For Easier Navigation

Activate the “Previous View” tool on the Adobe “Page Navigation Toolbar.” To do this:

1. Right click on the toolbar.
2. In the drop down menu that appears, left click “More Tools.”
4. Select the checkbox beside to “Previous View.”
5. Click “OK.”
Module: Perioperative assessment and care  
Topic: Preoperative assessment for urgent surgery

An 82-year-old woman is brought to the Emergency Department after falling down a flight of stairs and sustaining a complex fracture of the right femoral neck. The patient is seen by an orthopedic surgeon, who recommends open reduction/internal fixation of the fracture within 48 hr. You are asked to see the patient for cardiology “clearance.”

The patient has moderate Alzheimer’s disease, lives in a nursing home, and is unable to provide a reliable history. Her nursing home records indicate that she has a history of hypertension and heart failure. Current medications include lisinopril, metoprolol, furosemide, and omeprazole, but she did not receive any of her medications prior to transfer. She can usually walk with a cane and perform her activities of daily living with assistance.

The patient is awake but confused and frequently moans. The heart rate is 100/min with a blood pressure of 160/90 mm Hg. There is no jugular venous distention and the lung fields are clear. Heart tones are normal and no murmurs are appreciated. The abdominal examination is unremarkable and there is no peripheral edema. The electrocardiogram shows sinus tachycardia with LVH and nonspecific ST-segment depression. The chest x-ray reveals cardiomegaly and degenerative changes of the thoracic spine. Electrolytes are normal and the creatinine is 0.6 mg/dl. The hemoglobin is 12.4 g/dl and the white blood cell count is 5600/mm. A troponin I level is <0.1 ng/ml, and a B-type natriuretic peptide level is 200 pg/ml.

Question 1. Which of the following factors has the greatest impact on this patient’s perioperative mortality risk?

A. Age  
B. Uncontrolled hypertension  
C. History of heart failure  
D. Emergency surgery  
E. Alzheimer’s disease

Perioperative mortality rates for emergency operations in older patients are at least three-times greater than for comparable procedures performed under elective conditions. Mortality rates for emergency procedures range from 10% to nearly 30%. Cardiac, vascular, intrathoracic, and intra-abdominal procedures are among the most risky for patients over the age of 80 who have preexisting, unstable comorbidities, and who undergo emergency surgery. While operative treatment of hip fractures in the elderly is usually straightforward, one-year mortality rates after hip fracture surgery have been reported to range from 14%-36%, primarily due to perioperative cardiac complications (i.e., heart failure, myocardial infarction), bronchopneumonia, and thromboembolism. However, since delaying surgery has been associated with increased risk of deep venous thrombosis and pulmonary embolism, atelectasis, pneumonia, and decubitus ulcer formation, current guidelines recommend that hip fracture patients who are deemed to be medically fit for surgery should be operated on the day of admission. Indeed, postponing surgery
to optimize the patient’s medical condition must be weighed against the risk of delaying surgery and the associated high morbidity and mortality in the event that emergency surgery is required (slide 1).

Increasing age, especially age ≥80 years, is associated with a progressive increase in perioperative mortality, but the magnitude of risk is much less than that associated with emergency surgery. In addition, recent studies suggest that surgical risk increases due to the increased prevalence of comorbid diseases and/or decreased physiologic reserve rather than as a result of increased age alone. Thus, although efforts should be made to optimize medical management prior to surgery, if possible, age per se is rarely a contraindication to a necessary surgical procedure.

Hypertension has not been shown to be a major predictor of perioperative cardiac risk (slide 2), even though the association between hypertension and end organ damage, particularly ischemic heart disease, heart failure, stroke and renal impairment, is well established. To date, there is no evidence that deferring urgent or elective surgery to allow hypertension to be addressed leads to a reduction in perioperative risk.

Although a history of heart failure is among the predictors of perioperative cardiovascular risk, it is an intermediate risk factor. This patient does not manifest signs or symptoms of acute, decompensated heart failure, the presence of which would confer significant risk for mortality. Patients with compensated heart failure should be monitored closely to avoid volume overload, but in most cases surgery can proceed without undue risk (slides 3 and 4).

