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• No relevant financial disclosures
Learning Objectives & Scope

• Use the ACC/AHA algorithm to approach perioperative cardiac risk assessment

• Review risk prediction models to estimate perioperative cardiovascular risks for patients undergoing noncardiac surgery

• Understand the current view of risk mitigation and when to seek further risk stratification
A 70 year-old man comes to see you in clinic because he is considering total knee replacement surgery…
Case Presentation

HPI:
- Was able to walk up a flight of stairs without chest pain or SOB 10 yrs. ago
- Has had progressive decline in mobility
- Now limited to 2-3 feet because of severe knee pain

PMH:
- Severe OA not responsive to medical therapies
- T2DM on insulin
- CKD (Cr 2.1)
- HTN
- Tobacco use and COPD
- Obesity
- No history of heart failure, MI, or stroke

Medications:
- Lantus
- ASA 81
- HCTZ
- lisinopril
- tiotropium
- fluticasone/salmeterol
- PRN albuterol
Case Presentation

Exam:
• HR 80s, BP 142/80, SaO2 93% on RA, RR 16
• Obese, elderly man, appearing older than stated age
• JVP not elevated
• Heart with regular rhythm, normal rate, normal S1 and S2, and no murmur
• Lungs with decreased air movement throughout, scattered wheeze, no focal crackles
• No leg edema
• OA changes of bilateral knees

Labs:
• Cr 2.2, Alb 3.0
The patient is worried about how well his heart will handle the surgery…

- How would you approach his preoperative cardiac assessment?
- How would you estimate his risk for perioperative cardiac complications?
- Is further cardiac testing indicated?
Does this patient/surgery combo make me nervous?

Do I really need to go through this flowsheet?

What's the functional capacity?

Do I need to get more info? Or even delay the procedure for cardiac treatment?
Do I really need to go through this flowsheet?

2014 ACC/AHA Guidelines
Step 1,2: Surgical Emergency or Active Cardiac Syndrome?

Acute Coronary Syndrome
- STEMI
- NSTEMI
- Unstable angina
- Recent MI (<30d)

Decompensated Heart Failure

Significant Arrhythmia
- Tachyarrhythmia
- Bradyarrhythmia

Severe or Symptomatic AS or MS

Patient scheduled for surgery with known or risk factors for CAD*
(Step 1)

Emergency

Yes
Clinical risk stratification and proceed to surgery

No

ACS†
(Step 2)

Yes
Evaluate and treat according to GDMT†

No

Estimated perioperative risk of MACE based on combined clinical/surgical risk
(Step 3)
Does this patient/surgery combo make me nervous?
Step 3,4: Estimated Risk Based on **Surgical Risk**

- **Low risk surgeries**
  - Superficial, breast, cataract, endoscopy, ambulatory surgeries

- **Intermediate risk surgeries**
  - HEENT, CEA, intrathoracic, intraperitoneal, prostate, orthopedic

- **High risk surgeries**
  - Aortic, peripheral or major vascular
Step 3,4: Estimated Risk Based on **Clinical Risk**

**Risk Calculators:**
- Revised Cardiac Risk Index or “RCRI”
- Gupta MICA NSQUIP Risk Prediction
Estimate Clinical Risk: RCRI

Lee et al., Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. *Circulation*. 1999:100:1043

- 4000 patients undergoing elective surgery
- Tracked complications: MI, pulmonary edema, VF or primary cardiac arrest, CHB
- Identified 6 risk factors predictive of complications (retrospectively derived in cohort of 2900, prospectively validated in another cohort of 1400)

- High Risk surgery
- Congestive Heart Failure
- Stroke/TIA
- Coronary Artery Disease
- Diabetes (on insulin)
- Chronic Kidney Disease (Cr>2)

• Widely used but several limitations:
  - Published 20 years ago
  - Not validated in advanced age patients (average age 65)
  - May not be applicable to patients undergoing urgent or emergent surgeries
  - Many patients have cardiac risk > 10% but risk “tops off”

<table>
<thead>
<tr>
<th>Points</th>
<th>RCRI Risk Class</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>I</td>
<td>0.5%</td>
</tr>
<tr>
<td>1</td>
<td>II</td>
<td>1%</td>
</tr>
<tr>
<td>2</td>
<td>III</td>
<td>5%</td>
</tr>
<tr>
<td>3 or more</td>
<td>IV</td>
<td>10%</td>
</tr>
</tbody>
</table>
Estimate Perioperative Risk of MACE: Gupta


- 400,000 patients from National Surgical Quality Improvement Program database
- Tracked complications: MI or CA
- Identified risk factors predictive of complications:
  - Age
  - Preoperative functional status
  - Creatinine > 1.5
  - Procedure
  - ASA class

- Grown in popularity
- Limitations:
  - Large database
  - Depended on accuracy and sensitivity of coding
  - Myocardial Infarction defined as STEMI
  - Cardiac Arrest defined as requiring CPR
- Most peri-operative MIs are asymptomatic – likely many cardiac events were missed, and the total cardiac risk is underestimated
<table>
<thead>
<tr>
<th>ASA Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA PS 1</td>
<td>Normal healthy patients</td>
</tr>
<tr>
<td>ASA PS 2</td>
<td>Patients with mild systemic disease</td>
</tr>
<tr>
<td>ASA PS 3</td>
<td>Patients with severe systemic disease</td>
</tr>
<tr>
<td>ASA PS 4</td>
<td>Patients with severe systemic disease that is a constant threat to life</td>
</tr>
<tr>
<td>ASA PS 5</td>
<td>Moribund patients not expected to survive without the operation</td>
</tr>
<tr>
<td></td>
<td>RCRI</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td><strong>Published</strong></td>
<td>1999</td>
</tr>
<tr>
<td><strong>Patients</strong></td>
<td>4000</td>
</tr>
<tr>
<td></td>
<td>Mostly elective surgeries</td>
</tr>
<tr>
<td><strong>Outcome screening</strong></td>
<td>Serial cardiac enzymes and electrocardiograms</td>
</tr>
<tr>
<td><strong>Outcome measured</strong></td>
<td>Myocardial infarction</td>
</tr>
<tr>
<td></td>
<td>Cardiac arrest</td>
</tr>
<tr>
<td></td>
<td>Pulmonary edema</td>
</tr>
<tr>
<td></td>
<td>Complete heart block</td>
</tr>
</tbody>
</table>
2014 ACC/AHA Guidelines

What's the functional capacity?
Step 5: Assess Functional Capacity
Table 3. Estimated Energy Requirements for Various Activities

<table>
<thead>
<tr>
<th>METs</th>
<th>Can you ...</th>
<th>METs</th>
<th>Can you ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Take care of yourself?</td>
<td>4</td>
<td>Climb a flight of stairs or walk up a hill?</td>
</tr>
<tr>
<td></td>
<td>Eat, dress, or use the toilet?</td>
<td></td>
<td>Walk on level ground at 4 mph (6.4 kph)?</td>
</tr>
<tr>
<td></td>
<td>Walk indoors around the house?</td>
<td></td>
<td>Run a short distance?</td>
</tr>
<tr>
<td></td>
<td>Walk a block or 2 on level ground at 2 to 3 mph (3.2 to 4.8 kph)?</td>
<td></td>
<td>Do heavy work around the house like scrubbing floors or lifting or moving heavy furniture?</td>
</tr>
<tr>
<td>4</td>
<td>Do light work around the house like dusting or washing dishes?</td>
<td></td>
<td>Participate in moderate recreational activities like golf, bowling, dancing, doubles tennis, or throwing a baseball or football?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greater than 10</td>
<td>Participate in strenuous sports like swimming, singles tennis, football, basketball, or skiing?</td>
</tr>
</tbody>
</table>

kph indicates kilometers per hour; MET, metabolic equivalent; and mph, miles per hour.

*Modified from Hlatky et al (11), copyright 1989, with permission from Elsevier, and adapted from Fletcher et al (12).
Back to Our Patient

**RCRI**
- High Risk surgery
- Congestive Heart Failure
- Stroke/TIA
- Coronary Artery Disease
- Diabetes (on insulin)
- Chronic Kidney Disease (Cr>2)

**GUPTA**
- Age
- Preoperative functional status
- Creatinine > 1.5
- Procedure
- ASA class
HPI: 70 year-old man comes to see you in clinic because he is considering total knee replacement surgery

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RCRI
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GUPTA
- Age
- Preoperative functional status
- Creatinine > 1.5
- Procedure
- ASA class

5%
1.2%
Systematic review of published cardiac risk indices relevant to patients undergoing noncardiac surgery

Risk indices identified generally fell into two groups:
1. Those with higher accuracy for predicting a narrow range of cardiac outcomes
2. Those with lower accuracy for predicting a broader range of cardiac outcomes

Using one index from each group may be the most clinically useful approach.
2014 ACC/AHA Guidelines

Do I really need to go through this flowsheet?

Does this patient/surgery combo make me nervous?

Do I need to get more info?
Or even delay the procedure for cardiac treatment?

What's the functional capacity?
Further Testing and Treatments

- Poor OR unknown functional capacity (<4 METs): Will further testing impact decision making OR perioperative care? (Step 6)
  - Yes: Pharmacologic stress testing (Class Ila)
    - If normal: Proceed to surgery according to GDMT OR alternate strategies (noninvasive treatment, palliation) (Step 7)
    - If abnormal: Coronary revascularization according to existing CPGs (Class I)
Coronary Artery Revascularization Prophylaxis (CARP) Trial


• 510 Veteran’s Affairs patients planned for vascular surgery with:
  - Sufficient cardiac risk to warrant cardiac catheterization
  - Significant CAD (1 or more vessels with > 70% stenosis) on catheterization which was amenable to revascularization

• Randomized to:
  - Medical Management
    N=229
  - Coronary Revascularization
    N=226

• Exclusion criteria: left main disease, EF <20%, severe aortic stenosis

![Graph showing survival probability over years after randomization with and without revascularization.](image)
Further Testing and Treatments

- Poor OR unknown functional capacity (<4 METs):
  - Will further testing impact decision making OR perioperative care? (Step 6)

  - Yes → Pharmacologic stress testing (Class IIa)
    - If normal → Proceed to surgery according to GDMT OR alternate strategies (noninvasive treatment, palliation) (Step 7)
    - If abnormal → Coronary revascularization according to existing CPGs (Class I)

  - No → Proceed to surgery according to GDMT OR alternate strategies (noninvasive treatment, palliation) (Step 7)
Stress Testing?

If revascularization doesn’t improve outcomes, in what situation would a stress test impact decision making or perioperative care?

• To exonerate severe cardiac disease that was not studied in CARP (e.g. left main disease) in patients with such low exercise tolerance that you cannot reasonably rule it out clinically

• To confirm a diagnosis of CAD in patients with moderate pretest probability to substantiate the need for medical management

• To assess prognosis that might aid in decision making regarding forgoing elective procedures
Beta Blockers?


- 780,000 patients >18yo having noncardiac surgery
- Retrospective cohort that matched cases (those receiving betablocker) and control (no beta blocker) using propensity scores
- Outcome: In-hospital mortality

<table>
<thead>
<tr>
<th>Propensity-Matched Cohort</th>
<th>Odds Ratio (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCRI score 0</td>
<td>1.43 (1.29–1.58)</td>
</tr>
<tr>
<td>RCRI score 1</td>
<td>1.13 (0.99–1.30)</td>
</tr>
<tr>
<td>RCRI score 2</td>
<td>0.90 (0.75–1.08)</td>
</tr>
<tr>
<td>RCRI score 3</td>
<td>0.71 (0.56–0.91)</td>
</tr>
<tr>
<td>RCRI score ≥4</td>
<td>0.57 (0.42–0.76)</td>
</tr>
</tbody>
</table>
Randomized to:

Given 2-4 hours before surgery.

Metoprolol Succinate 100mg PO

N=4174

Placebo

N=4177

The primary endpoint: a composite of cardiovascular death, non-fatal myocardial infarction, and non-fatal cardiac arrest.

8351 patients planned for non-cardiac surgery

- With documented CAD/PVD/CVD
- With elevated risk for CAD with a risk assessment tool

Exclusion criteria:

- Baseline bradycardia
- Chronic BB therapy or verapamil
- Heart Block
- Asthma
- Recent Coronary revascularization

Devereaux et al., for the POISE Study Group
Effects of extended-release metoprolol succinate in patients undergoing non-cardiac surgery (POISE trial): a RCT

Figure 2: Kaplan-Meier estimates of the primary outcome (A), myocardial infarction (B), stroke (C), and death (D)
• Lessons from Lindenauer: Beta-Blockers may be harmful in low risk patients (RCRI 1-2). For patients at higher risk by RCRI, Beta-Blockers are probably beneficial.

• Lessons from POISE: If given, Beta-Blockers should be started well before surgery. Acute use of Beta-Blockers, particularly at high dose, is not a good strategy.
• 2014 ACC/AHA recommendations provide a stepwise approach to perioperative cardiac assessment.

• This approach uses cardiac risk indices that have differing characteristics:
  1. Those with higher accuracy for predicting a narrow range of cardiac outcomes (e.g. Gupta)
  2. Those with lower accuracy for predicting a broader range of cardiac outcomes (e.g. RCRI)

• Consider that pre-op revascularization may not offer a great benefit in many CAD patients. Consider whether Stress Testing is therefore useful.

• Beta-Blockers are not for everyone.
Next Best Steps

• Become comfortable using one index from each group of risk indices. It may be the most clinically useful approach to assessing cardiac risk for non-cardiac surgery

• Identify patients with Left Main Disease and Severe AS. These are the patients most likely to benefit from preoperative revascularization.
References


• Lee et al., Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. Circulation, 1999:100:1043

• Drips et al. The role of anesthesia in surgical mortality. JAMA. 1961;178:261-266

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