Evaluation of Cardiac and Pulmonary Risk in the Preop Patient

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Conflicts of Interest
I have no conflicts of interest to declare

Introduction
The role of the internist performing preoperative evaluations is not to provide medical “clearance” prior to surgery. Instead, the internist should:
- Provide an assessment of the patient’s cardiac and other risks going into the procedure
- Decide whether additional preoperative testing, such as a cardiac stress test, is needed
- When indicated, recommend measures to reduce the perioperative risk, such as beta blockers and statins
- Assist the surgeon in deciding whether to go forward with the procedure

Risk Assessment
Lee Goldman (while still a resident) examined 4315 patients aged > 50 years undergoing elective major noncardiac procedures to derive an index to determine perioperative cardiac risk. This index was designed to predict which patients were at elevated risk for major cardiac complications (defined as: myocardial infarction, pulmonary edema, ventricular fibrillation or primary cardiac arrest, and complete heart block). This index is referred to as the Revised Cardiac Risk Index (RCRI) and contains 6 risk factors.

Risk Assessment: RCRI
The rates of major cardiac complications increase with the number of RCRI risk factors that are present.

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<th>Risk Factor</th>
<th>Definition</th>
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<td>1. High-risk type of surgery</td>
<td>Intraabdominal, intrathoracic, or suprainguinal vascular procedures</td>
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<td>2. Ischemic heart disease</td>
<td>History of MI, positive stress test, current cardiac CP, nitrate usage, ECG with pathologic Q waves</td>
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<td>3. History of congestive heart failure</td>
<td>History of CHF, pulmonary edema, or PND; rales or S3 on exam; chest x-ray with pulmonary edema</td>
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<td>4. History of cerebrovascular disease</td>
<td>History of transient ischemic attack or stroke</td>
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<td>5. Insulin therapy for diabetes</td>
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<td>6. Preoperative serum creatinine &gt; 2.0 mg/dL</td>
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These are the risk factors that are used (with some minor modifications) in the current ACC/AHA Periop Guidelines.
ACC/AHA 2007 Periop Guidelines

If the surgery is emergent, then the patient goes to surgery, and one manages the risks.

As part of the history and physical, the internist needs to ascertain whether there are any active cardiac conditions, which require treatment prior to nonemergent surgery.

Active cardiac conditions (for which surgery is usually delayed) include:
- Unstable coronary syndromes
  - such as unstable or severe angina, or MI within the last 30 days
- Decompensated heart failure
  - including NYHA class IV or new-onset
- Significant arrhythmias
  - including 3rd-degree AV block, symptomatic ventricular arrhythmias, uncontrolled supraventricular arrhythmias, or symptomatic bradycardia
- Severe valvular disease
  - including severe aortic stenosis, defined as a mean pressure gradient > 40 mm Hg or aortic valve area < 1.0 cm², or symptomatic mitral stenosis

If a patient is scheduled to undergo a low-risk procedure—such as endoscopy, breast surgery, or cataract surgery—then no further cardiac testing is indicated.

If the patient can go ≥ 4 METs without any cardiac symptoms, then the patient should go to surgery without further cardiac testing. This is in essence the poor man’s stress test.

A functional capacity of 4 METs corresponds to climbing a flight of stairs with a bag of groceries, walking 3.5 mph briskly on a level surface, or sweeping the sidewalk.

In situations where the patients’ functional capacity is < 4 METs, or when the patients’ functional capacity cannot be assessed, such as if they are wheelchair bound, then their risk factors must be considered.

The risk factors in the Guidelines correspond to the RCRI risk factors we discussed earlier, except for two exceptions:
- High-risk surgery is not a risk factor but is instead integrated into the algorithm separately.
- High-risk surgery is defined as vascular surgery only (and does not include intraperitoneal or intrathoracic surgeries, which the Guidelines consider intermediate risk).
Patients with 0, or 1 or 2 risk factors will generally proceed to surgery without further cardiac testing. Patients with 3 or more clinical risk factors who are undergoing vascular surgery (high risk surgery) are the patients for whom a stress test should most seriously be considered.

The Guidelines we just discussed are easier to apply when thought of in the context of the literature on which they are based. Two key articles in the preop literature include:

- DECREASE-II Trial (2006)
- CARP Trial (2004)

**DECREASE-II Trial**

- The goal of this trial was to assess whether a preop stress test is beneficial in intermediate risk patients (1 or 2 cardiac risk factors) undergoing vascular surgery.
- 770 patients were intermediate risk and were randomized to either a preoperative stress test or no stress test.
- Patients whose stress tests showed extensive ischemia were considered for revascularization, if feasible.
- All patients received periop beta blockers, with a goal heart rate of 60-65 bpm.
- The endpoint used was a composite of cardiac death and non-fatal MI at 30 days.


Intermediate risk patients who got stress tests prior to surgery did no better than those who did not get stress tests preoperatively. The rate of the composite endpoint among the patients who got stress tests was 2.3%, compared to 1.8% among the patients who did not receive stress tests (P=0.62).

Revascularization of the intermediate risk patients with extensive ischemia also did not appear beneficial, though the number of patients in this group was too small to draw firm conclusions.

Thus the results of this trial suggest that it is not advantageous to have intermediate risk patients undergo preoperative stress tests, in patients who are receiving beta blockers.


**CARP Trial**

- This trial examined whether revascularization prior to surgery is beneficial in a population of patients undergoing vascular surgery with demonstrated CAD.
- 510 patients who were considered at elevated cardiac risk, and who therefore had already undergone diagnostic cardiac catheterization, were eligible for enrollment only if their cardiac catheterization showed ≥ 70% coronary stenosis.
- Enrolled patients were randomized to revascularization or no revascularization prior to surgery.
- The rate of perioperative beta blocker use was similar in both groups, at around 85%.
- Among the patients who underwent revascularization, 59% underwent PCI and 41% underwent CABG.


There was no significant difference in the outcomes between the revascularization and no revascularization groups, who had similar MI rates at 30 days (11.6% in the revascularization group versus 14.3% in the no revascularization group; P=0.37).

The two groups also had similar 30-day death rates and long-term outcomes.

In this group of patients undergoing vascular surgery, all of whom had angiographically proven CAD, preoperative revascularization did not improve outcomes.

These studies are why only in a patient with a functional capacity < 4 METs, and who has 3 or more clinical risk factors, and who is undergoing high risk (vascular) surgery will you consider a stress test, if it will change management.

Perioperative Beta Blockers

- Perioperative beta-blockage appears to be of benefit in selected patients who are at elevated risk of perioperative cardiac events.
- Per the ACC/AHA 2007 Periop Guidelines, there are two class I indications for perioperative beta-blocker use:
  - Beta blockers should be continued in the perioperative setting in patients who are already taking beta blockers for an appropriate indication
  - Beta blockers should be given to patients undergoing vascular surgery in whom preoperative testing has demonstrated cardiac ischemia

Lindenauer et al. performed a large retrospective cohort study examining the benefits of periop beta blockers based on the cardiac risk of the patient. Patients undergoing noncardiac surgery (mainly orthopedic and abdominal procedures), both routine and emergent, were included. Patients receiving prophylactic periop beta blockers were compared with patients not receiving beta blockers. This study is debated:
- On the one hand, it was quite large (n=663,635)
- On the other hand, it was retrospective, and based on the use of an administrative database. No charts were reviewed. Beta blockers started on hospital day 1 or 2 were considered prophylactic.

Perioperative Beta Blockers

Patients without cardiac risk factors who got periop beta blockers seemed to be harmed by them.

Patients with an RCRI of at least 2, and certainly with an RCRI of 3, appeared to benefit from beta blockers.

