Cardiac Preoperative Evaluation

Prior To Non-cardiac Surgery

Sandra Keavey, DHSc, DFAAPA, PA-C
Scope of the Problem

* Cardiovascular complications are the most common cause of death among patients undergoing non cardiac surgery.

* Incidence of peri-operative MI has not changed in 2 decades.

* Peri-operative myocardial infarction has a 20-30% mortality.

* Peri-operative ischemia is an independent predictor of cardiac death and myocardial infarction during the 2 years after surgery.

* Cardiac complications after non-cardiac surgery prolong hospitalization by a mean of 11 days.

Sun and Maguire American Heart Journal December 2007
Inevitably....

- The process of peri-operative evaluation has become synonymous with peri-operative cardiac evaluation.
- And this will likely continue for the foreseeable future.
- An increasing proportion of patients undergoing surgery are elderly, have cardiovascular disease or have her risk factors for heart disease.
- In addition, the trauma of surgery itself can initiate physiologic responses that can result in coronary plaque rupture, myocardial injury or the arrhythmias.
Scope of the Problem

• Each year 44 million procedures are performed in the US.

• 1/3 of these procedures are performed on patients greater than 65.

• 30% of patients undergoing surgery have CAD. Many more have risk factors for CAD.

• Factors that increase risk in the peri-operative period:
  • anesthesia
  • intubation/extubation
  • pain, fasting
  • hypothermia
  - stress steroid surges
  - blood loss
  - thrombophilia
  - hypercoaguability
## Mortality of Common Surgical Procedures

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<th>Procedure</th>
<th>30 day mortality (%)</th>
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<tr>
<td>Hip arthroplasty</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3.2</strong></td>
</tr>
</tbody>
</table>

• What is often left on said however in the retelling of these otherwise grim statistics, is the fact that peri-operative cardiac complications are uncommon in that most patients survive their surgery, surgeons and anesthesiologists.

• This is data from the VA quality improvement project which reviewed several common operations involving over 60,000 patients. As you can see, the operative mortality for most non-cardiac operations, including major vascular surgery, is in the order of 5%.

• Therefore, the vast majority of patients can undergo surgery safely, and the pre-surgical evaluation is essentially an attempt to identify the few patients at risk for complications.
What To Look For

• Utilizing this framework, a majority of your patients can be evaluated with a carefully taken history, physical examination and an ECG to:
  • Determine the risks specific to the planned procedure
  • Search for active/unstable conditions
  • Recognize co-morbid conditions
  • Evaluate the patients functional capacity
What You Provide-Not Medical Clearance

- Identify the patients risk profile
- Decide whether additional testing is necessary
- Make recommendations to reduce the risk
- Provide a risk profile and recommended testing and steps to reduce risk.
2007 ACC/AHA Peri-operative Guidelines – Step 1

Step 1
Need for emergency noncardiac surgery?
Yes (Class I, LOE C) → Operating room → Perioperative surveillance and postoperative risk stratification and risk factor management
No

Step 2
Active cardiac conditions?
Yes (Class I, LOE B) → Evaluate and treat per ACC/AHA guidelines → Consider operating room
No

Step 3
Low risk surgery
Yes (Class I, LOE B) → Proceed with planned surgery
No

Step 4
Good functional capacity (MET level greater than or equal to 4) without symptoms?
Yes (Class I, LOE B) → Proceed with planned surgery
No or unknown

Step 5
Vascular surgery
Class IIa, LOE B → Consider testing if it will change management
Intermediate risk surgery
Proceed with planned surgery
If it will change management
Intermediate risk surgery
Vascular surgery

1 or 2 clinical risk factors?
No clinical risk factors?
Class IIa, LOE B → Proceed with planned surgery

3 or more clinical risk factors?
### Active Cardiac Conditions for Which the Patient Should Undergo Evaluation and Treatment Before Noncardiac Surgery

<table>
<thead>
<tr>
<th>Condition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstable coronary syndromes</td>
<td>Unstable or severe angina. (CCS class III or IV)</td>
</tr>
<tr>
<td></td>
<td>Recent MI</td>
</tr>
<tr>
<td>Decompensated HF</td>
<td>NYHA functional class III - IV</td>
</tr>
<tr>
<td></td>
<td>worsening or new-onset HF</td>
</tr>
<tr>
<td>Significant arrhythmias</td>
<td>High-grade atioventricular block</td>
</tr>
<tr>
<td></td>
<td>Mobitz II atioventricular block</td>
</tr>
<tr>
<td></td>
<td>Third-degree atioventricular heart block</td>
</tr>
<tr>
<td></td>
<td>Symptomatic ventricular arrhythmias</td>
</tr>
<tr>
<td></td>
<td>Supraventricular arrhythmias (including atrial fibrillation)</td>
</tr>
<tr>
<td></td>
<td>with uncontrolled ventricular rate (HR greater than 100 bpm at rest)</td>
</tr>
<tr>
<td></td>
<td>Symptomatic bradycardia</td>
</tr>
<tr>
<td></td>
<td>Newly recognized ventricular tachycardia</td>
</tr>
<tr>
<td>Severe valvular disease</td>
<td>Severe aortic stenosis (mean pressure gradient greater than 40 mm Hg, aortic valve area</td>
</tr>
<tr>
<td></td>
<td>less than 1.0 cm², or symptomatic)</td>
</tr>
<tr>
<td></td>
<td>Symptomatic mitral stenosis (progressive dyspnea on exertion, exertional presyncope, or HF)</td>
</tr>
</tbody>
</table>
2007 ACC/AHA Perioperative Guidelines – Step 3

Step 1
Need for emergency noncardiac surgery?
- Yes (Class I, LOE C)
  - Operating room
  - Perioperative surveillance and postoperative risk stratification and risk factor management
- No

Step 2
Active cardiac conditions?
- Yes (Class I, LOE B)
  - Evaluate and treat per ACC/AHA guidelines
  - Consider operating room
- No

Step 3
Low risk surgery
- Yes (Class I, LOE B)
  - Proceed with planned surgery
- No

Step 4
Good functional capacity (MET level greater than or equal to 4) without symptoms†
- Yes (Class I, LOE B)
  - Proceed with planned surgery
- No or unknown
  - 3 or more clinical risk factors‡
    - Vascular surgery
      - Class IIa, LOE B
        - Consider testing if it will change management§
  - 1 or 2 clinical risk factors‡
    - Intermediate risk surgery
      - Proceed with planned surgery with HR control§ (Class IIa, LOE B) or consider noninvasive testing (Class IIb, LOE B) if it will change management
    - No clinical risk factors‡
      - Proceed with planned surgery
What is the Risk of the Planned Procedure?

<table>
<thead>
<tr>
<th>Risk stratification</th>
<th>Procedure examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular (reported cardiac risk often more than 5 percent)</td>
<td>Aortic and other major vascular surgeries</td>
</tr>
<tr>
<td></td>
<td>Peripheral vascular surgery</td>
</tr>
<tr>
<td>Intermediate (reported cardiac risk generally 1 to 5 percent)</td>
<td>Intra-peritoneal and intrathoracic surgeries</td>
</tr>
<tr>
<td></td>
<td>Carotid endarterectomy</td>
</tr>
<tr>
<td></td>
<td>Head and neck surgery</td>
</tr>
<tr>
<td></td>
<td>Orthopedic surgery</td>
</tr>
<tr>
<td></td>
<td>Prostate surgery</td>
</tr>
<tr>
<td>Low † (reported cardiac risk generally less than 1 percent)</td>
<td>Endoscopic, superficial, or cataract procedures</td>
</tr>
<tr>
<td></td>
<td>Breast or ambulatory surgery</td>
</tr>
</tbody>
</table>
2007 ACC/AHA Peri-operative Guidelines – Step 4

Step 1: Need for emergency noncardiac surgery?
- Yes (Class I, LOE C) -> Operating room -> Perioperative surveillance and postoperative risk stratification and risk factor management
- No

Step 2: Active cardiac conditions
- Yes (Class I, LOE B) -> Evaluate and treat per ACC/AHA guidelines -> Consider operating room
- No

Step 3: Low risk surgery
- Yes (Class I, LOE B) -> Proceed with planned surgery
- No

Step 4: Good functional capacity (MET level greater than or equal to 4) without symptoms
- Yes (Class I, LOE B) -> Proceed with planned surgery
- No

Step 5: No or unknown
- 3 or more clinical risk factors
  - Vascular surgery
    - Class IIa, LOE B -> Consider testing if it will change management
  - Intermediate risk surgery
    - Proceed with planned surgery with HR controls (Class IIa, LOE B) or consider noninvasive testing (Class IIb, LOE B) if it will change management
- 1 or 2 clinical risk factors
  - Vascular surgery
  - Intermediate risk surgery
- No clinical risk factors
  - Class I, LOE B

Proceed with planned surgery
Functional Capacity and Outcomes

- Oxygen uptake, measured in metabolic equivalents or METs, is considered the best measure of cardiovascular fitness and exercise capacity.
- Functional capacity is measured by the number of METs a person can achieve on a regular basis.
  - Excellent > 10 METS
  - Good 7 – 10 METS
  - Moderate 4 – 7 METS
  - Poor < 4 METS
<table>
<thead>
<tr>
<th>Physical activity</th>
<th>MET</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Light intensity activities</strong></td>
<td></td>
</tr>
<tr>
<td>sleeping</td>
<td>0.9</td>
</tr>
<tr>
<td>watching television</td>
<td>1.0</td>
</tr>
<tr>
<td>writing, desk work, typing</td>
<td>1.8</td>
</tr>
<tr>
<td>walking, 1.7 mph (2.7 km/h), level ground, strolling, very slow</td>
<td>2.3</td>
</tr>
<tr>
<td>walking, 2.5 mph (4 km/h)</td>
<td>2.9</td>
</tr>
<tr>
<td><strong>Moderate intensity activities</strong></td>
<td>3 to 6</td>
</tr>
<tr>
<td>bicycling, stationary, 50 watts, very light effort</td>
<td>3.0</td>
</tr>
<tr>
<td>walking 3.0 mph (4.8 km/h)</td>
<td>3.3</td>
</tr>
<tr>
<td>calisthenics, home exercise, light or moderate effort, general</td>
<td>3.5</td>
</tr>
<tr>
<td>walking 3.4 mph (5.5 km/h)</td>
<td>3.6</td>
</tr>
<tr>
<td>bicycling, &lt;10 mph (16 km/h), leisure, to work or for pleasure</td>
<td>4.0</td>
</tr>
<tr>
<td>bicycling, stationary, 100 watts, light effort</td>
<td>5.5</td>
</tr>
<tr>
<td><strong>Vigorous intensity activities</strong></td>
<td>&gt; 6</td>
</tr>
<tr>
<td>jogging, general</td>
<td>7.0</td>
</tr>
<tr>
<td>calisthenics (e.g. pushups, situps, pullups, jumping jacks), heavy, vigorous effort</td>
<td>8.0</td>
</tr>
<tr>
<td>running jogging, in place</td>
<td>8.0</td>
</tr>
<tr>
<td>rope jumping</td>
<td>10.0</td>
</tr>
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2007 ACC/AHA Peri-operative Guidelines – Step 4

Step 1: Need for emergency noncardiac surgery?
- Yes (Class I, LOE C) → Operating room → Perioperative surveillance and postoperative risk stratification and risk factor management
- No → Step 2

Step 2: Active cardiac conditions*
- Yes (Class I, LOE B) → Evaluate and treat per ACC/AHA guidelines → Consider operating room
- No → Step 3

Step 3: Low risk surgery
- Yes (Class I, LOE B) → Proceed with planned surgery
- No → Step 4

Step 4: Good functional capacity (MET level greater than or equal to 4) without symptoms†
- Yes (Class I, LOE B) → Proceed with planned surgery
- No or unknown → Step 5

Step 5:
- No or unknown →
  - 3 or more clinical risk factors‡ → Consider testing if it will change management§
  - 1 or 2 clinical risk factors‡ → Proceed with planned surgery with HR control§ (Class IIa, LOE B) or consider noninvasive testing (Class IIb, LOE B) if it will change management
  - No clinical risk factors§ → Proceed with planned surgery

* Class IIa, LOE B
† Class IIa, LOE B
‡ Class IIa, LOE B
§ Class IIb, LOE B

(Flowchart diagram)
2007 ACC/AHA Peri-operative Guidelines – Step 5

Step 1
- Need for emergency noncardiac surgery?
  - Yes (Class I, LOE C)
    - Operating room
    - Perioperative surveillance and postoperative risk stratification and risk factor management
  - No

Step 2
- Active cardiac conditions*
  - Yes (Class I, LOE B)
    - Evaluate and treat per ACC/AHA guidelines
    - Consider operating room
  - No

Step 3
- Low risk surgery
  - Yes (Class I, LOE B)
    - Proceed with planned surgery
  - No

Step 4
- Good functional capacity (MET level greater than or equal to 4) without symptoms†
  - Yes (Class I, LOE B)
    - Proceed with planned surgery
  - No or unknown

Step 5
- 3 or more clinical risk factors‡
- 1 or 2 clinical risk factors‡
- No clinical risk factors§
  - Vascular surgery
    - Class IIa, LOE B
      - Consider testing if it will change management§
  - Intermediate risk surgery
  - Vascular surgery
  - Intermediate risk surgery
  - Proceed with planned surgery with HR control§ (Class IIa, LOE B) or consider noninvasive testing (Class IIb, LOE B) if it will change management
  - Proceed with planned surgery
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Significant Co-morbid Conditions

• history of ischemic heart disease (suggestive hx, symptoms, or Q-waves on ECG)

• history of compensated or prior HF (suggestive hx, symptoms, or examination findings)

• history of cerebrovascular disease (CVA or TIA)

• insulin-dependent diabetes mellitus

• renal insufficiency (Cr > 2 mg/dL)
2007 ACC/AHA Peri-operative Guidelines – Step 5

Step 1
Need for emergency noncardiac surgery?
Yes (Class I, LOE C)
Operating room
Perioperative surveillance and postoperative risk stratification and risk factor management

Step 2
Active cardiac conditions*
Yes (Class I, LOE B)
Evaluate and treat per ACC/AHA guidelines
Consider operating room

Step 3
Low risk surgery
Yes (Class I, LOE B)
Proceed with planned surgery

Step 4
Good functional capacity (MET level greater than or equal to 4) without symptoms‡
Yes (Class I, LOE B)
Proceed with planned surgery

Step 5
No or unknown

Vascular surgery
Class IIa, LOE B
Consider testing if it will change management§

Intermediate risk surgery

Vascular surgery

Intermediate risk surgery

1 or 2 clinical risk factors‡
Proceed with planned surgery with HR control§ (Class IIa, LOE B)
or consider noninvasive testing (Class IIb, LOE B) if it will change management

No clinical risk factors‡

Proceed with planned surgery

Class I, LOE B
2007 ACC/AHA Peri-operative Guidelines – Step 5

* Patients with no clinical risk factors - proceed with surgery

* Patients with 1-2 clinical risk factors
  - proceed with surgery after starting beta blockers (2A)
  - Non invasive stress testing (2B)

* Patients with 3 or more clinical risk factors
  - Intermediate risk surgery
    - proceed with surgery after starting beta blockers (2A)
    - Non invasive stress testing (2B)
  - Vascular or high risk surgery
    - Non invasive stress testing (2A)
    - proceed with surgery after starting beta blockers (2B)
1 OR 2 Risk Factors

- Those with 1 or 2 clinical risk factors can be allowed to proceed with surgery after initiation of beta blocker therapy that is titrated to achieve heart rate control.

- Noninvasive testing can be considered only if the results would change management.

- These same recommendations apply to patients with 3 or more clinical risk factors who are to undergo intermediate risk surgery.
3 or More Risk Factors

- It is in patients with 3 or more risk factors who are scheduled to undergo vascular surgery or extensive/high risk surgical procedure that the surgery should be deferred until noninvasive testing for further risk stratification is performed.

- And this again should be performed only if it would change patient management.

- In cases of emergent surgery, do the surgery and be prepared to manage the outcomes.
## Mortality of Common Surgical Procedures

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Current Recommendations

- The current recommendations is a departure of sorts from previous recommendations and conventional practice, wherein extensive testing is often performed as part of the pre surgical evaluation.

- For years, it was common to treat identified ischemia with an intervention to help ‘‘get the patient through’’ the surgical procedure safely.

- With roughly 5% peri-operative mortality, we would have to test a large number of patients who would otherwise do well regardless.

- This dilemma is reflected in the performance of noninvasive testing before surgery.
## Non-invasive Testing Prior to Non-cardiac Surgery

<table>
<thead>
<tr>
<th>Test</th>
<th>n.</th>
<th>Postoperative cardiac events</th>
<th>Positive predictive value (PPV)</th>
<th>Negative predictive value (NPV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise testing</td>
<td>1302</td>
<td>72/919 (8%)</td>
<td>55/334 (18%)</td>
<td>568/585 (97%)</td>
</tr>
<tr>
<td>Peripheral vascular/ AAA</td>
<td>1104</td>
<td>64/721 (9%)</td>
<td>53/293 (18%)</td>
<td>417/428 (97%)</td>
</tr>
<tr>
<td>Peripheral vascular/ non-cardiac</td>
<td>198</td>
<td>8/198 (4%)</td>
<td>2/41 (5%)</td>
<td>151/157 (96%)</td>
</tr>
<tr>
<td>Myocardial perfusion imaging</td>
<td>3508</td>
<td>238 (7%)</td>
<td>180/1397 (13%)</td>
<td>1527/1550 (99%)</td>
</tr>
<tr>
<td>Vascular</td>
<td>2834</td>
<td>189 (7%)</td>
<td>145/1181 (12%)</td>
<td>1192/1211 (98%)</td>
</tr>
<tr>
<td>Nonvascular</td>
<td>674</td>
<td>49 (7%)</td>
<td>35/216 (16%)</td>
<td>335/339 (99%)</td>
</tr>
<tr>
<td>Dobutamine stress echocardiography</td>
<td>1657</td>
<td>83 (5%)</td>
<td>74/484 (15%)</td>
<td>1162/1171 (99%)</td>
</tr>
<tr>
<td>Vascular</td>
<td>1001</td>
<td>48 (5%)</td>
<td>39/260 (15%)</td>
<td>730/739 (99%)</td>
</tr>
<tr>
<td>Nonvascular</td>
<td>656</td>
<td>35 (5%)</td>
<td>35/224 (16%)</td>
<td>432/432 (100%)</td>
</tr>
<tr>
<td>ST segment ambulatory monitoring</td>
<td>869</td>
<td>51 (6%)</td>
<td>21/215 (10%)</td>
<td>624/654 (95%)</td>
</tr>
</tbody>
</table>

Cohn, S. MCNA 2003: 111-135
Optimal Medical Therapy in Preparation for High Risk Surgery

McFalls, NEJM 2004: 2795-2804
Beta Blocker Therapy – Not For Everyone

- Adjusted risk of death associated with beta blocker therapy according to risk
- Patients at higher risk benefit
- Patients at low risk may be harmed with excessive hypotension or bradycardia.

Lindenauer, P et al. NEJM 353:4 July 28, 2005
# Beta Blockers Prior to Surgery

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Description and Rationale</th>
</tr>
</thead>
</table>
| Monitor peri-operative heart rate and blood pressure | Serially assess hemodynamic measures at prespecified intervals  
Withhold or administer beta-blocker according to preset thresholds/criteria  
Such an approach may help detection of issues such as hypovolemia, infection, sepsis |
| Implement a “run-in” phase for perioperative beta blockade | Initiate therapy at least 7 days before operative intervention  
Allows for both acute (hemodynamic) and delayed (anti-inflammatory) effects of beta-blockers  
Promotes early recognition of adverse effects (eg, bradycardia, hypotension, bronchospasm) |
| Adjust dose to achieve a target heart-rate of 60 beats per minute, avoiding hypotension | Heart rate control remains the major mechanism of beta-blocker benefit  
Helps identify and prevent perioperative bradycardia and intraoperative hypotension  
Can require variable doses of drug and thus allows for individualization of therapy |
| Recognize that beta-blockers differ considerably       | Short vs long-acting agents, varying clinical effects based on receptor agonism  
IV vs PO route of administration important as IV route can rapidly precipitate side effects  
Tailor therapy to maintain same agent/dose(s) as in the preoperative setting |
| Continue beta-blockers if already on this therapy     | Sudden withdrawal of beta-blockers known to cause upregulated beta-receptor state  
Class I ACC/AHA recommendation, especially if an original indication already exists  
Strive to maintain same agent as the preoperative setting |
Effects of Perioperative Statins in Various Studies

- Statins may be cardioprotective in the perioperative period
- They should be continued perioperatively
- Not enough data to start routinely
Clopidigrel (PLAVIX)  
The Period of Risk

- The period of risk is dependent on the type of procedure performed, and generally corresponds to the amount of time needed for the area or the stent to be endothelialized.

- Balloon angioplasty – 6 weeks
- Bare metal stent (BMS) – 2 months
- Drug Eluting Stent (DES) – 12 months?
What to do about clopidogrel (Plavix)

- Avoid putting in a stent
- Avoid/delay surgery
- Perform surgery on both ASA and clopidogrel (Plavix).
- Dental extraction, cataract surgery, endoscopy, bronchoscopy, skin biopsy etc., can be performed while on clopidogrel + ASA.
What to do about clopidogrel (Plavix)?

• If the surgeon refuses, try to continue at least one

• Reinstitute dual anti-platelet therapy ASAP with loading

• The treatment planned is best synthesized by communicating with all involved such as the cardiologist, the surgeon and the anesthesiologist.
What to do about clopidogrel (Plavix)?

- The practice of bridging with heparin or IIb/IIIa inhibitor (Integrillin) after clopidogrel (Plavix) is discontinued. This is not supported by data and not recommended.
- Stent thrombosis is platelet mediated
- Majority of cases of stent thrombosis occur after surgery
- Primary PCI post-operatively is as effective as in other setting
Remember

- As the evaluator you are just making recommendations to minimize the risk to the patient.
- You are not ‘clearing’ the patient for surgery.
- Monitor the outcome of the surgery to be available to provide support and continued management if needed.