Perhaps surprisingly, Alzheimer’s disease is not an independent risk factor for perioperative mortality. It is, however, a major risk factor for postoperative delirium, which in itself is associated with significant morbidity, increased length of stay, higher cost, decreased likelihood of discharge to home, and diminished 5-year survival (see Delirium Case in this module for additional discussion).

References.

Question 2. For this patient, compared to general anesthesia, regional anesthesia may have favorable effects on all of the following EXCEPT:

A. Perioperative blood loss
B. Postoperative ileus
C. Thromboembolic complications
D. Postoperative cognitive dysfunction
E. Ventilation-perfusion mismatching

Neither the choice of anesthetic technique nor the modality used for the management of postoperative pain is an important determinant of postoperative cognitive dysfunction in elderly patients. (Please refer to Delirium Case in this module for discussion of the mechanisms, diagnosis, prevention, and treatment of perioperative delirium and cognitive dysfunction.)

Geriatric patients, in general, have decreased functional reserve and become increasingly less tolerant to surgical stress. Local anesthetics block afferent and efferent signals to and from the spinal cord, thus suppressing the surgical stress response and spinal reflex inhibition of diaphragmatic and gastrointestinal function (slide 5). Although discrepancies exist among studies that evaluated early mortality, e.g., within 1 month, in elderly patients after major orthopedic surgery under either regional (epidural or spinal) or general anesthesia, a meta-analysis showed that regional anesthesia for hip fracture surgery was associated with a reduced early mortality and incidence of deep vein thrombosis in comparison to general anesthesia (slide 6). Long-term morbidity and mortality (2 mo to 1 yr) do not appear to be altered by the type of anesthesia used during hip repair.

When compared with general anesthesia, intraoperative blood loss is reduced by spinal or epidural anesthesia, especially in patients undergoing hip surgery (slide 7). This is attributed to lower venous pressures during central neural blockade compared with general anesthesia.

Postoperative ileus is a major surgical morbidity, particularly in the elderly following abdominal surgery (Kehlet H. 2001). Colonic motility may be inhibited for up to 48-72 hours, and contributes to increased hospital length of stay. One theory for postoperative ileus is that pain activates a spinal reflex arc that inhibits intestinal motility. Use of opioids for pain control can further contribute to reduced return of bowel function. Randomized clinical trials that investigated the recovery of GI function after surgery have shown that the use of postoperative thoracic epidural analgesia with local anesthetics compared with systemic opioid analgesia allows earlier return of GI function and shorter hospital stay (Kehlet 2001).

The incidence of thromboembolic complications is lower in patients operated under lumbar epidural and spinal anesthesia as compared with general anesthesia (slide 8). The mechanism is thought to be due to a combination of improved lower extremity blood flow, favorable changes in coagulation and fibrinolysis, inhibition of thrombocyte aggregation, and reduced blood viscosity. Moreover, the regional anesthetic technique provides excellent pain control, thus sparing the sedative effects of opioids and facilitating early postoperative mobilization which likely decreases the incidence of clot formation. As noted above, intraoperative and
postoperative neuroaxial anesthesia attenuates the surgical adrenergic stress response, thereby reducing postoperative hypercoagulability.

Respiratory problems during the early recovery period are a major cause of postoperative complications in the elderly. A meta-analysis of 48 randomized controlled clinical trials assessed improvements in pulmonary outcomes comparing systemic opioid, epidural opioid, and epidural local anesthetics. Compared to systemic opioids, epidural analgesia with local anesthetics significant reduced the incidence of pulmonary complications, atelectasis, and pneumonia (Ballantyne JC. Anesth Analg 1998;86:598-612). Another meta-analysis also showed reductions in pulmonary embolism, pneumonia, and respiratory depression with the use of epidural anesthesia/analgesia (Rodgers A. 2000) (slides 8 and 9).

References
- Rodgers A, Walker N, Schug S, Mckee A, Kehlet H, van Zundert A, Sage D, Futter M, Saville G, Clark T, MacMahon S. Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomised trials. Bmj 2000;321:1493. The benefits of neuraxial vs. general anesthesia have long been debated. This meta-analysis looks at mortality and morbidity data from 141 published trials. The results suggest that neuraxial anesthesia confers some benefits and reduces some postoperative complications. However, many of the studies included are small and the results have not been replicated elsewhere.
- O'Hara DA, Duff A, Berlin JA, Poses RM, Lawrence VA, Huber EC, Noveck H, Strom BL, Carson JL. The effect of anesthetic technique on postoperative outcomes in hip fracture repair. Anesthesiology 2000;92:947-57. This large retrospective study addressed the controversial issue of regional vs. general anesthesia for hip fracture patients. They reviewed over 9000 cases, approximately 6000 general vs. 3000 regional anesthetics. The 30 day unadjusted mortality rates were not significantly different between the two groups. This paper demonstrates that outcomes in hip fractures patients are not heavily dependent on the anesthetic technique

Question 3. Which of the following is the most appropriate recommendation for preoperative assessment and management of this patient?

A. No further cardiac evaluation; resume metoprolol and proceed with surgery within 24 hours.
B. Echocardiogram to assess left ventricular function.
C. Adenosine sestamibi stress test to evaluate for ischemia.
D. Place a pulmonary artery catheter for hemodynamic monitoring and proceed with surgery.
E. Defer surgery pending discussions with the patient’s family about initiation of hospice.
Based on current ACC/AHA recommendations, this patient should proceed with urgent surgery rather than delaying surgery for further cardiac evaluation (slides 10-16).

Patients with unstable or markedly symptomatic cardiovascular conditions should undergo evaluation and treatment before noncardiac surgery. These conditions include unstable coronary syndromes, decompensated heart failure, significant uncontrolled arrhythmias, or severe valvular disease. Because this patient does not have evidence of active heart failure, ischemia or valvular dysfunction, neither an adenosine sestamibi stress test nor an echocardiogram is recommended (slides 17-19). Furthermore, as noted in the 2007 ACC/AHA guidelines, “no study has clearly demonstrated a change in outcome from the routine use of the following techniques: a pulmonary artery catheter, ST-segment monitor, transesophageal echocardiography, or intravenous nitroglycerin. Therefore, the choice of anesthetic technique and intraoperative monitors is best left to the discretion of the anesthesia care team.” Controlled trials have failed to demonstrate improved outcomes related to the use of perioperative pulmonary artery catheters, and a large-scale cohort study suggested potential harm (slides 20-23).

With regard to hospice, although there are times when clinicians, patients, and families need to redirect care from aggressive curative treatment to supportive palliative care, the planned operation in this case provides the best option for minimizing pain and morbidity, as well as for allowing the patient to return to her previous level of function.

In summary, based on current ACC/AHA recommendations for evaluation of patients undergoing noncardiac surgery (slide 10), appropriate management of this patient is as follows:

Step 1: Is this an emergency noncardiac surgery? Although this case is not an emergency procedure, it is considered to be urgent. Thus, the clinician should bear in mind that any recommendations that may delay surgery should be weighed against the increased risk for developing deep venous thrombosis and pulmonary embolism, atelectasis, pneumonia, and decubitus ulcer formation if hip fracture repair is delayed.

Step 2: Does the patient have active cardiac conditions? This patient does not have any active cardiac conditions (unstable coronary syndromes, decompensated heart failure, uncontrolled arrhythmias, or severe valvular disease).

Step 3: Is this a low-risk surgery? No; orthopedic surgery is an intermediate risk procedure.

Step 4: Does the patient have good functional capacity (≥ 4 METS) without symptoms? Prior to the fall, the patient was walking with a cane and was able to perform ADLs, putting her at a MET level below 4 (slide 18).

Step 5: How many clinical risk factors does the patient have? At this point in the algorithm, further management is determined by the patient’s clinical risk factors and type of surgery. For this patient (with poor functional status, 2 risk factors, and undergoing an intermediate risk procedure) the 2007 revision of the AHA/ACC guidelines indicate that proceeding with surgery with control of heart rate (class IIa, level of evidence B) is preferable to pursuing noninvasive
testing (class IIb, level of evidence B), especially since the latter is unlikely to change management.

Acute Comorbidities Preventing Early Surgery for Hip Fracture

<table>
<thead>
<tr>
<th>Reason for Delay of Surgery</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>High international normalized ratio (≥1.7)</td>
<td>16</td>
<td>7.8</td>
</tr>
<tr>
<td>Active chest infection</td>
<td>43</td>
<td>20.9</td>
</tr>
<tr>
<td>Anemia</td>
<td>37</td>
<td>18.0</td>
</tr>
<tr>
<td>Dysrhythmia (mainly uncontrolled atrial fibrillation)</td>
<td>42</td>
<td>20.4</td>
</tr>
<tr>
<td>Electrolyte imbalance</td>
<td>25</td>
<td>12.1</td>
</tr>
<tr>
<td>Heart failure</td>
<td>22</td>
<td>10.7</td>
</tr>
<tr>
<td>Others</td>
<td>21</td>
<td>10.2</td>
</tr>
<tr>
<td>Total</td>
<td>206</td>
<td>100</td>
</tr>
</tbody>
</table>

## Perioperative Risk Predictors

<table>
<thead>
<tr>
<th>Active cardiac conditions</th>
<th>Unstable coronary syndromes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Decompensated Heart Failure</td>
</tr>
<tr>
<td></td>
<td>Significant Arrhythmias</td>
</tr>
<tr>
<td></td>
<td>Significant valvular disease</td>
</tr>
<tr>
<td>Clinical risk factors</td>
<td>Stable angina</td>
</tr>
<tr>
<td></td>
<td>History of myocardial infarction</td>
</tr>
<tr>
<td></td>
<td>Compensated Heart Failure</td>
</tr>
<tr>
<td></td>
<td>Diabetes</td>
</tr>
<tr>
<td></td>
<td>Renal insufficiency</td>
</tr>
<tr>
<td>Minor risk predictors</td>
<td>Advanced age</td>
</tr>
<tr>
<td></td>
<td>Abnormal electrocardiogram*</td>
</tr>
<tr>
<td></td>
<td>Rhythm other sinus</td>
</tr>
<tr>
<td></td>
<td>Poor exercise capacity</td>
</tr>
<tr>
<td></td>
<td>History of cerebrovascular accident</td>
</tr>
<tr>
<td></td>
<td>Uncontrolled hypertension</td>
</tr>
</tbody>
</table>
Perioperative Implications of Heart Failure History

Above knee amputation
Below knee amputation
Carotid endarterectomy
Colon Cancer Resection
Hip Replacement
Knee Replacement
Laparoscopic cholecystectomy
Lower extremity bypass
Open AAA repair
Open Cholecystectomy
Other abdominal CA resection
Pulmonary cancer resection
Spinal fusion

Fig. 1. Effects of heart failure and coronary artery disease, compared to neither, on operative mortality by procedure. Procedure-specific models include indicators for disease group, age, sex, race, admission characteristics, comorbidities, and hospital teaching status. AAA = abdominal aortic aneurysm.
Table 5. Regression Models of Operative Mortality and 30-Day Readmission for Heart Failure Groups with or without Coronary Artery Disease

<table>
<thead>
<tr>
<th>Effect</th>
<th>Unadjusted*</th>
<th>Adjusted†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative mortality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart failure group with coronary artery disease vs. comparison group</td>
<td>2.52 (2.36–2.70)</td>
<td>1.60 (1.49–1.72)</td>
</tr>
<tr>
<td>Heart failure group without coronary artery disease vs. comparison group</td>
<td>2.57 (2.33–2.85)</td>
<td>1.74 (1.57–1.92)</td>
</tr>
<tr>
<td>*P value‡</td>
<td>0.69</td>
<td>0.11</td>
</tr>
<tr>
<td>30-Day readmission</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart failure group with coronary artery disease vs. comparison group</td>
<td>1.94 (1.86–2.02)</td>
<td>1.53 (1.46–1.60)</td>
</tr>
<tr>
<td>Heart failure group without coronary artery disease vs. comparison group</td>
<td>1.72 (1.59–1.85)</td>
<td>1.43 (1.33–1.54)</td>
</tr>
<tr>
<td>*P value‡</td>
<td>0.001</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Values are expressed as hazard ratio (95% confidence interval) unless otherwise indicated.

* Unadjusted model includes indicators for disease group and type of procedure.  † Adjusted model includes indicators for disease group, type of procedure, age, sex, race, admission characteristics, comorbidities, and hospital teaching status. ‡ P value tests for difference in effect magnitude between heart failure groups.
Effects of Analgesic Technique on Postop Surgical Stress Response

<table>
<thead>
<tr>
<th>Type of analgesia</th>
<th>Endocrine responses</th>
<th>Inflammatory responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systemic opioid (PCA)</td>
<td>↓</td>
<td></td>
</tr>
<tr>
<td>NSAID</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Epidural opioid</td>
<td>↓</td>
<td></td>
</tr>
<tr>
<td>Lumbar epidural LA (lower extremity surgery)</td>
<td>↓↓↓↓</td>
<td></td>
</tr>
<tr>
<td>Thoracic epidural LA (abdominal surgery)</td>
<td>↓↓</td>
<td></td>
</tr>
</tbody>
</table>

Kehlet and Holte. Br J Anaesth 2001;87:62-72
# Effect of Anesthetic Technique on postoperative mortality in elderly


<table>
<thead>
<tr>
<th>Author</th>
<th>No. of pts (reg/GA)</th>
<th>Method</th>
<th>7d RA/GA</th>
<th>30 d RA/GA</th>
<th>1 year RA/GA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sutcliffe</td>
<td>383/950</td>
<td>Prospective</td>
<td>9.4/8.8</td>
<td>36.9/32.6</td>
<td></td>
</tr>
<tr>
<td>O’Hara</td>
<td>3129/6206</td>
<td>Retrospective</td>
<td>1.6/1.3</td>
<td>5.4/4.4</td>
<td></td>
</tr>
<tr>
<td>Gilbert</td>
<td>430/311</td>
<td>Prospective</td>
<td></td>
<td></td>
<td>19.1/16.6</td>
</tr>
<tr>
<td>Urwin</td>
<td>1028/1005</td>
<td></td>
<td></td>
<td></td>
<td>6.4/9.4*</td>
</tr>
</tbody>
</table>

RA = regional anesthesia (spinal or epidural)  
GA = general anesthetic  
* P<0.05 Advantage RA over GA
# Perioperative Blood Loss: Regional vs. General Anesthesia

## Table 2 Summary of vascular events and bleeding

<table>
<thead>
<tr>
<th>Group</th>
<th>Deep vein thrombosis</th>
<th>Pulmonary embolism</th>
<th>Myocardial infarction</th>
<th>Cardiac arrhythmia</th>
<th>Other fatal cardiac event</th>
<th>Stroke</th>
<th>Perioperative transfusion requiring &gt;2 units red cells</th>
<th>Postoperative bleed requiring transfusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>26</td>
<td>24</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Orthopaedics</td>
<td>117</td>
<td>184</td>
<td>27</td>
<td>59</td>
<td>7</td>
<td>19</td>
<td>36</td>
<td>41</td>
</tr>
<tr>
<td>Urology</td>
<td>2</td>
<td>11</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Vascular</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>35</td>
<td>30</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>145</td>
<td>220</td>
<td>30</td>
<td>66</td>
<td>45</td>
<td>59</td>
<td>59</td>
<td>76</td>
</tr>
</tbody>
</table>

NB = neuraxial blockade.
Effects of Neuroaxial Blockade (spinal or epidural) on postop complications

<table>
<thead>
<tr>
<th>Events</th>
<th>NB</th>
<th>No NB</th>
<th>Odds ratio and 95% CI</th>
<th>Odds reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vascular events</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep vein thrombosis</td>
<td>145</td>
<td>220</td>
<td></td>
<td>44% (10)</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>30</td>
<td>66</td>
<td></td>
<td>55% (15)</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>45</td>
<td>59</td>
<td></td>
<td>33% (17)</td>
</tr>
<tr>
<td>Stroke</td>
<td>19</td>
<td>23</td>
<td></td>
<td>15% (29)</td>
</tr>
<tr>
<td><strong>Bleeding</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perioperative transfusion &gt;2 units</td>
<td>193</td>
<td>280</td>
<td></td>
<td>50% (10)</td>
</tr>
<tr>
<td>Post operative bleed requiring transfusion</td>
<td>31</td>
<td>69</td>
<td></td>
<td>55% (15)</td>
</tr>
<tr>
<td><strong>Infection</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wound infection</td>
<td>29</td>
<td>33</td>
<td></td>
<td>21% (24)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>149</td>
<td>238</td>
<td></td>
<td>39% (9)</td>
</tr>
<tr>
<td>Death from other infective causes</td>
<td>2</td>
<td>10</td>
<td></td>
<td>67% (36)</td>
</tr>
<tr>
<td><strong>Other events</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory depression</td>
<td>26</td>
<td>38</td>
<td></td>
<td>59% (19)</td>
</tr>
<tr>
<td>Renal failure</td>
<td>18</td>
<td>32</td>
<td></td>
<td>43% (22)</td>
</tr>
</tbody>
</table>

Fig 3 Effects of neuraxial blockade (NB) on postoperative complications. Diamonds denote 95% confidence intervals for odds ratios of combined trial results. The vertical dashed line represents the overall pooled result. Size of shaded boxes is proportional to number of events.
Potential Benefits of epidural anesthesia/analgesia in the elderly

- Reduce stress response to surgery
- Improve myocardial oxygen supply/demand balance
- Improve endocardial blood flow
- Improve lower extremity graft patency
- Preserve pulmonary function
- Reduce postoperative narcotic requirements
- Early return of gastrointestinal motility
- Attenuate thromboembolic complications
- Early ambulation
Cardiac evaluation and care algorithm for noncardiac surgery based on active clinical conditions (high-risk indicators), known cardiovascular disease, or cardiac risk factors for patients aged >=50 years

Gregoratos, G. Circulation 2008;117:3134-3144
Perioperative Heart Rate Control and Myocardial Ischemia

Mean heart rate in relation to myocardial ischemia assessed by continuous electrocardiography and troponin T release

Results of the CARP (Coronary Artery Revascularization Prophylaxis) study: long-term survival among patients assigned to undergo coronary artery revascularization or no revascularization.

## Recommendations for Perioperative β-Blockade from Randomized Trials

*Br J Anaesth 2008;100:23-8.*

<table>
<thead>
<tr>
<th>Surgery</th>
<th>No Clinical Risk Factors</th>
<th>1 or More Clinical Risk Factors</th>
<th>CHD or High Cardiac Risk</th>
<th>Patients Currently Taking Beta Blockers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular</td>
<td>Class IIb, Level of Evidence: B</td>
<td>Class IIa, Level of Evidence: B</td>
<td>Patients found to have myocardial ischemia on preoperative testing: Class I, Level of Evidence: B</td>
<td>Class I, Level of Evidence: B</td>
</tr>
<tr>
<td>Intermed risk</td>
<td>…</td>
<td>Class IIb, Level of Evidence: C</td>
<td>Class IIa, Level of Evidence: B</td>
<td>Class I, Level of Evidence: C</td>
</tr>
<tr>
<td>Low risk</td>
<td>…</td>
<td>…</td>
<td>…</td>
<td>Class I, Level of Evidence: C</td>
</tr>
</tbody>
</table>

. Ellipses (…) indicate that data were insufficient to determine a class of recommendation or level of evidence.
Perioperative Beta Blockade: *Considerations post-POISE trial*

- Continue beta blockers in those patients already on beta blockers (Class I)
- Avoid perioperative commencement of *high* dose beta blockade to high-risk patients with known CAD (e.g. suggest low dose, 1-2 weeks prior to surgery)
- Treat all underlying causes of tachycardia before initiation of beta blockers
Perioperative Beta Blockade: Balance Risks & Benefits


<table>
<thead>
<tr>
<th>Event</th>
<th>Metoprolol group (n=4174)</th>
<th>Placebo group (n=4177)</th>
<th>Hazard ratio</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular death, non-fatal myocardial infarction, or non-fatal cardiac arrest*</td>
<td>244 (5.8%)</td>
<td>290 (6.9%)</td>
<td>0.84 (0.70–0.99)</td>
<td>0.0399</td>
</tr>
<tr>
<td>Cardiovascular death</td>
<td>75 (1.8%)</td>
<td>58 (1.4%)</td>
<td>1.30 (0.92–1.83)</td>
<td>0.1368</td>
</tr>
<tr>
<td>Non-fatal myocardial infarction</td>
<td>152 (3.6%)</td>
<td>215 (5.1%)</td>
<td>0.70 (0.57–0.86)</td>
<td>0.0008</td>
</tr>
<tr>
<td>Non-fatal cardiac arrest</td>
<td>21 (0.5%)</td>
<td>19 (0.5%)</td>
<td>1.11 (0.60–2.06)</td>
<td>0.7436</td>
</tr>
<tr>
<td>Total mortality</td>
<td>129 (3.1%)</td>
<td>97 (2.3%)</td>
<td>1.33 (1.03–1.74)</td>
<td>0.0317</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>176 (4.2%)</td>
<td>239 (5.7%)</td>
<td>0.73 (0.60–0.89)</td>
<td>0.0017</td>
</tr>
<tr>
<td>Cardiac revascularisation†</td>
<td>11 (0.3%)</td>
<td>27 (0.6%)</td>
<td>0.41 (0.20–0.82)</td>
<td>0.0123</td>
</tr>
<tr>
<td>Stroke</td>
<td>41 (1.0%)</td>
<td>19 (0.5%)</td>
<td>2.17 (1.26–3.74)</td>
<td>0.0053</td>
</tr>
<tr>
<td>Non-fatal stroke</td>
<td>27 (0.6%)</td>
<td>14 (0.3%)</td>
<td>1.94 (1.01–3.69)</td>
<td>0.0450</td>
</tr>
<tr>
<td>Congestive heart failure†</td>
<td>132 (3.2%)</td>
<td>116 (2.8%)</td>
<td>1.14 (0.89–1.46)</td>
<td>0.3005</td>
</tr>
<tr>
<td>New clinically significant atrial fibrillation†</td>
<td>91 (2.2%)</td>
<td>120 (2.9%)</td>
<td>0.76 (0.58–0.99)</td>
<td>0.0435</td>
</tr>
<tr>
<td>Clinically significant hypotension†</td>
<td>625 (15.0%)</td>
<td>404 (9.7%)</td>
<td>1.55 (1.38–1.74)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Clinically significant bradycardia†</td>
<td>277 (6.6%)</td>
<td>101 (2.4%)</td>
<td>2.74 (2.19–3.43)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Non-cardiovascular death</td>
<td>54 (1.3%)</td>
<td>39 (0.9%)</td>
<td>1.39 (0.92–2.10)</td>
<td>0.1169</td>
</tr>
</tbody>
</table>
## Perioperative Beta Blockade Balance Risks & Benefits


<table>
<thead>
<tr>
<th></th>
<th>All-cause mortality</th>
<th>Cardiovascular mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Deaths</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>POISE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>β-blocker</td>
<td>4174</td>
<td>129 (3.1%)</td>
</tr>
<tr>
<td>Control</td>
<td>4177</td>
<td>97 (2.3%)</td>
</tr>
<tr>
<td><strong>Non-POISE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>β-blocker</td>
<td>1896</td>
<td>36 (1.9%)</td>
</tr>
<tr>
<td>Control</td>
<td>1615</td>
<td>41 (2.5%)</td>
</tr>
<tr>
<td><strong>Non-POISE total</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-POISE, strokes reported</td>
<td></td>
<td></td>
</tr>
<tr>
<td>β-blocker</td>
<td>1536</td>
<td>31 (2.0%)</td>
</tr>
<tr>
<td>Control</td>
<td>1346</td>
<td>27 (2.0%)</td>
</tr>
<tr>
<td>Non-POISE, strokes not reported</td>
<td></td>
<td></td>
</tr>
<tr>
<td>β-blocker</td>
<td>350</td>
<td>5 (1.4%)</td>
</tr>
<tr>
<td>Control</td>
<td>269</td>
<td>14 (5.2%)</td>
</tr>
</tbody>
</table>
Recommendations for Noninvasive Stress Testing Before Noncardiac Surgery
ACC/AHA 2007 guidelines

- **Class I**
  - Patients with active cardiac conditions in whom noncardiac surgery is planned should be evaluated and treated in accordance with other relevant ACC/AHA guidelines before noncardiac surgery.

- **Class IIa**
  - Noninvasive stress testing of patients with ≥ 3 clinical risk factors and poor functional capacity (<4 METs) who require vascular surgery is reasonable if it will change management.

- **Class IIb**
  - Noninvasive stress testing may be considered:
    - For patients with at least 1 or 2 clinical risk factors and poor functional capacity (<4 METs) who require intermediate-risk noncardiac surgery if it will change management.
    - For patients with at least 1 or 2 clinical risk factors and good functional capacity who are to undergo vascular surgery.

- **Class III**
  - Noninvasive testing is not useful for patients undergoing low-risk noncardiac surgery and pts with no clinical risk factors undergoing intermediate-risk noncardiac surgery.
### Functional Assessment

**Estimate of Metabolic Equivalent for different activities**

<table>
<thead>
<tr>
<th>1 MET:</th>
<th>Activities of Daily Living (eating, dressing, walking indoors, dishwashing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 METs:</td>
<td>More strenuous activities (1 flight of stairs, walking 4mph, running a short distance, scrubbing floors, playing golf, tennis doubles)</td>
</tr>
<tr>
<td>10 METs:</td>
<td>Playing sports (swimming, singles tennis, football)</td>
</tr>
</tbody>
</table>
**Recommendations for noninvasive testing**

**ACC/AHA 2007 guidelines**

<table>
<thead>
<tr>
<th>Type of Surgery</th>
<th>Functional Capacity</th>
<th>Number of Clinical Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Vascular Surgery</td>
<td>Good</td>
<td>[Green bar]</td>
</tr>
<tr>
<td>Intermediate Risk Surgery</td>
<td>Good</td>
<td>[Green bar]</td>
</tr>
<tr>
<td>Low Risk Surgery</td>
<td>Good</td>
<td>[Green bar]</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>[Green bar]</td>
</tr>
</tbody>
</table>

*Green bars* indicate no recommendation of noninvasive stress testing and that patients can go directly to surgery; *orange bars* indicate patients for whom testing may be considered if it will change management (class IIb); and the *red bar* indicates a class IIa recommendation for noninvasive stress testing. ACC/AHA = American College of Cardiology/American Heart Association.

*Circulation 2007;116(17):1971-1996*
Clinical Indications for perioperative PAC Monitoring

• Major Procedures involving Large Fluid Shifts or Blood Loss in Patients with:
  – Severe unstable CAD or CHF
  – Cardiogenic or septic shock
  – Right-sided heart failure, pulmonary hypertension, or pulmonary embolism
  – Hemodynamic instability requiring inotropes or IABP
  – Hepatic transplantation
  – Massive ascites requiring major surgery
Effects of PAC in high-risk, older surgical patients

Effects of PAC in high-risk, older surgical patients

Figure 1. Kaplan-Meier Survival Curves to One Year.
Data for six patients in the standard-care group and seven patients in the catheter group for whom exact dates of death were unavailable are included in the number at risk up to the last follow-up contact when the patient was still alive.

In-Hospital Mortality: PAC vs. Standard Care

Figure 2. Estimated Differences in In-Hospital Mortality in the Catheter Group as Compared with the Standard-Care Group, Overall and According to American Society of Anesthesiologists (ASA) Risk Class, Type of Surgery, Sex, Age, and New York Heart Association (NYHA) Class.

Positive differences indicate excess mortality in the catheter group as compared with the standard-care group, whereas negative differences indicate lower mortality in the catheter group. Bars represent 95 percent confidence intervals.