Managing Cardiac & Pulmonary Risk in the Surgical Patient

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Preoperative Evaluation Guidelines

Cardiac:

Pulmonary:
Preoperative Cardiac Evaluation

Is this patient at increased risk for perioperative cardiac complications?

Does the patient need further preoperative medical tests to clarify this risk?

What should be done to reduce the risk of cardiac complications?

Clinical Risk Prediction

70-y.o. man with progressive weakness due to cervical myelopathy need spinal decompression & fusion. He needs help with some ADLs and walks slowly with a cane.

He has stable coronary artery disease & HTN
He is an active smoker.

What increases this patient’s risk for perioperative cardiac complications?
Question 1: What increases this patient’s risk for perioperative cardiac complications?

1. History of coronary disease
2. History of HTN
3. Current tobacco use
4. Limited functional status
5. All of the above

Identifying Higher Risk Patients

Known cardiovascular disease predicts risk
Atherogenic risk factors (except diabetes) do not

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischemic heart disease</td>
<td>2.4</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>1.9</td>
</tr>
<tr>
<td>Diabetes</td>
<td>2.8</td>
</tr>
<tr>
<td>History of Stroke or TIA</td>
<td>3.2</td>
</tr>
<tr>
<td>Poor functional status</td>
<td>1.8</td>
</tr>
</tbody>
</table>
### Surgery Specific Risk

<table>
<thead>
<tr>
<th>Level</th>
<th>Procedures</th>
</tr>
</thead>
</table>
| **High** | (> 5% risk)  
Major aortic or peripheral vascular surgery  
Emergent major surgery  
Long cases w/ large fluid shifts or blood loss |
| **Intermediate** | (< 5% risk)  
Carotid endarterectomy  
Head & Neck  
Abdominal & Thoracic  
Orthopedic |
| **Low** | (< 1% risk)  
Endoscopic procedures  
Skin & Breast |

### Revised Cardiac Risk Index

**Predictors:**
- Ischemic heart disease
- Congestive heart failure
- Diabetes requiring insulin
- Creatinine > 2 mg/dL
- Stroke or TIA
- “High Risk” operation  
  (intraperitoneal, intrathoracic, or suprainguinal vascular)

<table>
<thead>
<tr>
<th># of RCRI Predictors</th>
<th>Complications MI &amp; cardiac arrest</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.4%</td>
</tr>
<tr>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>2</td>
<td>2.4%</td>
</tr>
<tr>
<td>≥ 3</td>
<td>5.4%</td>
</tr>
</tbody>
</table>

RCRI > 2 is “Elevated Risk”

New Cardiac Risk Prediction Tool

Derived from National Surgical Quality Improvement Program (NSQIP) database:
• > 400,000 patients in derivation & validation cohorts
• Wide range of operations
• “Complication” = 30-day incidence of MI & cardiac arrest

<table>
<thead>
<tr>
<th>Independent Predictors</th>
<th>1. Type of surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Age</td>
</tr>
<tr>
<td></td>
<td>3. Serum creatinine &gt; 1.5 mg/dL</td>
</tr>
<tr>
<td></td>
<td>4. Functional status (dependency for ADLs)</td>
</tr>
<tr>
<td></td>
<td>5. American Society of Anesth (ASA) class</td>
</tr>
</tbody>
</table>


ASA Class (a brief digression)

American Society of Anesthesiologists Physical Classification

1. Healthy, normal
2. Mild systemic disease
3. Severe systemic disease
4. Severe systemic disease that is a constant threat to life
5. Moribund patient not expected to survive without surgery
70-y.o. with h/o CAD, now undergoing cervical spine surgery. Needs help with some ADLs.

Age 70
Cr < 1.5
ASA Class 3
Partially dependent
Spine surgery
70-y.o. with h/o CAD, stroke, IDDM undergoing cervical spine surgery for progressive weakness.

Estimated risk of perioperative myocardial infarction or cardiac arrest: 0.72%

www.qxmd.com/calculate-online/cardiology/gupta-perioperative-cardiac-risk

Other findings:
- Excellent performance (AUC = 0.88)

Caveats:
- Didn’t look at all possible variables (e.g., TTE, stress test)

Which Prediction Tool is Better?

<table>
<thead>
<tr>
<th></th>
<th>RCRI</th>
<th>NSQIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>~4000</td>
<td>~400,000</td>
</tr>
<tr>
<td># of hospitals</td>
<td>1</td>
<td>&gt; 200</td>
</tr>
<tr>
<td>Currency of data</td>
<td>’89 – ’94</td>
<td>’07 – ’08</td>
</tr>
<tr>
<td>Screen for MI?</td>
<td>CK-MB, ECG</td>
<td>No</td>
</tr>
</tbody>
</table>

Which to choose?
- 2014 ACC/AHA guideline endorses both tools
- Personal practice: use NSQIP when quantifying risk
ACC/AHA: When is Risk Excessive?

- Unstable coronary syndromes
  - Recent MI with post-infarct ischemia
  - Class III or IV angina
- Decompensated CHF
- Significant arrhythmia
  - High grade atroventricular block
  - Symptomatic ventricular arrhythmia
  - Supraventricular arrhythmia with uncontrolled rate
- Severe valve disease (e.g., critical aortic stenosis)

ACC/AHA: When is Risk Excessive?

Severe or unstable cardiac disease that requires urgent evaluation & treatment, regardless of planned surgery
Utility of Stress Testing

A 63 y.o. man will undergo a Whipple procedure for newly diagnosed pancreatic cancer. He had a remote myocardial infarction, diabetes, and HTN. He has not had chest pain in the past year.

- **Meds:** lovastatin, atenolol, glyburide, benazepril, ASA
- **PEx:** BP=115 / 70 HR=60; normal heart & lung exam
- **ECG:** NSR, LVH, otherwise normal

**Should this patient receive further preoperative tests?**

**Question 2:**

63 y.o. man s/f Whipple procedure. Remote MI, long-standing diabetes & HTN. No chest pain.

Should this patient receive further preoperative tests?

1. No further testing
2. Yes, exercise ECG
3. Yes, nuclear scintigraphy
Noninvasive Stress Testing

Predictive value:
• Mainly studied in vascular surgery patients
• Strong negative predictive value ~ 98% (neg LR = 0.1 - 0.2)
• Weak positive predictive value ~10 - 20% (pos LR = 2 - 3)
• Adds little information to lower risk patients
• More useful for cases with increased risk

Stress Tests: More Useful in Patients at Higher Risk

Pretest Probability = 1%  (e.g. TKA)
• Positive Test: Posttest probability = 2 - 3%
• Negative Test: Posttest probability = 0 - 1%

Pretest Probability = 10%  (e.g. AAA repair)
• Positive Test: Posttest probability = 18-25%
• Negative Test: Posttest probability = 2%
Revascularization

You diagnose a 63 y.o. man with resectable pancreatic cancer. He has known coronary disease. P-Mibi & angiography last year showed mild inferior reversibility and a 75% RCA lesion and normal LVEF. He did not receive PCI.

Meds: lovastatin, atenolol, benazepril, ASA
PEx: BP=115 / 70 HR=60; normal CV & lung exam

Should this patient have coronary revascularization?
Question 3:

63 y.o. man with CAD undergoing Whipple procedure. His P-Mibi showed mild inferior reversibility. Angiogram showed a 75% RCA lesion and normal LVEF.

1. No, proceed to surgery
2. Consult cardiologist for possible PCI

CARP Trial: Coronary Artery Revascularization Prophylaxis

510 patients undergoing vascular surgery
- At least 1 vessel with 70% occlusion
- Excluded left main dz, AS, or LVEF < 20%

Choice of CABG or PCI plus Medical management

Medical management alone

1° Endpoint: Long-term mortality
2° Endpoint: MI, Stroke, Limb loss, Dialysis

McFalls, et al. NEJM, 2004
CARP: Complications After CABG or PCI

<table>
<thead>
<tr>
<th>Complication</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>1.7%</td>
</tr>
<tr>
<td>MI</td>
<td>5.8%</td>
</tr>
<tr>
<td>Reoperation</td>
<td>2.5%</td>
</tr>
</tbody>
</table>


CARP: Outcomes After Vascular Surgery

<table>
<thead>
<tr>
<th></th>
<th>Revascularized (n=225)</th>
<th>Med Mgt Only (n=237)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death before surgery</td>
<td>10 (4%)</td>
<td>1</td>
</tr>
<tr>
<td>Death &lt; 30 days post-op</td>
<td>7 (3%)</td>
<td>8 (3%)</td>
</tr>
<tr>
<td>Postoperative MI</td>
<td>26 (12%)</td>
<td>34 (14%)</td>
</tr>
<tr>
<td>Long-term mortality (2.7 yrs after randomization)</td>
<td>70 (22%)</td>
<td>67 (23%)</td>
</tr>
</tbody>
</table>

p = NS for all comparisons

ACC/AHA Guidelines for PCI

• Indications for PCI are same as for nonsurgical patients
• Avoid PCI if antiplatelet drugs will need to be held prematurely
• Delay elective surgery after elective PCI:
  - Bare metal stent: 30 days
  - Drug eluting stent: 6 months (optimal)
    3 months (if harm in delay)
• Continue or restart antiplatelet agents (especially ASA) as soon as possible, unless bleeding risk precludes

Beta-blockers

A 75 y.o. woman with diabetes and HTN will undergo revision of an infected knee arthroplasty. Denies cardiac history or symptoms. She is not on a beta-blocker.

Her examination and ECG are unremarkable.

Should this patient be started on a beta-blocker?
Question 4:

75 y.o. woman with stable coronary disease and HTN will undergo hip fracture repair. Not currently on β-blocker.

Should this patient be started on a beta-blocker now?

1. Oh yeah, definitely
2. Probably
3. Probably not
4. Are you crazy? No!

POISE: Biggest β-blocker Trial

Patients: 8351 pts with s/f major noncardiac surgery
• CAD, CHF, CVA/TIA, CKD, DM, or high-risk surgery
• Not already taking β-blocker

2-4 h OR 0-6 h 12 h
1st dose 2nd dose 3rd & daily dose
Metoprolol XL Metoprolol XL Metoprolol XL
100 mg* 100 mg* 200 mg*^

* Study drug held for SBP < 100 or HR < 50
^ Daily dose reduced to 100 mg if persistent bradycardia or hypotension

Outcome: 30-day cardiac mortality, nonfatal arrest or MI

POISE: Results

Metoprolol XL:
- Reduced cardiac events (mostly nonfatal MI)
- Increased risk of stroke & total mortality

2014 ACC / AHA Guideline for β-blockers

Definite indications to continue if… (Helps)
- Already using β-blocker to treat angina, HTN, arrhythmia

Reasonable to consider initiation if… (Maybe)
- High clinical risk (RCRI score ≥ 3)
- Ischemia seen on preoperative stress test
- Compelling indication for long-term beta-blockade

Avoid initiation… (Harms)
- On day of surgery
Take Home Points

Use a validated clinical prediction tool:
- RCRI is easy to use & has become the “new standard”
- NSQIP tool may be more broadly applicable

Reserve stress testing for highest risk patients:
- Elevated risk and poor functional status
- Only do stress test if results will change management (e.g., cancel, delay, or modify surgery)

Take Home Points

Beware perioperative coronary revascularization:
- Indications are the same as for non-surgical patients
- Don’t perform PCI if patient may have upcoming surgery that requires stopping antiplatelet therapy

Beta-blockers:
- Only consider starting in very high risk patients after considering risks
- Start cautiously at least 1 day prior to surgery
Preoperative Pulmonary Evaluation

Is this patient at increased risk for perioperative pulmonary complications?

Does the patient need further preoperative medical tests to clarify this risk?

What should be done to reduce the risk of pulmonary complications?
Pulmonary Risk Prediction

A 65 y.o. man is to undergo repair of an abdominal aortic aneurysm. He has COPD and continues to smoke. He denies change in cough, or worsening of his chronic dyspnea when walking uphill.

Exam: Resp Rate 20 O₂ sat 95% RA
Lungs: prolonged expiration, no wheeze

What do you recommend for this patient?

Question 5:
65 y.o. man is s/f repair of an AAA. He has COPD and smokes. No change in cough or usual chronic dyspnea.

What do you recommend for this patient?

1. Obtain PFTs
2. Quit smoking first
3. Incentive spirometry after surgery
Pathophysiology of Postoperative Pulmonary Complications

Normal

- Tidal Breathing

Decreased FRC

- Incisional pain
- Anesthesia
- Supine position

Abnormally high Closing Volume

- Age
- COPD
- Smoking

Procedure Related Risk Factors

<table>
<thead>
<tr>
<th>Surgical Site</th>
<th>Risk Factor</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurosurgery</td>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td>Head &amp; Neck</td>
<td></td>
<td>2.2</td>
</tr>
<tr>
<td>Aortic</td>
<td></td>
<td>6.9</td>
</tr>
<tr>
<td>Thoracic</td>
<td></td>
<td>4.2</td>
</tr>
<tr>
<td>Abdominal</td>
<td></td>
<td>3.0</td>
</tr>
<tr>
<td>Vascular</td>
<td></td>
<td>2.1</td>
</tr>
<tr>
<td>Emergency surgery</td>
<td></td>
<td>2.2</td>
</tr>
<tr>
<td>Prolonged surgery</td>
<td></td>
<td>2.3</td>
</tr>
<tr>
<td>General anesthesia</td>
<td></td>
<td>1.8</td>
</tr>
</tbody>
</table>
### Patient Related Risk Factors

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 60 - 69</td>
<td>2.3</td>
</tr>
<tr>
<td>Age 70 - 79</td>
<td>5.6</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>2.9</td>
</tr>
<tr>
<td>COPD</td>
<td>2.4</td>
</tr>
<tr>
<td>ASA Class ≥ II vs. Class I</td>
<td>Odds ratio = 4.9</td>
</tr>
<tr>
<td>ASA Class ≥ III vs. Class I or II</td>
<td>Odds ratio = 3.1</td>
</tr>
</tbody>
</table>

Class I: no systemic disease
Class II: mild systemic disease
Class III: severe systemic disease
Class IV: systemic disease that is a constant threat to life

### Respiratory Failure Prediction Tool

- Derived from National Surgical Quality Improvement Program (NSQIP) database:
  - > 400 K patients in derivation & validation cohorts
  - Wide range of operations
  - “Respiratory Failure” = on vent > 48 hrs or reintubation

<table>
<thead>
<tr>
<th>Independent Predictors</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. American Society of Anesth (ASA) class</td>
<td></td>
</tr>
<tr>
<td>2. Functional status (dependency)</td>
<td></td>
</tr>
<tr>
<td>3. Type / location of surgery</td>
<td></td>
</tr>
<tr>
<td>4. Emergency surgery</td>
<td></td>
</tr>
<tr>
<td>5. Preoperative sepsis or SIRS</td>
<td></td>
</tr>
</tbody>
</table>

Emergency surgery? No

ASA Class 3 (severe systemic)

Function/dependency Independent

Surgery type Aortic

Sepsis or SIRS? No

Estimated risk of postoperative respiratory failure: 6.7 %
Pulmonary Function Tests & Spirometry

PFTs & spirometry add little to risk assessment
- Usually just tells you what you already know
- Abnormal chest exam findings more predictive of PPC
- Can’t use results to identify patients with prohibitively high risk of PPC or mortality
- Use as diagnostic tool to evaluate unexplained findings
- Maybe to assess whether COPD patients are at baseline (if clinical judgment equivocal)

Preoperative Prevention Strategies

Optimize chronic lung disease
- Treat COPD exacerbation (steroids, antibiotics)

Smoking cessation
- Limited evidence for benefit for PPC but other benefits
- May require 8 weeks of cessation for benefit

Respiratory conditioning
- Education on lung expansion & Inspiratory muscle training
- Benefit seen in RCTs in cardiac surgery

Nutrition
- No benefit to hyperalimentation (enteral or TPN)
Preoperative Smoking Cessation Counseling

RCTs of Preoperative Smoking Cessation Counseling:
1. 120 patients undergoing arthroplasty in 6-8 weeks
2. 60 patients undergoing colorectal resection in 2-3 weeks

Intervention: Smoking cessation counseling & offer free nicotine replacement products

Outcomes: Postop complications, especially wound related (e.g., dehiscence, infection, hematoma)

Smoking Cessation 6-8 Weeks Before TKA or THA

Moller et al. Lancet, 2002
Smoking Cessation 2-3 Weeks Before Colorectal Surgery

Lung expansion maneuvers
- Deep breathing or incentive spirometry recommended, though quality of evidence poor
- Consideration of CPAP for very high risk patients

I COUGH – a multi-intervention strategy to prevent PPC
- Incentive spirometry, Coughing & deep breathing, Oral care, Understanding, Get out of bed tid, Head of bed elevated
- Reduced postop pneumonia and unplanned reintubation

Causes of Postoperative Hypoxemia

Upper airway obstruction
• Early onset - often POD 0 or prior to leaving PACU
• Airway edema, vocal cord injury, laryngospasm, OSA

Atelectasis
• Often onset POD 1-2
• Secretion management: chest therapy, pulmonary toilet
• Positive airway pressure: CPAP, BiPAP, EzPAP

Pulmonary edema
• Often onset by POD 2
• Cardiogenic vs. non-cardiogenic

Pneumonia
• Most common in first 5 days postop (unless on ventilator)
• Think Staph aureus & gram negative rods
• Pseudomonas? Risk with ≥ 5 days hospitalization or prior antibiotic exposure, dialysis, nursing home

Other etiologies:
• Pulmonary embolism
• Bronchospasm
• Effusions – common after abdominal surgery, usually small, exudative and usually don’t require treatment
Take Home Points

Patient related risks:
• Elderly
• COPD
• Severe medical comorbidity
• Functionally dependent or generally debilitated

Procedure related risks:
• Thoracic surgery
• Abdominal surgery
• Emergency surgery
• Prolonged surgery > 3 hrs
• General anesthesia

Take Home Points

Chest x-rays and PFTs:
• Should not be done routinely
• Consider spirometry to evaluate unexplained symptoms

Risk Reduction:
• Patients at increased risk for pulmonary complications should receive lung expansion maneuvers
• Smoking cessation likely beneficial but may require two months lead time to be effective
Thank You

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