The ACC/AHA 2007 Periop Guidelines are consistent with the Lindenauer data:
- Beta blockers are probably recommended for patients in whom preoperative assessment identifies CHD or high cardiac risk, as defined by the presence of more than 1 clinical risk factor, who are undergoing intermediate-risk or vascular surgery (class IIa recommendation).

The POISE Trial

- The PeriOperative Ischemic Evaluation (POISE) Trial enrolled 8351 patients undergoing noncardiac surgery with at least one cardiac risk factor.
- Patients were randomized to either placebo or controlled-release metoprolol (CR metoprolol). 100 mg orally 2 – 4 hours prior to surgery, a postoperative dose of CR metoprolol based on heart rate and blood pressure, and then 200 mg of CR metoprolol orally daily for the next 30 days.
- The beta blocker arm had a lower rate of the primary outcome (30-day cardiac events): 5.6% in the beta blocker arm versus 6.9% in the placebo arm (P=0.04).
- However, the total mortality was higher in the CR metoprolol group (3.1%) than in the placebo group (2.3%) (P=0.03).
- The higher mortality in the beta blocker arm was driven by an increase in the stroke rate in this group.
- The general view of this trial is that the dose of periop beta blockers given was too large, and so led to the increased stroke rate.
**DECREASE-IV Trial**

- It is an RCT that examines the periop benefit of beta blockers and statins alone and in combination.
- This study enrolled patients who were age ≥ 40 years, scheduled for elective noncardiac surgery, and who had an estimated risk for cardiovascular death of 1% - 6%.


**DECREASE-IV Trial**

- The trial has 4 arms:
  1. Beta blocker alone (bisoprolol)
  2. Statin alone (fluvastatin)
  3. Combination of beta blocker and statin
  4. Control group
- The study medication was begun a median of 34 days prior to surgery and was continued until 30 days after surgery.
- Patients receiving beta blockers had the dose titrated to a goal HR of 50 – 70 bpm.
- The primary endpoint was a 30-day composite of cardiovascular death or non-fatal MI.


**DECREASE-IV Trial**

- The results of this trial were published in June 2009.
- Among patients receiving bisoprolol, 2.1% reached the primary endpoint of CV death or non-fatal MI, compared to 6.0% of the control patients (P=0.002). This is a 67% relative reduction.
- There was no significant difference in the rate of stroke between patients receiving bisoprolol (0.8%) and control patients (0.6%) (P=0.68). This is in contrast to the POISE trial.


**DECREASE-IV Trial**

- Among patients receiving fluvastatin, 3.2% reached the primary endpoint of CV death or non-fatal MI, compared to 4.9% of the control patients (P=0.17).
- Thus there was a trend favoring fluvastatin, but it did not reach statistical significance.
- The primary endpoint among patients receiving both bisoprolol and fluvastatin was 2.2%, which was similar to the rate in patients receiving bisoprolol alone (1.9%).
- There was no significant difference among the groups in all-cause 30-day mortality.
- All the enrolled patients had to be statin and beta blocker naïve. This made enrollment a challenge. Only 1066 patients were enrolled. The goal was 6000.


**DECREASE-IV Trial: Take-home Points**

- Corroborates other data indicating that periop beta blockers do reduce cardiac events.
- Shows that how beta blockers are given in the periop setting is important.
  - Ideally, beta blockers should be started weeks, not hours before surgery.
  - Beta blockers should be carefully titrated to achieve a HR in the 50 – 70 bpm range, while avoiding hypotension.
- Suggests that periop statins are beneficial.
- Unable to demonstrate an additive benefit from using both a beta blocker and statin together.
### Perioperative Beta Blockers: Practical Issues

- One retrospective study from April 2011 examined perioperative atenolol versus metoprolol.
- 3787 patients undergoing inpatient surgery at the San Francisco VAMC were included.
- Patients who received atenolol, versus metoprolol, had lower 30-day mortality (1% versus 3%, $P < 0.0008$) and lower 1-year mortality (7% versus 13%, $P < 0.0001$).
- Another retrospective study of 37151 geriatric patients similarly found the combined endpoint of death or MI was significantly lower for patients receiving atenolol compared to those receiving metoprolol (2.5% versus 3.2%, $P < 0.001$).
- These results are thought to be due to the risk of missing doses of the shorter-acting metoprolol, with resultant beta-blocker withdrawal effect.

### Perioperative Beta Blockers: Take-home Points

- In patients who are already on beta blockers as outpatients for an appropriate indication, the beta blocker should be continued perioperatively, as beta-blocker withdrawal can be detrimental.
- In patients with known cardiac ischemia, such as has been demonstrated in preoperative stress testing, beta blockers should be used perioperatively in patients undergoing intermediate and high-risk surgery.

### Perioperative Statins

- When it comes to medicines to reduce periop cardiac risk, we generally think primarily of beta blockers, with statins being at most an afterthought.
- This should change.

### DECREASE III Trial

- Enrolled 497 patients, age > 40, at elevated cardiac risk, scheduled to undergo noncardiac vascular surgery.
- All patients had to be statin naive.
- All patients were on beta blockers:
  - Patients who were already taking a beta blocker were continued on this beta blocker.
  - Patients who were not on a beta blocker were started on one, and their dose was titrated based on their HR.
- Patients were randomized to fluvastatin 80 mg daily or a placebo. This statin was started on average 37 days prior to surgery and continued for at least 30 days after surgery.

Perioperative Statins: Take-home Points

- Per the ACC/AHA 2007 Periop Guidelines:
  - Class I Recommendation: “For patients currently taking statins and scheduled for noncardiac surgery, statins should be continued.”
  - Class IIa Recommendation: “For patients undergoing vascular surgery with or without clinical risk factors, statin use is reasonable.”
  - Class IIb recommendation: “For patients with at least 1 clinical risk factor who are undergoing intermediate-risk procedures, statins may be considered.”
- Statin withdrawal in the periop setting, like beta-blocker withdrawal, may be harmful and so should be avoided
- Given the encouraging data on periop statins, and the modest risk associated with them, using them as per the class IIb recommendation above is very reasonable

Perioperative Pulmonary Complications

- Although less studied in the literature than perioperative cardiac complications, perioperative pulmonary complications can be a significant cause of morbidity
- One of the reasons pulmonary complications are less often studied is that the available interventions to reduce these risks are limited
- In one series, postoperative pulmonary complications developed in 3.4% of patients undergoing noncardiac surgery at Veterans Affairs hospitals
- Postoperative pulmonary complications that contribute to this morbidity include pneumonia, respiratory failure requiring mechanical ventilation, bronchospasm, and atelectasis

Perioperative Pulmonary Risk Reduction Strategies: Lung Expansion

- In patients at elevated risk, such as those undergoing abdominal surgery, a lung expansion maneuver is appropriate, and is more effective than no intervention
- Options include incentive spirometry, lung expansion exercises, and continuous positive airway pressure
- There is no compelling evidence favoring one lung expansion intervention over another
- Continuous positive airway pressure may be appropriate in patients who are unable to undergo either incentive spirometry or lung expansion exercises

Perioperative Pulmonary Complications

- The American College of Physicians has a guideline on perioperative pulmonary complications, which makes the following recommendations:
  - Patients should be evaluated preoperatively regarding their pulmonary risk, using the risk factors we have reviewed
  - Preop spirometry and chest radiography should not be used routinely for pulmonary risk prediction
  - Patients found to be at elevated risk for pulmonary complications should:
    - Perform deep breathing exercises and/or incentive spirometry
    - Receive a nasogastric tube for postop nausea/vomiting and/or abdominal distension (that is, selectively, not routinely)


Perioperative Pulmonary Risk Reduction Strategies: NG Tube

- A Cochrane review regarding NG tube placement following abdominal surgery, which included 5240 patients, concluded that:
  - Routine prophylactic use of NG tubes after all abdominal surgeries was harmful, as patients without NG tubes had fewer pulmonary complications.
  - However, selective use of NG tubes after abdominal surgery (that is, only in the case of nausea, vomiting, or abdominal distension) may be beneficial in reducing pulmonary complications.


Perioperative Pulmonary Risk Reduction Strategies: Take-home Points

- Many of the most important risk factors for postop pulmonary complications are procedure related, such as aortic aneurysm repair and thoracic surgery.
- In general, the closer the surgical site is to the diaphragm, the higher the risk of pulmonary complications.
- Advanced age and functional capacity also are important risk factors.


Perioperative Pulmonary Risk Reduction Strategies: Take-home Points

- Interventions that appear to reduce postop pulmonary complications include lung expansion maneuvers, such as incentive spirometry and deep breathing exercises.
- Selective use of NG tubes (only in the case of nausea/vomiting or abdominal distension, not routinely) postop may be helpful.
- Avoiding long-acting neuromuscular blockade also may be helpful.


Perioperative Case 1

A 74-year-old female with a history of diabetes mellitus on metformin, hyperlipidemia, and hypertension comes to your office one week prior to a total knee replacement for osteoarthritis. She smokes 1 pack daily of cigarettes. She denies any chest pain or dyspnea on exertion. Her blood pressure is 128/84 mm Hg and her pulse is 72 bpm. Medications include amiodipine, atorvastatin, and ibuprofen prn. Which one of the following recommendation regarding perioperative management is appropriate?

- Start the patient on metoprolol
- Obtain a nuclear stress test prior to surgery
- Obtain an EKG stress test prior to surgery
- Instruct the patient to continue her atorvastatin perioperatively
- Urge the patient to stop smoking prior to surgery

The correct answer is (d): Instruct the patient to continue her atorvastatin perioperatively. The Guidelines recommend that patients currently taking statins be continued on them in the perioperative period.

The patient has zero RCRI risk factors and is undergoing intermediate risk surgery. Thus there is no reason to have the patient undergo a stress test or add a beta blocker prior to surgery.

There are data suggesting that smoking cessation immediately (< 8 weeks) before surgery may increase the risk of pulmonary complications, so urging the patient to stop smoking one week prior to surgery is not recommended.
Perioperative Case 2

A 72-year-old male with a history of diabetes mellitus on insulin, CVA, MI, hypertension, and hyperlipemia is scheduled for a bowel resection in three weeks for a localized colonic adenocarcinoma. Current medications are aspirin, atorvastatin, amlodipine, and insulin. The patient feels well and can walk up 2 flights of stairs without chest pain or shortness of breath. Which one of the following recommendation regarding perioperative management is appropriate?

- a) Obtain a nuclear stress test prior to surgery
- b) Obtain an EKG stress test prior to surgery
- c) Start metoprolol now and titrate it to a heart rate of 60 – 70 bpm
- d) Start metoprolol after he is admitted and titrate it to a heart rate of 60 – 70 bpm
- e) Stop his atorvastatin to avoid the risk of rhabdomyolysis

The correct answer is (c): Start metoprolol now and titrate it to a heart rate of 60 – 70 bpm. The patient has 3 RCRI risk factors (diabetes mellitus on insulin, CVA, and MI) and so starting a beta blocker perioperatively is recommended. The goal heart rate is 60 – 70 bpm, which can best be achieved by starting the beta blocker now and titrating it based on the heart rate.

The patient has a functional capacity of \( \geq 4 \) METs and is undergoing intermediate risk surgery, and so no stress test is indicated. His atorvastatin should be continued. Its benefits far outweigh the risk of rhabdomyolysis in this patient.

Key References
