Perioperative Medicine and the Preoperative Cardiac Evaluation

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68 year old clinic patient presents to your office for preoperative evaluation prior to an elective total hip arthroplasty

Why do this evaluation?
Ethical requirement to inform patients

Aid in decisions about whether or not to undergo surgery

Guide decisions about operative treatment, postop monitoring and length of stay

Guide decisions about intensity of postoperative care

Facility and Anesthesiologist requirement

Overestimation of risk can have negative consequences

Overestimation of Risk

Referral for preoperative cardiac testing

Delay or cancel beneficial surgery

Inappropriate transfer to monitored beds (i.e., critical care unit, cardiac step-down unit, telemetry unit)
Epidemiology

10 million adults annually worldwide have a major cardiac complication in the first 30 days after noncardiac surgery.

1.5% of adults who undergo inpatient noncardiac surgery die during the subsequent 30 days.

Cardiac complications account for at least one third of perioperative deaths.

Perioperative death is the third leading cause of death in the United States.

Factors Associated with Perioperative Cardiac Complications in Patients Undergoing Major Noncardiac Surgery
Preoperative factors
  Chronic conditions
  Recent conditions (up to 6 months before surgery)
  Acute conditions

Intraoperative factors

Postoperative factors

Preoperative Factors

Chronic cardiac conditions

Chronic conditions associated with cardiac disease

Recent preoperative conditions

Acute conditions
Intraoperative Factors

Surgery and anesthesia are associated with:
- activation of the sympathetic nervous system
- inflammation
- hypercoagulability
- hemodynamic compromise
- bleeding
- hypothermia

Postoperative Factors

Several postoperative factors are associated with cardiac complications:
- hypotension
- tachycardia
- bleeding
- hypoxemia
- pain

What are the Goals of the Preoperative Evaluation?
What is the risk of surgery?

What clinical tools are available to estimate the risks?

What diagnostic testing is appropriate?

What interventions are available to reduce risk?

What kind of monitoring should be done postoperatively?

Preoperative Prediction of Cardiac Complications

Clinical risk models

Noninvasive cardiac testing

Measurement of cardiac biomarker levels

Clinical Risk Models

Revised Cardiac Risk Index (RCRI)

National Surgical Quality Improvement Program Myocardial Infarction and Cardiac Arrest Risk Index (NSQIP MICA Risk Index)

American Society of Anesthesiologists Classification

ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery
Clinical Models for the Prediction of Cardiac Events in Patients Undergoing Major Noncardiac Surgery


Revised Cardiac Risk Index

Uses 6 predictors of Major Adverse Cardiac Events

- High Risk Surgery
- History of ischemic Heart Disease
- History of Congestive Heart Failure
- History of Cerebrovascular Disease
- Preoperative Treatment with Insulin
- Preoperative Creatinine > 2mg/dl
Revised Cardiac Risk Index

Best-validated risk model
Simple, practical, & does not require a risk calculator

Original risk estimates are 50% lower than the rates of events observed in more recent cohort studies
Does not inform risk among patients undergoing emergency surgery
Does not account for functional capacity or status of coronary artery disease

NSQIP MICA Risk Index

American College of Surgeons National Surgical Quality Improvement Program risk index for Myocardial Infarction and Cardiac Arrest (NSQIP MICA) Surgical Risk Calculator

Used data from over 1 million operations to create calculator
Assess risk based on procedure by CPT code and whether emergency procedure or not
Uses 21 patient-specific variables
Calculates the percentage risk of a MACE, death and 8 other variables

Patient Variables

<table>
<thead>
<tr>
<th>Age Group</th>
<th>BMI</th>
<th>Sex</th>
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<tbody>
<tr>
<td>Functional Status</td>
<td>Emergency Case</td>
<td>ASA Class</td>
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<tr>
<td>Diabetes</td>
<td>Dyspnea</td>
<td>AKI</td>
</tr>
<tr>
<td>Dialysis</td>
<td>Ventilator Dependence</td>
<td></td>
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<tr>
<td>Disseminated Cancer</td>
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<td></td>
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<tr>
<td>Steroid use for chronic condition</td>
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<td></td>
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<tr>
<td>Ascites within 30 days prior to surgery</td>
<td></td>
<td></td>
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<tr>
<td>Systemic Sepsis within 48 hours prior to surgery</td>
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<td></td>
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<tr>
<td>Hypertension requiring medication</td>
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<tr>
<td>Congestive Heart Failure in 30 days prior to surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Smoker within 1 Year</td>
<td></td>
<td></td>
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<tr>
<td>History of Severe COPD</td>
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</tbody>
</table>
NSQIP MICA Risk Index

Was shown to have a predictive performance that was superior to that of the RCRI, especially in vascular surgery.

Underestimates actual risk because the definition of myocardial infarction in the study was based only on electrocardiographic changes or troponin>3 times normal.

It does not account for functional capacity or status of coronary artery disease.

