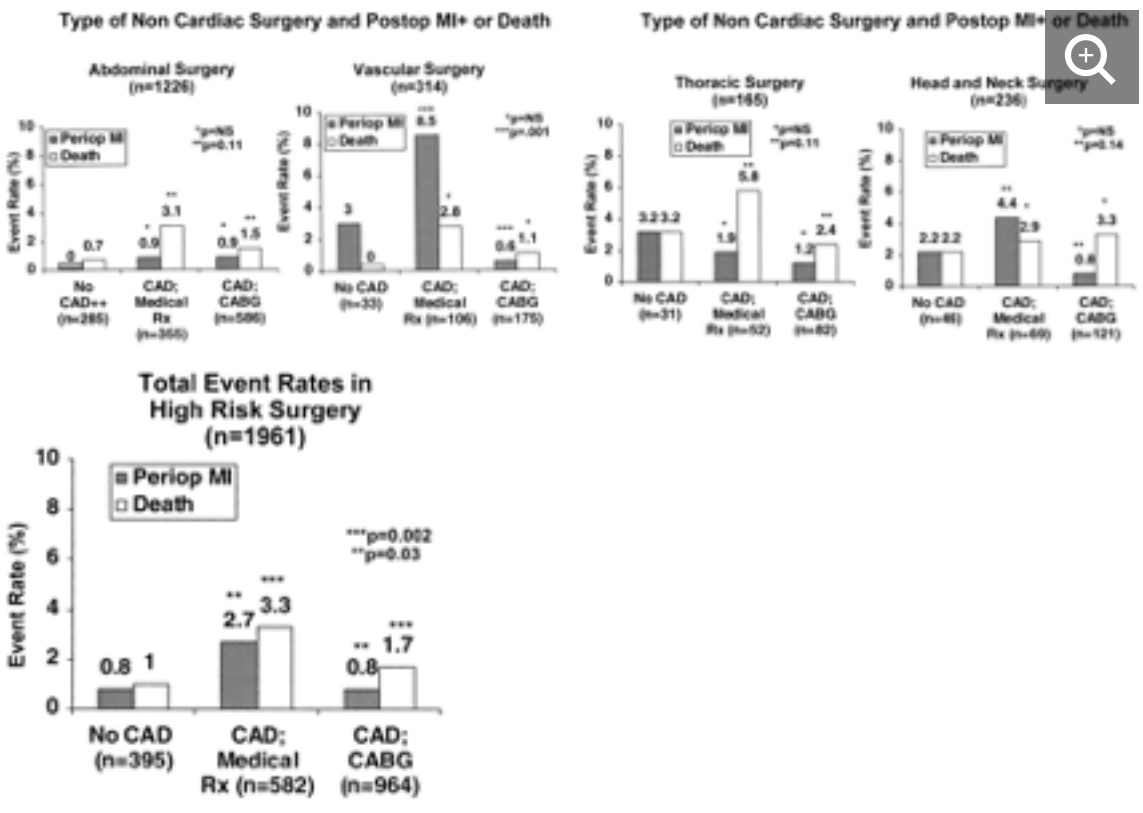
urologic procedures accounting for more than one half of the totals.

View inline View popup

Table 1.

Types of Noncardiac Surgery

The Figure⇓ and Table 2⇓ stratify patients undergoing each particular type of surgery into those without definite obstructive coronary disease, those with coronary disease managed with medical therapy before the noncardiac procedure, and those having undergone prior coronary bypass surgery before the noncardiac operation (average, 4.1 years before). Also listed or illustrated is the proportion of patients in each category who had postoperative death or postoperative myocardial infarction. The Figure⇓ illustrates the outcomes of those patients who underwent "high-risk" noncardiac surgery, that is, combined myocardial infarction or death rate ≥4% in medically treated patients with known coronary disease. As one can see, abdominal, vascular, thoracic, and head and neck surgery each had a combined rate of myocardial infarction and/or death ≥4%. The Figure⇓ indicates that patients undergoing "higher-risk" noncardiac surgery on average had a lower perioperative risk if they had undergone prior coronary bypass surgery. For the higher-risk patients overall, postoperative death was 3.3% in medically treated patients versus 1.7% in those having had prior coronary bypass surgery (P=.03). Similarly, the rate of myocardial infarction for high-risk surgical patients was lower if prior coronary bypass surgery had been performed. In this case, the rate was 2.7% among 582 patients who were being treated medically compared with 0.8% among 964 who had undergone prior coronary bypass surgery (P=.002). Table 2⇓ indicates, on average, that patients undergoing the lower-risk operations such as urologic, orthopedic, breast, and skin operations had very low risks of operative myocardial infarction or death that were not significantly affected by having had prior bypass surgery.



Download figure
Open in new tab

Download powerpoint

Figure 1.

Type of noncardiac surgery and postoperative myocardial infarction (MI) or death among higher-risk procedures (combined MI and death rate ≥4% in medically treated patients). Rates of MI or death among patients undergoing abdominal, vascular, thoracic, and head and neck surgeries are stratified by the presence or absence of coronary artery disease (CAD) and whether it was previously treated medically or with coronary artery bypass surgery (CABG).

View inline View popup

Table 2.

Type of Noncardiac Surgery and Postoperative MI or Death Among Lower-Risk Surgical Categories

Table 3⇓ examines clinical variables stratified against medical treatment versus prior coronary bypass treatment among patients with known coronary artery disease who underwent noncardiac surgery during follow-up. Exclusion of patients who did not have significant obstructive coronary disease on CASS enrollment resulted in a subgroup of 2677 patients. Patients who particularly may have benefited from prior revascularization included those whose initial indication for enrollment in the CASS study was for unstable angina and those patients having more than one-vessel disease. There were trends for coronary artery bypass surgery to confer more protection among the elderly and men, although the strengths of the associations were of borderline statistical significance.

View inline View popup

Table 3.

Correlates of Improved Outcome Conferred by Prior CABG (n=2677 Patients With CAD)

Table 4⇓ examines cardiac outcomes after higher-risk noncardiac surgery stratified by the number of diseased coronary arteries as well as whether or not the patient underwent coronary bypass surgery before the noncardiac procedure. Once again, these data suggest that patients with more advanced coronary disease involving two or three vessels are the subgroup deriving risk reduction for death and/or myocardial infarction as a result of coronary revascularization.

View inline View popup

Table 4.

Cardiac Outcomes After Higher-Risk Noncardiac Surgery Stratified by Coronary Status (n=1546 Patients With Known CAD)

Table 5⇓ identifies multivariate predictors of 30-day death or myocardial infarction after noncardiac surgery, including all patients with known coronary disease. Significant correlates of poor cardiac outcome included advanced age, congestive heart failure score, the presence of hypertension, and medical treatment as opposed to prior coronary artery bypass surgery. The odds ratio for medical treatment was 1.88 (95% confidence intervals, 1.17 to 3.01; medical therapy versus prior coronary artery bypass surgery). Table 6⇓ provides the multivariate predictors of 30-day death or myocardial infarction among 1515 patients with known coronary disease undergoing higher-risk noncardiac surgery. In this analysis, congestive heart failure score, known hypertension, and smoking were significant independent correlates. When compared with prior coronary artery bypass surgery, medical treatment was highly correlated with an increased risk of perioperative myocardial infarction or death. For this high-risk surgery–specific subgroup, the odds ratio for medical treatment was 2.51 (95% confidence intervals, 1.41 to 4.46).

View inline **View popup**

Table 5.

Multivariate Predictors of 30-Day Death or MI After Noncardiac Surgery (All Patients With CAD, n=2617; 71 Events)

View inline **View popup**

Table 6.

Multivariate Predictors of 30-Day Death or MI After Higher-Risk Noncardiac Surgery (n=1515 Patients With Known CAD)

Table 7⇓ shows the correlation between the number of years from coronary bypass surgery to noncardiac surgery and the relative perioperative risk for myocardial infarction or death among patients who had undergone previous coronary bypass surgery before noncardiac surgery. These data suggest no major fall in protection from perioperative events for at least the first 6 years after coronary bypass surgery in this cohort. In particular, the low rate of myocardial infarction in patients who had undergone coronary bypass surgery 4 to 6 years previously (2 of 357 or 0.6%) suggests that protection afforded by prior revascularization is maintained for at least this period. While there appears to be a trend toward a higher myocardial infarction rate after 6 years (2.2%), this incidence is not statistically significant from those observed during prior intervals (P=.15).

View inline **View popup**

Table 7.

How Long Does Prior CABG Protect Against Perioperative MI or Death After Noncardiac Surgery?

Discussion

Among patients undergoing noncardiac surgery, cardiac risk continues to be an important problem and is often the major concern of perioperative consultants.[12] Recent guidelines suggest that overall risk of perioperative myocardial infarction or cardiac death is related to clinical factors such as prior recognized congestive heart failure, angina pectoris, myocardial infarction, advancing age, poor functional capacity, and for patients undergoing noninvasive testing, the demonstration of significant myocardial ischemic territories with provocative testing. The degree of risk conferred by the noncardiac surgical procedure in addition to patient-specific risk factors has been difficult to elucidate. By far the largest experience has been with vascular surgery, in which the known association between peripheral vascular disease and coronary disease is believed to explain the majority if not all of the surgery-specific risk.[8 9 13]

This analysis represents a unique opportunity to examine surgery-specific risk in patients with well-defined coronary artery disease. We have shown that vascular, thoracic, abdominal, and major head and neck surgery are those specific procedures associated with a higher risk of a myocardial infarction or death in the face of nonrevascularized coronary artery disease. Furthermore, any benefit conferred by coronary revascularization appears to be particularly suited for this higher-risk subcategory of noncardiac procedures. In univariate analysis, those clinical situations that appear to perhaps most benefit from prior coronary revascularization included patients with advanced angina at the time of enrollment in CASS, patients over the age of 60 years, patients with multivessel coronary disease, and perhaps men, although the number of women in this analysis limits the power to identify differences that are based on sex. Importantly, multivariate analysis confirms that prior coronary artery bypass surgery is correlated with a significant reduction in perioperative myocardial infarction or death after accounting for the major independent correlates of risk in patients with demonstrated coronary artery disease. Not unexpectedly, in patients with known coronary disease, advanced age, worsened congestive heart failure score, hypertension, and smoking were associated with elevated risk in an independent fashion. However, once these clinical factors had been entered in a stepwise multivariate assessment, the lack of prior coronary artery bypass (medical therapy) continued to correlate with a heightened risk of perioperative infarction or death, with an odds ratio of 1.88 among all patients with coronary disease in this study and 2.51 among those undergoing higher-risk surgery.

Although an analysis of a portion of this dataset several years ago indicated a potential risk reduction for patients who had undergone prior coronary bypass surgery, the duration of this protection remained unclear.[10] Further follow-up of the CASS registry patients in this analysis provides an opportunity to more critically examine this question. On the basis of our results, it appears that coronary revascularization protects from perioperative myocardial infarction or death for at least 6 years after revascularization. That is, during the periods of follow-up, there appeared to be no trend toward higher risk between 0 to 2, 2 to 4, and 4 to 6 years from prior coronary revascularization to noncardiac surgery. The numbers of patients within each subcategory limit the power to detect small differences, but certainly major differences are not present. Longer duration of follow-up would be required to identify a point in time at which coronary bypass surgery loses its protective effects.

Summary

We have identified four particular types of noncardiac surgery that appear to be associated with a heightened risk of perioperative death or myocardial infarction in patients with known coronary heart disease. Furthermore, we have defined the clinical subsets for whom prior coronary artery revascularization appears to be particularly protective against perioperative myocardial infarction or death. These unique findings add further evidence to a growing knowledge base surrounding patient-specific and surgery-specific risk factors for noncardiac surgery.[12 14]

Implications for Clinical Practice

These data provide confidence that clinically stable patients undergoing low-risk operations such as urologic procedures or orthopedic surgery are unlikely to benefit from extensive coronary evaluations. Furthermore, clinically stable patients who have undergone coronary bypass surgery within the last 5 or 6 years are relatively “protected” from myocardial infarction complicating noncardiac surgery and thus probably should not be subjected to routine preoperative stress testing.

Limitations

The unique nature of the CASS registry for the purposes of this analysis has been clearly outlined. Obviously, a major limitation is the fact that patient enrollment into this study occurred more than 15 years ago. During the intervening time, virtually all aspects of our management of coronary artery disease as well as perioperative treatment have changed and probably have improved. Thus, assessment of the potential benefit of revascularization before noncardiac surgery in 1997 may be different than it would have been 10 years ago. Clearly, the medical treatment for coronary heart disease has evolved greatly, with a clearer view of medical and preventive strategies and improved perioperative management. Likewise, coronary artery bypass surgery has improved significantly, with better methods of cardiopelgia and the broader use of arterial conduits. Further, this analysis does nothing to deal with the ongoing debate as to whether coronary angioplasty or bypass surgery would be the preferred method of revascularization either in this subpopulation or others. Another important limitation is the observation that the risk of the prior coronary artery bypass operation has not been factored into the analysis of periprocedure outcomes. This is extremely important because the risk of coronary bypass surgery itself, when added to the subsequent risk of noncardiac surgery, actually exceeds the periprocedure risk of noncardiac surgery in patients who have not undergone prior coronary bypass surgery.[10] This argues that performance of coronary bypass surgery simply to get a patient through a noncardiac surgery is rarely justified. However, in patients for whom revascularization can be justified on the basis of symptoms and/or coronary anatomy, these data confirm prior suggestions that coronary artery revascularization should occur before noncardiac procedures.[15 16]

Received October 15, 1996.

Revision received April 28, 1997.

Accepted May 1, 1997.

References

↵ Mangano DT. Perioperative cardiac morbidity. *Anesthesiology*. 1990;**72**:153-184. **CrossRef** **PubMed** **Google Scholar**

↵ Lubitz J, Deacon R. The rise in the incidence of hospitalizations for the aged, 1967 to 1979. *Health Care Financing Rev*. 1982;**3**:21-40. **PubMed** **Google Scholar**

↵ Hertzer NR. Basic data concerning associated coronary disease in peripheral vascular patients. *Ann Vasc Surg*. 1987;**1**:616-620. **PubMed** **Google Scholar**

↵ Ashton CM, Petersen NJ, Wray NP, Kiefe CI, Dunn JK, Wu L, Thomas JM. The incidence of perioperative myocardial infarction in men undergoing noncardiac surgery. *Ann Intern Med*. 1993;**118**:504-510. **CrossRef** **PubMed** **Google Scholar**

↵ Greenburg AG, Saik RP, Pridham D. Influence of age on mortality of colon surgery. *Am J Surg*. 1985;**150**:65-70. **CrossRef** **PubMed** **Google Scholar**

↵ Plecha FR, Bertin VJ, Plecha EJ, Avellone JC, Farrell CJ, Hertzer NR, Mayda J II, Rhodes RS. The early results of vascular surgery in patients 75 years of age and older: an analysis of 3259 cases. *J Vasc Surg*. 1985;**2**:769-774. **CrossRef** **PubMed** **Google Scholar**

↵ Goldman L. Cardiac risks and complications of noncardiac surgery. *Ann Intern Med*. 1983;**98**:504-513. **Google Scholar**

↵ Krupski WC, Layug EL, Reilly LM, Rapp JH, Mangano DT. Comparison of cardiac morbidity rates between aortic and infrainguinal operations: two-year follow-up: study of Perioperative Ischemia Research Group. *J Vasc Surg*. 1993;**18**:609-615. **CrossRef** **PubMed** **Google Scholar**

↵ L'Italien GJ, Cambria RP, Cutler BS, Leppo JA, Paul SD, Brewster DC, Hendel RC, Abbott WM, Eagle KA. Comparative early and late cardiac morbidity among patients requiring different vascular surgery procedures. *J Vasc Surg*. 1995;**21**:935-944. **CrossRef** **PubMed** **Google Scholar**

↵ Foster ED, Davis KB, Carpenter JA, Abele S, Fray D. Risk of noncardiac operation in patients with defined coronary disease: the Coronary Artery Surgery Study (CASS) registry experience. *Ann Thorac Surg*. 1986;**41**:42-50. **CrossRef** **PubMed** **Google Scholar**

↵ The Principal Investigators of CASS and Their Associates. The National Heart, Lung and Blood Institute Coronary Artery Surgery (CASS). *Circulation*. 1981;63(suppl I):I-1-I-81. **Google Scholar**

↵ Eagle KA, Brundage BH, Chaitman BR, Ewy GA, Fleisher LA, Hertzer NR, Leppo JA, Ryan TJ, Schlant RC, Spencer WH, Spittell JA, Twiss RD. ACC/AHA Task Force Special Report. Guidelines for perioperative cardiovascular evaluation for noncardiac surgery. *Circulation*. 1996:93;1278-1317. **Google Scholar**

↵ Hertzer NR, Beven EG, Young JR, O'Hara PJ, Ruschhaupt WF III, Graor RA, Dewolfe VG, Maljovec LC. Coronary artery disease in peripheral vascular patients: a classification of 1000 coronary angiograms and results of surgical management. *Ann Surg*. 1984;**199**:223-233. **CrossRef** **PubMed** **Google Scholar**

↵ Mangano DT, Goldman L. Current concepts: preoperative assessment of patients with known or suspected coronary disease. *N Engl J Med*. 1995;**333**:1750-1756. **CrossRef** **PubMed** **Google Scholar**

↵ Gersh BJ, Rihal CS, Rooke TW, Ballard DJ. Evaluation and management of patients with both peripheral vascular and coronary artery disease. *J Am Coll Cardiol*. 1991;**18**:203-214. **PubMed** **Google Scholar**

↵ Fleisher LA, Eagle KA. Screening noncardiac surgery patients for cardiac disease. *Ann Intern Med*. 1996;**124**:767-772. **PubMed** **Google Scholar**

View Abstract

◀ Previous ▲ Back to top Next ▶

This Issue

Circulation
September 16, 1997, Volume 96, Issue 6

Article Tools

Share this Article

Related Articles

No related articles found.

Cited By...

Incidence and Outcome of Surgical Procedures After Coronary Artery Bypass Grafting Compared With Those After Percutaneous Coronary Intervention: A Report From the Coronary Revascularization Demonstrating Outcome Study in Kyoto PCI/CABG Registry Cohort-2

Guidelines on the radical management of patients with lung cancer

2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM Guidelines for the Diagnosis and Management of Patients With Thoracic Aortic Disease: A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, American Association for Thoracic Surgery, American College of Radiology, American Stroke Association, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of Thoracic Surgeons, and Society for Vascular Medicine

2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM Guidelines for the Diagnosis and Management of Patients With Thoracic Aortic Disease

2009 ACCF/AHA Focused Update on Perioperative Beta Blockade Incorporated Into the ACC/AHA 2007 Guidelines on Perioperative Cardiovascular Evaluation and Care for Noncardiac Surgery: A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines

2009 ACCF/AHA Focused Update on Perioperative Beta Blockade Incorporated Into the ACC/AHA 2007 Guidelines on Perioperative Cardiovascular Evaluation and Care for Noncardiac Surgery

Perioperative Risk of Patients Undergoing Noncardiac Surgery After Coronary Artery Bypass Surgery

Pre-Operative Risk Assessment and Risk Reduction Before Surgery

ACC/AHA 2007 Guidelines on Perioperative Cardiovascular Evaluation and Care for Noncardiac Surgery: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 2002 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery)

ACC/AHA 2007 Guidelines on Perioperative Cardiovascular Evaluation and Care for Noncardiac Surgery: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 2002 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery) Developed in Collaboration With the American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Rhythm Society, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society for Vascular Medicine and Biology, and Society for Vascular Surgery

Coronary Stents and Noncardiac Surgery

A Clinical Randomized Trial to Evaluate the Safety of a Noninvasive Approach in High-Risk Patients Undergoing Major Vascular Surgery: The DECREASE-V Pilot Study

Assessing and Reducing the Cardiac Risk of Noncardiac Surgery

Managing patients undergoing non-cardiac surgery: need to shift emphasis from risk stratification to risk modification

Surveillance and prevention of major perioperative ischemic cardiac events in patients undergoing noncardiac surgery: a review

Cardiac Troponin After Major Vascular Surgery: The Role of Perioperative Ischemia, Preoperative Thallium Scanning, and Coronary Revascularization

Heart rate variability and cardiac troponin I are incremental and independent predictors of one-year all-cause mortality after major noncardiac surgery in patients at risk of coronary artery disease

Preoperative Thallium Scanning, Selective Coronary Revascularization, and Long-Term Survival After Major Vascular Surgery

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)

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)

Anaesthesia and the cardiac patient: the patient versus the procedure

Guidelines on the selection of patients with lung cancer for surgery

Catastrophic outcomes of noncardiac surgery soon after coronary stenting

Influence of Congenital Heart Disease on Mortality After Noncardiac Surgery in Hospitalized Children

Noncardiac Surgery in CAD Patients Response

Cardiac Risk of Noncardiac Surgery Response

CrossRef

Journal Policies

Email Alerts

Open Access Information

AHA Journals RSS

AHA Newsroom

Editorial Office Address:
200 Fifth Avenue, Suite 1020
Waltham, MA 02451
email: circ@circulationjournal.org

Information for:

Advertisers

Subscribers

Subscriber Help

Institutions / Librarians

Institutional Subscriptions FAQ

International Users

National Center
7272 Greenville Ave.
Dallas, TX 75231

Customer Service
1-800-AHA-USA-1
1-800-242-8721
Local Info
Contact Us

ABOUT US

Our mission is to build healthier lives, free of cardiovascular diseases and stroke. That single purpose drives all we do. The need for our work is beyond question. Find Out More

Careers

SHOP

Latest Heart and Stroke News

AHA/ASA Media Newsroom

OUR SITES

TAKE ACTION

ONLINE COMMUNITIES

Follow Us: