Managing Cardiac & Pulmonary Risk in the Surgical Patient

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Preoperative Evaluation Guidelines

Cardiac:


Pulmonary:

The Pirate's Code states that you must release me! The Code is more what you'd call "guidelines" than actual rules.
Clinical Risk Prediction

A 73 y.o. smoker will undergo aorto-femoral bypass for a non-healing LE ulcer. He has no cardiac history, but has long-standing diabetes & HTN.

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

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

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

1. Just the type of surgery
2. Type of surgery & history of diabetes
3. Type of surgery, h/o diabetes & h/o HTN
4. Type of surgery, diabetes, HTN & smoking
Identifying Higher Risk Patients

<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>Risk Category</th>
<th>Surgery Types</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

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Complications**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher risk operation*</td>
<td>0.5%</td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>1.3%</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>4%</td>
</tr>
<tr>
<td>Diabetes requiring insulin</td>
<td>9%</td>
</tr>
<tr>
<td>Creatinine &gt; 2 mg/dL</td>
<td></td>
</tr>
<tr>
<td>Stroke or TIA</td>
<td></td>
</tr>
</tbody>
</table>

* Defined as intraperitoneal, intrathoracic, or suprainguinal vascular surgery  
** Defined as MI, pulmonary edema, cardiac arrest, complete heart block  

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 atrioventricular 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. Go to O.R. without further testing
2. Noninvasive stress test

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%
770 vascular patients with 1 or 2 of following:
Age > 70, MI, angina, CHF, DM, stroke / TIA, Cr > 1.8

No stress test (n = 384)
Stress test (n = 386)

352 with no or limited ischemia
1.8%

34 with extensive ischemia (9%):
12 had PCI or CABG
15%

2.3%

30-day CV Death or MI

2007 ACC/AHA Guideline

Good Functional Capacity?

yes

no or ?

no predictors*

1 or 2 predictors

≥ 3 predictors

Go to OR

Control HR & go to OR (IIa)

Vascular surgery?

yes

no

Consider stress test if results will change management (IIa)

* CAD, CHF, DM, CKD, CVA/TIA

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

Who do you consult?
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. Consult general surgeon for planned operation
2. Consult cardiac surgeon for potential CABG
3. Consult invasive 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 death</td>
<td>70 (22%)</td>
<td>67 (23%)</td>
</tr>
<tr>
<td>Required later revasc</td>
<td>21 (8%)</td>
<td></td>
</tr>
</tbody>
</table>

p = NS for all comparisons

Beware of Coronary Stents

<table>
<thead>
<tr>
<th>Risk Factor for Cardiac Mortality (192 patients having surgery after stenting)</th>
<th>Cardiac Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Surgery Bare-metal stent &lt; 4 wk Drug-eluting stent &lt; 3-6 mo</td>
<td>RF+ 13%</td>
</tr>
<tr>
<td>Antiplatelet drugs held for surgery</td>
<td>RF- 0.6%</td>
</tr>
<tr>
<td>Antiplatelet drugs held &amp; early surgery (versus continued therapy &amp; early surgery)</td>
<td>5.5%</td>
</tr>
<tr>
<td></td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>31%</td>
</tr>
<tr>
<td></td>
<td>0%</td>
</tr>
</tbody>
</table>

Schouten O, et al. JACC, 2007

Effects of Delaying Surgery: BMS

Bare Metal Stent:
- Significant drop in risk after first month
- Brief delay useful

Drug Eluting Stent:
- Risk remains steady for first 12 months
- Brief delay low yield
ACC/AHA Guidelines for PCI

- Avoid PCI if patient may have upcoming surgery that requires stopping dual antiplatelet therapy
- Delay elective surgery in patients with recent PCI
  - Balloon angioplasty: 2 - 4 weeks
  - Bare metal stent: 4 weeks
  - Drug eluting stent: 12 months
- If clopidogrel must be stopped, try to continue ASA
- No evidence for bridging with anticoagulants or glycoprotein inhibitors

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 DM & HTN will undergo hip fracture repair. No cardiac history or symptoms. Not on β-blocker. Should this patient be started on a beta-blocker?

1. Oh yeah, definitely
2. Probably
3. Probably not
4. Are you crazy? No!
111 patients undergoing vascular surgery
- All had ischemic potential on dobutamine echo
- Randomized to beta-blocker started 2 weeks preop

Bisoprolol

POISE: Treatment Protocol

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
DECREASE-IV

**Patients:** 1066 pts with estimated 1-6% risk of postoperative cardiac complications, undergoing elective non-CV surgery

**Treatment:**
1. Bisoprolol 2.5 mg daily started at randomization; 
   -- dose titrated in hospital by 1.25 - 2.5 mg daily; 
   -- maximum 10 mg daily; 
   -- target heart rate = 50-70 with SBP >100
2. Fluvastatin XL 80 mg daily
3. Bisoprolol + Fluvastatin
4. Double placebo

• Drugs started median 34 days prior to surgery

**Outcome:** 30-day cardiovascular mortality or nonfatal MI


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DECREASE-IV Results

**Bisoprolol-treated patients had fewer complications**

**Trend towards benefit with statins**

**No safety issues**

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Lessons from POISE & DECREASE-IV

Beta-blockers clearly do prevent postoperative MI

Aggressive β-blockade causes hypotension and bradycardia, leading to stroke & death

✓ Initiating β-blockade immediately prior to surgery may increase risk

✓ Gradual postoperative dose titration may be safer than trying to achieve target HR before surgery

✓ Avoid one-size-fits-all approach to dosage
2009 ACC / AHA Guideline for β-blockers

Definite indications (Class 1):
• Already using β-blocker to treat angina, HTN, arrhythmia

Probable indications (Class 2a):
• Vascular or intermediate-to-high risk surgery patients with coronary disease, or more than 1 risk predictor *

Uncertainty (Class 2b):
• Patients undergoing vascular or intermediate risk surgery without coronary disease & with only 1 risk predictor *

* CAD, CHF, DM, CKD, CVA/TIA

Statins: DECREASE-III

Patients: 497 statin naive pts s/f major vascular surgery
• All patients also maintained or started on beta-blocker
Treatment: Fluvastatin XL 80 mg daily or placebo
• Median 37 days of treatment prior to surgery
Outcomes:
• Composite of cardiovascular death and nonfatal MI
• Safety outcome: CPK and ALT elevation

Schouten et al. NEJM 2009

DECREASE III: Results

Fluvastatin XL:
• Reduced incidence of ischemia
• Reduced the composite outcome of cardiac death & nonfatal MI
• No difference in rates of LFT or CPK elevation

Schouten et al. NEJM 2009
ACC/AHA Guidelines: Perioperative Statins

Definite indications (Class 1):
- Already taking statin prior to surgery

Probable indications (Class 2a):
- All vascular surgery patients, regardless of cholesterol

Possible indications (Class 2b):
- At least one risk predictor* in any intermediate risk surgery

*Coronary disease, renal insufficiency, diabetes, CVA/TIA

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Take Home Points

Be familiar with the Revised Cardiac Risk Index:
- Easy to use & has become the “new standard”

Reserve stress testing for highest risk patients:
- Vascular surgery patients with multiple RCRI predictors
- Limited ischemia generally predicts acceptable risk
- Extensive ischemia in vascular patients predicts high risk that may not be modifiable -- will you cancel surgery?

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Take Home Points

Avoid 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 & Statins:
- Start β-blocker cautiously & only in higher risk pts
- Start statins in vascular (? and other higher risk) surgery patients
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?
Procedure Related Risk Factors

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurosurgery</td>
<td>2.5</td>
</tr>
<tr>
<td>Head &amp; Neck</td>
<td>2.2</td>
</tr>
<tr>
<td>Aortic</td>
<td>6.9</td>
</tr>
<tr>
<td>Thoracic</td>
<td>4.2</td>
</tr>
<tr>
<td>Abdominal</td>
<td>3.0</td>
</tr>
<tr>
<td>Vascular</td>
<td>2.1</td>
</tr>
<tr>
<td>Emergency surgery</td>
<td>2.2</td>
</tr>
<tr>
<td>Prolonged surgery</td>
<td>2.3</td>
</tr>
<tr>
<td>General anesthesia</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>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>Cigarette smoking</td>
<td>1.4</td>
</tr>
<tr>
<td>Dependence in ADLs</td>
<td>1.6</td>
</tr>
<tr>
<td>Unplanned weight loss</td>
<td>1.6</td>
</tr>
<tr>
<td>Heavy alcohol use</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Effect of Comorbidity on Risk

American Society of Anesthesiologists Classification

- 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

ASA Class ≥ II vs. Class I  Odds ratio = 4.9
ASA Class ≥ III vs. Class I or II  Odds ratio = 3.1
Obstructive Sleep Apnea

Case-control study with 101 orthopedic patients with sleep apnea matched with non-apneic controls

A third of patients with OSA were undiagnosed prior to surgery

<table>
<thead>
<tr>
<th>Complication</th>
<th>Control</th>
<th>Old OSA dx</th>
<th>New OSA dx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unplanned ICU</td>
<td>6%</td>
<td>12%</td>
<td>33%</td>
</tr>
<tr>
<td>Any Complication</td>
<td>18%</td>
<td>32%</td>
<td>50%</td>
</tr>
<tr>
<td>Length of Stay</td>
<td>5.1 d</td>
<td>6.4 d</td>
<td>7.4 d</td>
</tr>
</tbody>
</table>


Screening for OSA

STOP:
- Snoring
- Tired during day
- Observed Apnea
- Pressure (hypertension)

Presence of 2 or more features:
- 78% PPV for sleep apnea
- Associated with RR ~2.5 for pulmonary complication


Predictive Value of Spirometry

<table>
<thead>
<tr>
<th>Study</th>
<th>Surgery</th>
<th>RR associated with abnormal spirometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Svensson, 1991</td>
<td>Aortic</td>
<td>1.5 (0.9 - 2.1)</td>
</tr>
<tr>
<td>Kispert, 1992</td>
<td>Vascular</td>
<td>3.8 (1.5-10.1)</td>
</tr>
<tr>
<td>Kroenke, 1993</td>
<td>Abd. &amp; Thoracic</td>
<td>1.4 (0.9-2.1)</td>
</tr>
<tr>
<td>Kocabas, 1996</td>
<td>Upper Abdominal</td>
<td>1.7 (0.9-3.3)</td>
</tr>
<tr>
<td>Bando, 1997</td>
<td>Cardiac</td>
<td>1.0 (0.5-2.2)</td>
</tr>
<tr>
<td>Jacob, 1997</td>
<td>CABG</td>
<td>0.9 (0.6-1.3)</td>
</tr>
</tbody>
</table>

Smetana, NEJM 1997
Can Spirometry Identify Patients with Prohibitive Risk?

Studies of 107 surgical patients with severe COPD (FEV₁ < 50% predicted):
- 6% overall mortality

Patients with cor pulmonale, CO₂ retention, or FEV₁ ≤ 450 mL still had acceptable surgical mortality rates.²

1. Kroenke, Arch Int Med 1992
2. Various

Effect of Smoking Cessation

<table>
<thead>
<tr>
<th>Time since quitting</th>
<th>Complication Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never quit</td>
<td></td>
</tr>
<tr>
<td>Less than 2 weeks</td>
<td></td>
</tr>
<tr>
<td>2 - 4 weeks</td>
<td></td>
</tr>
<tr>
<td>4 - 8 weeks</td>
<td></td>
</tr>
<tr>
<td>8 or more weeks</td>
<td></td>
</tr>
<tr>
<td>Non-smokers</td>
<td></td>
</tr>
</tbody>
</table>

Warner, Anesthesiology 1984

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 at weekly meetings
(or by telephone) & 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

Møller et al. Lancet, 2002

Smoking Cessation 2-3 Weeks Before Colorectal Surgery

Sørensen, et al. Colorectal Dis, 2003

ACP: Postoperative Interventions to Reduce Risk

Lung expansion maneuvers:
- Deep breathing exercises
- Incentive spirometry
- Chest physiotherapy
- CPAP
- IPPB
- Some studies show maneuvers reduce complications
- No clear evidence one intervention better than others
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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