American Society of Anesthesiologists Classification

1-Normal healthy patient
2-Patient with mild systemic disease
3-Patient with severe systemic disease
4-Patient with severe systemic disease that is a constant threat to life
5-Patient not expected to survive without surgery

It does not account for functional capacity or status of coronary artery disease.

Functional Capacity
**Functional Capacity**

Independent predictor of perioperative death

Adding Functional Capacity to risk models will improve stratification rates of all-cause mortality and 30-day postoperative complications

Physicians should incorporate functional capacity into their preoperative evaluation, perhaps by increasing a patient’s level to the next higher level if patient is functionally dependent

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**Coronary Artery Disease Status**

Coronary artery disease is a risk factor for adverse perioperative outcomes

Preoperative Angina is a significant predictor of postoperative MI

The incidence of postop MI is significantly greater in patients who have anginal symptoms; cardiac intervention and length of stay is also higher

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**ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery**
Preoperative Prediction of Cardiac Complications

Clinical risk models

Noninvasive cardiac testing

Measurement of cardiac biomarker levels

Noninvasive Cardiac Testing
Cardiac Stress Testing

What are the guidelines on cardiac assessment and care of patients undergoing noncardiac surgery regarding cardiac stress testing preoperatively?

What are the studies on cardiac assessment and care of patients undergoing noncardiac surgery regarding cardiac stress testing preoperatively?

None of the studies showed the overall absolute net rate of reclassification of patients to a higher or lower risk category on the basis of cardiac stress testing, as compared with the use of a clinical risk index.

CCTA


CCTA improved the estimation of risk among patients in whom the primary outcome occurred

CCTA overestimated the risk among patients who did not have the primary outcome.

CCTA will result in an inappropriate estimate of risk (higher or lower category) in 141/1000 patients.

Reassignment of Risk in a Sample of 1000 Patients on the Basis of Findings on CCTA, as Compared with Findings on the RCRI.
Preoperative Prediction of Cardiac Complications

Clinical risk models
Noninvasive cardiac testing

Measurement of cardiac biomarker levels

Measurement of Cardiac Biomarker Levels

“The prognostic value of pre-operative and post-operative B-type natriuretic peptides in patients undergoing noncardiac surgery.” J AM Coll Cardiol 2014

An elevated preoperative natriuretic peptide was the strongest independent preoperative predictor of the primary outcome. Preoperative measurement of natriuretic peptide levels improved risk estimation among both patients who had the primary outcome and those who did not. Preoperative measurement of natriuretic peptide levels would result in a more appropriate estimate of the risk of death or myocardial infarction in 155/1000 patients.

Measurement of Cardiac Biomarker Levels

Advantages of testing natriuretic peptide level preoperatively
Cost
Speed of results
Guide need for referral
Perioperative Interventions

Preoperative Coronary Revascularization

Perioperative Medical Therapy
  Interventions Targeting the Stress Response, Inflammation, Hypotension, and Hypercoagulable State vs Bleeding Risk

Postoperative Monitoring
  Shared Care
  Monitoring for Hypoxemia, Hemodynamic Compromise, and Myocardial Ischemia

Results of Studies of the Effect of Perioperative Prophylactic Cardiac Interventions on Perioperative Cardiac Events
Perioperative Interventions

Preoperative Coronary Revascularization

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  Interventions Targeting the Stress Response, Inflammation, Hypotension, and Hypercoagulable State vs Bleeding Risk

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Coronary revascularization vs no coronary revascularization before vascular surgery

No significant effect on the primary outcome of long-term survival

No short-term benefit of preoperative coronary revascularization
Perioperative Interventions

Preoperative Coronary Revascularization

Perioperative Medical Therapy
- Interventions Targeting the Stress Response, Inflammation, Hypotension, and Hypercoagulable State vs Bleeding Risk

Postoperative Monitoring
- Shared Care
  - Monitoring for Hypoxemia, Hemodynamic Compromise, and Myocardial Ischemia

Beta Blockers
- Clonidine
- Statins
- ACEI and ARB
- ASA
- Antiplatelet Therapy and Stents
- Anticoagulation for Atrial Fibrillation
- Transfusion

Beta Blockers
Reduced the risk of nonfatal myocardial infarction but increases the risk of death, nonfatal stroke, hypotension, and bradycardia.

Clinically important hypotension was a strong independent predictor of stroke and death.

Only patients with highest baseline risk benefit from beta blocker therapy.

Beta blockers showed be used only in high-risk patients undergoing high-risk surgery.
Clonidine

Low-dose clonidine produces less hypotension than beta-blockers.

Had no effect on the rates of myocardial infarction, stroke, or death

Targeting the Stress Response

Maintaining the most effective match between perioperative myocardial oxygen supply and demand.

Controlling the perioperative sympathetic stress response has benefit, but it is necessary to find a way to do it safely.

A strategy that holds promise is the use of continuous monitoring system that noninvasively assesses a patient's hemodynamic status and ST-segments after surgery.

Statin Therapy

Significantly reduces rates of all-cause mortality, MI and CVA in vascular surgery.

Significantly reduces the composite of all-cause mortality, myocardial injury or stroke in noncardiac surgery

Seem appropriate in patients at high risk and benefit may be evident in as little as 5 days.

Adverse effects of statins appear to be low in the perioperative setting
ACEI and ARB

Impair the RAAS which maintains BP under General Anesthesia

ACEI and ARB induced intraoperative hypotension is often refractory to adrenergic vasopressors

Delay in resuming chronic ACEI and ARB therapy is common and associated with a higher 30-day mortality rate

Use of Aspirin

POISE-2 trial showed that aspirin did not reduce the risk of myocardial infarction but increased the risk of major bleeding.

These data suggest that aspirin should not be administered during the perioperative period, but that it is important to reinitiate the use of aspirin 8 to 10 days after surgery in patients with an indication for long-term aspirin use.

Coronary Stents and Antiplatelet Therapy

The risk of perioperative adverse events differs by both the stent type and the time from PCI to surgery

The risk of adverse events with BMS remains high over time

The risk of adverse events with DES levels off 90 days after PCI
Coronary Stents and Antiplatelet Therapy

2016 ACC/AHA guideline focused update on duration of DAPT in patients with CAD recommends:

- A minimum of 6 months DAPT (as opposed to 12 months) after DES placement before elective surgery
- Allow surgery after 3 months (as opposed to 6 months) if the risk of delaying surgery outweighs the risk of stent thrombosis or myocardial infarction

Perioperative Anticoagulation

“BRIDGE” Trial

American College of Chest Physicians recommendations for atrial fibrillation patients on warfarin:

- No bridging for low or intermediate risk patients
- Bridging for high risk patients

Transfusion Threshold

The Transfusion Trigger Trial for Functional Outcomes in Cardiovascular Patients Undergoing Surgical Hip Fracture Repair

- No benefit associated with a liberal transfusion strategy.

This study was limited to patients undergoing hip-fracture surgery. However, a restrictive transfusion strategy after any noncardiac surgery is probably prudent unless proved otherwise.
Perioperative Interventions

Preoperative Coronary Revascularization

Perioperative Medical Therapy

Interventions Targeting the Stress Response, Inflammation, Hypotension, and Hypercoagulable State vs Bleeding Risk

Postoperative Monitoring

Shared Care

Monitoring for Hypoxemia, Hemodynamic Compromise, and Myocardial Ischemia

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Postoperative Monitoring

Shared Care

Monitoring for Hypoxemia and Hemodynamic Compromise

Monitoring for Myocardial Ischemia

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Shared Care

In the POISE-2 trial, the median duration of clinically important hypotension during surgery was 15 minutes, whereas on the first postoperative day it was 150 minutes (P<0.001).

These data suggest a need for procedures to facilitate more rapid management of cardiovascular compromise on surgical wards.

Models of shared care arrangements between surgeons and readily available medical specialists have the potential to improve outcomes for patients.
Postoperative Monitoring for Hypoxemia & Hemodynamic Compromise

Monitoring of Vital Signs

Analgesic Medications

Incidence of Hypoxemia

Hypotension is an independent predictor of the subsequent risk of myocardial infarction (adjusted hazard ratio, 1.37) during a 30-day follow-up.

Studies have also shown that continuous ST-segment monitoring after surgery can identify asymptomatic ischemia that is independently associated with myocardial infarction.

Monitoring for Myocardial Ischemia


Measurement of Troponin Levels

Most myocardial infarctions occur within 48 hours after noncardiac surgery.
The use of analgesic medications explains why 65% of patients in whom a perioperative myocardial infarction occurs do not have symptoms of ischemia.
Asymptomatic myocardial infarctions are associated with an increase in the risk of death within 30 days (adjusted odds ratio, 4.00).
Asymptomatic perioperative elevations in troponin levels are also associated with increased risk of death at 30 days (adjusted hazard ratio, 3.30).
CONCLUSIONS

Death during surgery is rare, but postop death is not

Cardiovascular complications are the leading cause of death within 30 days after noncardiac surgery

Addition of functional capacity and status of coronary artery disease increases the accuracy of cardiac risk models

Measurement of natriuretic peptide levels enhances preoperative risk prediction

CONCLUSIONS

Randomized, controlled trials have not identified an effective and safe intervention to prevent perioperative cardiac complications

Enhanced monitoring on surgical wards and rapid management of cardiac complications when they occur may improve outcomes

Because most patients in whom a perioperative myocardial infarction occurs do not have symptoms, physicians should monitor troponin levels after surgery in high risk patients

References

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“Update in Perioperative Cardiac Medicine” Cleveland Clinic Journal of Medicine, 10/2016

“Preoperative Evaluation for Noncardiac Surgery” Annals of Internal Medicine, 12/6/2016

“2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery”