Pre-operative Evaluation of Patients Undergoing Major Non-Cardiac Surgery

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August 2nd, 2019
Disclosure Statement

I have no conflicts of interest to disclose.
Objectives

1. Review the 2014 ACC and ESC/ESA guidelines for non-cardiac surgery

2. Understand guidelines for low and elevated risk (intermediate and high risk combined) surgical interventions.

3. Understand risk class of patients, RCRI (Revised cardiac risk index), NSQIP (National Surgical Quality Improvement Program), and MICA (Myocardial infarction or Cardiac arrest calculator).

4. Recognize findings in the 2018 METS prospective cohort study and the 2017 Peri-operative MACCE (Major adverse cardiovascular and cerebrovascular with non-cardiac surgery study).
Peri-operative Evaluation: Medical Consultation

- What is the purpose of this appointment and/or consultation?
  - Eliminate the need for tedious informed consent?
  - Transfer of medico-legal risk?
  - In the Hospitalist world, for generation of H&P for chart?
- “Clearance” implies no risk...
Peri-operative Evaluation

- What is the purpose of this appointment and/or consultation?
  - Guide informed consent, Weight benefits v. risk, Optimize timing of surgery, Uncover undiagnosed problems, Develop intervention plan, Plan to prevent complications
  - ...pre-operative evaluation in most cases does not result in delay or cancellation

- Result of peri-operative evaluation?
  - Proceed with strategies in place
  - Postpone for more testing (rare)
  - Cancel, offer alternative treatment plan

- History, exam, type of surgery to develop an initial estimate of peri-operative risk (quantification).
Peri-operative Evaluation:
ECG

2014 ACA/AHA guidelines for noncardiac surgery

- Not part of the RCRI or NSQIP because of lack of prognostic specificity associated with these findings
- Obtain an ECG in patients with known CAD, arrhythmia, PAD, CVD, SHD EXCEPT those undergoing low-risk surgery
- Monitor for Q waves, ST elevation/depression/ LVH, QTc prolongation, BBB, arrhythmia
- Considered in asymptomatic patients without CAD, NOT having low risk procedure
  - Most of the value is in baseline to measure against any post-op changes (1-3 months pre-op)
FIGURE 1 Stepwise Approach to Perioperative Cardiac Assessment for CAD

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

Emergency

Yes

Clinical stratification and proceed to surgery

No

ACST (Step 2)

Yes

Evaluate and treat according to GDMT

No

Estimated perioperative risk of MACE based on combined clinical/surgical risk (Step 3)

Low risk (<1%) (Step 4)

Elevated risk (Step 5)

No further testing (Class IIb)

Moderate or greater functional capacity

No or unknown

Proceed to surgery

Moderate/Good

(4–10 METs)

Excercised (>10 METs)

No further testing

Excellent

(>10 METs)

No further testing (Class IIa)

Class IIb

Pharmacologic stress testing (Class IIa)

Will further testing impact decision making or perioperative care? (Step 6)

Yes

Coronary revascularization according to existing CPGs (Class I)

No

Proceed to surgery according to GDMT or alternate strategies (noninvasive treatment, palliation) (Step 7)

If normal If abnormal

If normal

If abnormal

J Am Coll Cardiol. 2014;64(22):e77.
Peri-operative Risk

- Considerations: Active coronary syndrome, decompensated heart failure, uncontrolled arrhythmia, severe valvular disease, recent PCI

- Risk class of the planned procedure (estimated risk of death or MI)
  - High: aortic, vascular surgery (>5%)
  - Intermediate: intra-peritoneal, -thoracic, CEA, head/neck, orthopedic, prostate (1 to 5%)
  - Low: endoscopic, superficial, cataract, breast, ambulatory procedures (<1%)

- Risk class of the patient
  - RCRI (Revised cardiac risk index)
  - NSQIP (National surgical quality improvement program)
Peri-operative Risk: Risk Models, Surgery-Specific

- RCRI (Revised Cardiac Risk Index),
  - also referred to as the Lee Index
  - simple
  - Published in 1999

- Underestimates risk:
  - Complete heart block
  - Heart failure

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**Table 1**

**Independent Predictors of Major Cardiac Complications and Estimation of Risk**

**Revised Cardiac Risk Index (RCRI\(^a\))**

1. High-risk surgery\(^a\)
2. Ischemic heart disease\(^b\)
3. History of congestive heart failure
4. History of cerebrovascular disease
5. Insulin therapy for diabetes
6. Preoperative serum creatinine >2.0 mg/dl.

**Risk of Major Perioperative Cardiac Event\(^c\) Based on Predictors in the RCRI\(^a\)**

<table>
<thead>
<tr>
<th>No. of Risk Factors</th>
<th>Risk of Cardiac Event, % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.4 (0.1 – 0.8)</td>
</tr>
<tr>
<td>1</td>
<td>1.0 (0.5 – 1.4)</td>
</tr>
<tr>
<td>2</td>
<td>2.4 (1.3 0 3.5)</td>
</tr>
<tr>
<td>≥3</td>
<td>5.4 (2.8 – 7.9)</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.

\(^a\)Includes vascular surgery and any open intraperitoneal or intrathoracic procedures.

\(^b\)History of myocardial infarction or a positive exercise test, current complaint of chest pain considered secondary to myocardial ischemia, use of nitrate therapy, or ECG with pathological Q-waves.

\(^c\)Includes cardiac death, nonfatal myocardial infarction, and nonfatal cardiac arrest.
Peri-operative Risk: Risk Models, Surgery-Specific

- RCRI (Revised Cardiac Risk Index),
  - 2009 systematic review, Ann Intern Med. 2010;152(1):26, evaluated the ability of the RCRI to predict cardiac complications and mortality
  - Performed well distinguishing low with high risk for all types of noncardiac surgery
  - Less accurate in patients undergoing only vascular noncardiac surgery
  - Did not predict all-cause mortality well (did not capture risk factors for noncardiac causes of perioperative mortality...only 1/3 of perioperative deaths are due to cardiac causes)
Peri-operative Risk: Risk Models, Surgery-Specific

- VSGNE risk index (Vascular Study Group of New England),
  - Risk index for patients specifically undergoing vascular surgery
  - Not externally validated
  - Did not include mortality as an end point
  - Evaluates: increasing age, smoking, IDDM, CAD, CHF, abnormal CPET, long term beta blocker therapy, COPD, creatinine $\geq 1.8$, prior PCI (protective)
  - Can be found online: www.vqi.org (Vascular Quality Initiative)
Peri-operative Risk: Risk Models, Surgery-Specific

- NSQIP (www.riskcalculator.facs.org)
- National Surgical Quality Improvement Program
  - Universal surgical risk, More complex
  - Performed well in predication:
    - Mortality, morbidity, & 6 complications
  - Requires online tool
  - Has yet to be validated in other populations

Peri-operative Risk: Risk Models

- Provide user with risk of a cardiac complication
  - Low risk
    - No further testing indicated
  - Elevated risk (possible referral to cardiologist)
    - Will further cardiovascular testing change management or improve outcome?
    - Reason to perform additional testing will be based not on the desire to lower risk at time of surgery, but lower long term risk
    - Additional testing done irrespective of the need for surgery
    - Very few circumstances in which testing should be performed solely because the patient has upcoming surgery
Peri-operative Risk

- New guidelines focus on low risk versus elevated risk
  - Intermediate and high risk categories are combined
Peri-operative Risk: Functional Status/Capacity

- Included in many risk models, none of which are optimally constructed
- Duke Activity Status Index (DASI) standardized questionnaire
- 2018 METS prospective cohort study
Peri-operative Risk: Functional Status/Capacity, METS

- 1 MET: eat, dress, use the toilet, resting oxygen consumption (3.5mL O2 uptake/kg per min)
- 4-10 METs: flight of stairs (2), walking uphill, walking on level ground at 3-4mph, heavy house work
- <4 METs: slow ballroom dancing, golfing with car, playing a musical instrument, walking slower than 4mph
- >10 METs: swimming, singles tennis, football, basketball, skiing
Peri-operative Risk: Functional Status/Capacity

- Duke Activity Status Index (DASI)
  - Take care of yourself by eating, dressing, bathing, toileting? (2.75 METS)
  - Walk indoors such as around the house? (1.75 METS)
  - Walk a block on level ground? (2.75 METS)
  - Climb a flight of stairs or walk up hill? (5.50 METS)
  - Run a short distance? (8.00 METS)
  - Do light housework such as dusting or washing dishes? (2.70 METS)
  - Do moderate housework: vacuuming, sweeping, or carrying groceries? (3.50 METS)
  - Do heavy housework such as scrubbing floors or moving furniture? (8.0 METS)
  - Do yard work such as raking, weeding, or pushing a mower? (4.5 METS)
  - Have sexual relations? (5.25 METS)
  - Moderate Exercise such as golf, bowl, dance, doubles tennis, throw ball? (6 METS)
  - Strenuous Exercise such as swim, ski, singles tennis, football, basketball? (7.5 METS)
Peri-operative Risk: Functional Status/Capacity

  - Subjectively assessed pre-operative functional capacity did not accurately identify patients with poor cardiopulmonary fitness or predict postoperative morbidity or mortality
  - 1401 patients scheduled for major noncardiac surgery who had one or more risk factors for cardiac complications, primary outcome death or MI within 30 days after surgery
  - Predictive ability of the subjective assessment of functional capacity (in METs) was compared with the Duke Activity Status Index (DASI), formal cardiopulmonary exercise testing (CPET), and N-terminal pro-brain natriuretic peptide concentrations
  - Subjective assessment of functional capacity had a 19.2 percent sensitivity and 94.7 percent specificity for predicting the inability to attain 4 METs during CPET
  - Subjective assessment resulted in substantial misclassification of high-risk patients as low risk
  - Only DASI scores were associated with successfully predicting the primary outcome (adjusted OR 0.96, 95% CI 0.83-0.99)
Peri-operative Risk: Evaluation

- Do not routinely order exhaustive or extensive evaluations:
  - Emergent surgery (risk indices derived from elective surgery cohorts are not accurate)
  - No active cardiac condition, low risk surgery
  - No active cardiac condition or symptoms, good exercise capacity
Peri-operative Risk: Cardiac Testing-Stress

- Patients with known CAD or suspected CAD (valvular heart disease, symptomatic arrhythmias), stress testing pursued only if it is indicated in the absence of proposed surgery

- No evidence that further diagnostic or prognostic evaluation improves outcomes
  - Stress testing (exercise and pharmacologic) with imaging demonstrates clear relationship between degree of ischemia and prognosis
  - No evidence that prophylactic revascularization, in addition to medical therapy, to prevent ischemia at the time of surgery improves outcomes (CARP Trial)

- Timing to perform additional testing should be determined by the urgency of the clinical situation

- Stress testing is not indicated in the peri-operative patient solely because of the surgery (if there is no other reason)

  Circulation. 2006;113(10):1361.
Peri-operative Risk: Additional Cardiac Testing-Resting ECHO

- Not indicated in the peri-operative patient unless there is another indication
  - Evaluate valve function in patient with murmur or LV systolic function in patients with heart failure or dyspnea of unknown origin
  - LV systolic dysfunction or severe valvular heart disease is associated with worse post-operative outcomes, particularly post-operative heart failure
  - Known or suspected moderate or severe valvular dysfunction, consider obtaining echo if no prior study completed within 1 year
  - If surgery is emergent or patient would otherwise be unable to pursue valve surgery:
    - Higher level of peri-operative monitoring
    - IV fluid volume support
    - Alpha agonist (phenylephrine)
Peri-operative Risk:
Additional Cardiac Testing-24 Hour Monitor

- Do not recommend 24 hour ambulatory monitoring for peri-operative diagnostic purposes
- Has not been shown to improve outcomes
- Indications are for patients with syncope, significant bradycardia, or tachycardia
Peri-operative Risk: Beta Blockers

- Continue to take
- Don’t start aimlessly
  - Start if patient suspected to have ischemia or 3+ RCRI risk factors
  - Start greater than 1 day before surgery; titrate
  - Do not start on day of surgery
Peri-operative Risk: Statins

- Don’t stop them
- Consider starting in at-risk patients, especially before vascular interventions
Peri-operative Risk:
ACEI/ARBS

- Reasonable to stop
- Reasonable to start
- Some physicians hold, others continue
Peri-operative Risk: MINS

- Myocardial injury after noncardiac surgery: defined as a myocardial cell injury during the first 30 days after noncardiac surgery due to an ischemic etiology (no evidence of a nonischemic etiology like sepsis, AF c/ RVR, PE, CCV, chronic troponin elevation, CKD) and is independently associated with mortality. Includes MI, symptomatic and non-symptomatic. Usually due to demand-supply mismatch or plaque rupture.

- Three large prospective cohort studies: evaluated each case of elevated troponin for evidence of a nonischemic etiology found that over 85% of troponin elevations after surgery were likely due to myocardial ischemia.

- Given the important prognostic significant of an elevated cTn value after surgery, baseline sample for cTn in those who are at high risk may be of benefit.
  - Principal argument: elevated baseline troponin may have surgery unnecessarily postponed
  - High risk for a peri-operative MI
    - In hospital surgery with one or more risk factors from the RCRI (1 of 6)
    - Subsequent troponin obtained 6 to 12 hours on days 1, 2, and 3 after surgery
  - Patients with risk factors for CVD (smokers, HTN, HLD) has not been well studied, do not routinely screen

- Rationale for this screening recommendation is that a positive troponin will lead to recommendations for preventative therapies such as aspirin and statin and will prompt evaluation by additional EKGs that might not have otherwise been done.

Peri-operative Risk: BNP

- Pre- and Post- operative BNP is associated with an increased risk of MACE at 30 days
- Role in care of patients undergoing non-cardiac surgery not well established
- Some routinely order pro-BNP or BNP
- 2009 meta analysis, 7 studies, 2841 patients, statistically significant association between a preoperative BNP elevation and the CV outcomes of death, cardiac death, nonfatal MI at 30 days
- 2011 meta analysis evaluated mortality at 6 months or later came to a similar conclusion
Peri-operative Risk: Pulmonary Risk

- Post-operative Pulmonary conditions (PPCs) are most costly than cardiac and result in greater LOS
- Occurrence varies, 2-19%

Greatest considerations
- COPD, medically optimized?
- Age (greater than 60 yo)
- Tobacco use, cessation?→meta analyses found no increase in risks with short term (<4 week) cessation, quitting >4 weeks lowers risk PPCs
- NYHA II PHTN
- Mod/Severe OSA, medically optimized?
- Nutrition status, malnutrition or obesity

Intra-operative risk factors
- Surgery site (thoracic or abdominal)
- Duration of surgery
- General anesthesia
- Use of long-acting neuromuscular blockers
- Emergency surgery
Peri-operative Risk:
Pulmonary Risk, H&P, Laboratory Testing

- Post-operative Pulmonary conditions (PPCs) Management:
  - H&P: smoking history, environmental exposures, medications (bleomycin, amiodarone)
  - Chest X-ray and CT: Does not usually provide additional, profound information peri-operatively
  - Spirometry with or without measurements of lung volume and diffusion capacity: insufficient evidence to support the pre-operative spirometry to stratify PPC risk
    - Imaging and spirometry more of value in assessing patients with unexplained dyspnea
    - No evidence has found PFTs helpful when H&P clearly identified poor exercise tolerance/cause of dyspnea
- Exercise capacity (METS): estimates patient’s exercise capacity before they report shortness of breath
- Laboratory testing: BUN >30, albumin <3, low Hgb

Peri-operative Risk: Pulmonary Risk, Lung Expansion Maneuvers

- Post-operative Pulmonary conditions (PPCs) Prevention
- Incentive spirometry: lung expansion technique, data is contradictory regarding efficacy
  
  Tyson et al, 2015 took place at a single-center randomized controlled trial. Patients underwent exploratory showed patient education and unmonitored IS use did not improve pulmonary dynamics or reduce PPCs. However, patients post-operatively in the control and intervention groups participated in post-operative deep breathing exercises
- Deep breathing exercises: lung expansion including IMT (inspiratory muscle training) includes IS, active breathing techniques, and forced expiration
- Continuous positive airway pressure (CPAP): decreases re-intubation, PPCs, in patients undergoing thoracic and non-thoracic surgery
- Preoperative pulmonary rehabilitation
A 65-year-old male chronic smoker with a history of type 2 diabetes, obesity, chronic obstructive pulmonary disease, and hypertension presents for preoperative risk assessment before repair of an abdominal aortic aneurysm measuring 5.5 cm in diameter. He reports that he has no chest pain, shortness of breath, or other anginal symptoms at rest. He states that he can walk for a few minutes but has to stop after less than one block because of severe pain from osteoarthritis in both knees; he mainly uses a wheelchair for mobility. His current medications are lisinopril, metoprolol, atorvastatin, aspirin, metformin, insulin degludec, and an ipratropium inhaler.

On examination, he has a blood pressure of 117/82 mm Hg, a heart rate of 72 beats per minute, a respiratory rate of 14 breaths per minute, an oxygen saturation of 94% while he breathes ambient air, and a BMI of 37. He has normal jugular venous pressure and no carotid bruits. His lungs are clear to auscultation, without wheezing, and cardiac examination demonstrates a regular rate and rhythm, without murmurs, rubs, or gallops. Palpation of the abdomen reveals a pulsatile mass, without evidence of enlarged liver or spleen. Lower extremities are without edema and have normal strength. Both knees have diminished range of motion.

Laboratory testing is remarkable for a serum creatinine level of 2.1 mg/dL (reference range, 0.8–1.3), a hemoglobin concentration of 15 g/dL (13.5–17.5), and a glycated hemoglobin level of 6.9% (3.8–5.6).

An electrocardiogram documents sinus rhythm with a left bundle-branch block, which is chronic.
Which one of the following tests, if any, should be performed next in this patient?

- Regadenoson stress test with myocardial perfusion study
- Coronary angiography
- Dobutamine stress cardiac MRI
- Exercise stress test
- No further testing before surgery
Which one of the following tests, if any, should be performed next in this patient?

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June 4th, 2019

Guidelines call for additional testing if it will change perioperative management.

If testing reveals underlying CAD (they certainly have a high probability, based on risk factors), would additional intervention (i.e., perioperative revascularization) be warranted?...No

The CARP trial convincingly demonstrated that there is no difference in mortality between patients with stable CAD who were randomized to revascularization vs. no revascularization prior to high risk vascular surgery (which included AAA repair).

The patient in the scenario provided is already on excellent medical therapy with beta blocker, ACE-I, and a statin.

2014 guidelines also tell us: “It is not recommended that routine coronary revascularization be performed before noncardiac surgery exclusively to reduce perioperative CV events (Class III, level B)”

Would additional testing change management for this patient?...No

Not surprisingly...this question is in the process of being edited after a warranted uproar from Family Medicine physicians

- Endovascular repair?
- Obesity?
- COPD (risk of PPCs)?
Peri-operative risk

- Very high risk patients: optimally treat, possible referral to cardiologist for further evaluation
  - Recent MI (60 days)
  - USA
  - Decompensated HF
  - High-grade arrhythmias
  - Hemodynamically significant valvular disease (aortic stenosis)
    - Obtain ECHO if no prior ECHO within 1 year or significant change in clinical status or exam since last ECHO
    - Valve surgery, if indicated, to decrease perioperative risk
      - If no time for or cannot tolerate valve surgery: higher level of periop monitoring, IV fluid volume support, alpha agonist
Peri-operative Evaluation

- Biggest value is in discussion of risk with patients and referring physicians
- Targeting expected concerns during peri-operative period
- Collaborative approach, better informed consent (anti-platelets)
- Framework for monitoring
- CV risk important to understand, but pulmonary risks are important too!
Peri-operative Evaluation