Guidelines for Perioperative Cardiovascular Evaluation for Noncardiac Surgery*

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guideline

Committee to Update the Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery

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Purpose of Preoperative Evaluation

- Evaluate patient’s current medical status
- Provide clinical risk profile
- Recommend management of cardiac risk over entire perioperative period
- Treatment of modifiable risk factors
Role of the Consultant

- Review available patient data, history and physical examination
- Determine if further testing is needed to define cardiovascular status
- Recommend treatment to improve medical condition
- Preoperative testing recommended only if it will change surgical care or perioperative medical therapy
General Approach to the Patient

- **History** – angina, recent or past MI, HF, symptomatic arrhythmias, presence of pacemaker or ICD
- **Physical Examination** – general appearance, rales, elevated JVP, carotid and other arterial pulses, S³ gallop, murmurs
- **Comorbid Diseases**
  - Pulmonary
  - Diabetes Mellitus
  - Renal Impairment
  - Hematologic Disorders
- **Ancillary Studies** - ECG almost always indicated, blood chemistries and chest X-ray based on history and physical findings
# Clinical Predictors of Increased Perioperative Cardiovascular Risk

<table>
<thead>
<tr>
<th>Major</th>
<th>Intermediate</th>
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<tbody>
<tr>
<td>Unstable coronary syndromes</td>
<td>Mild angina pectoris</td>
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<tr>
<td>Decompensated CHF</td>
<td>Prior MI</td>
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<tr>
<td>Significant Arrhythmias</td>
<td>Compensated or prior HF</td>
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<td></td>
<td>Diabetes Mellitus (particularly taking insulin)</td>
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<td>Renal insufficiency</td>
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<td>Advanced Age.</td>
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<td>Abnormal ECG.</td>
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<td>Rhythm other than sinus.</td>
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<td>Low functional capacity.</td>
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<tr>
<td></td>
<td>History of stroke.</td>
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<td>Uncontrolled systemic hypertension</td>
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</table>
Disease Specific Approaches

- **Coronary Artery Disease (CAD)**
  - Patients with known CAD
  - Patients with major risk factors for CAD
- **Hypertension**
- **Heart Failure**
- **Valvular Heart Disease**
- **Arrhythmias and Conduction Defects**
- **Implanted Pacemakers and ICD’S**
- **Pulmonary Vascular Disease**
Type of Surgery

- **Urgency**
- **High surgical risk:**
  - Emergent major operations, particularly in the elderly
  - Aortic and other major vascular surgery
  - Peripheral vascular surgery
  - Anticipated prolonged surgical procedures associated with large fluid shifts and/or blood loss.
Type of Surgery

- Intermediate surgical risk:
  - Carotid endarterectomy
  - Head and neck surgery
  - Intraperitoneal and intrathoracic
  - Orthopedic surgery
  - Prostate surgery
Type of Surgery

- Low surgical risk:
  - Endoscopic procedures
  - Superficial procedures
  - Cataract surgery
  - Breast surgery
Supplemental Preoperative Evaluation

Noninvasive testing in preoperative patients indicated if 2 or more of following present:

- **Intermediate clinical predictors** (Canadian Class I or II angina, prior MI based on history or pathological Q waves, compensated or prior HF, or diabetes)
- **Poor functional capacity** (<4 METs)
- **High surgical risk procedure** (emergency major surgery*, aortic repair or peripheral vascular, prolonged surgical procedures with large fluid shifts or blood loss)

* Emergency major operations may require immediately proceeding to surgery without sufficient time for noninvasive testing or preoperative interventions.
Supplemental Preoperative Evaluation: When and Which Test*

- **2 or more of the following?‡**
  - Intermediate clinical predictors
  - Poor functional capacity (less than 4 METS)
  - High surgical risk
  - No further preoperative testing recommended

- **Indications for angiography? (eg, unstable angina?)**
  - Yes → Preoperative angiography
  - No → No further preoperative testing recommended

- **Patient ambulatory and able to exercise?‡**
  - Yes → ECG ETT
  - No → Exercise echo or perfusion imaging‡**

- **Bronchospasm? II° AV Block? Theophylline dependent? Valvular dysfunction?**
  - No → Prior symptomatic arrhythmia (particularly ventricular tachycardia)? Marked hypertension?
  - Yes → Pharmacologic stress imaging (nuclear or echo)

- **Prior symptomatic arrhythmia (particularly ventricular tachycardia)? Borderline or low blood pressure? Marked hypertension? Poor echo window?**
  - No → Dobutamine stress echo or nuclear imaging
  - Yes → Dipyridamole or adenosine perfusion

- **Other (eg, Holter monitor, angiography)**

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*Testing is only indicated if the results will impact care.

‡See Table 1 for the list of intermediate clinical predictors, Table 2 for thermodynamic equivalents, and Table 3 for the definition of high-risk surgical procedure.

‡ Able to achieve more than or equal to 85% MPHR

** In the presence of LBBB, vasodilator perfusion imaging is preferred.
Supplemental Preoperative Evaluation

- Noninvasive resting left ventricular function:
  - Risk of complications greatest with EF<35%.

- Recommendations
  - Class I: Poorly controlled HF.*
  - Class IIa: Prior HF or dyspnea of unknown etiology.
  - Class III: Routine test without prior HF.

*If previous evaluation has documented severe left ventricular dysfunction, repeat preoperative testing may not be necessary.
Assessment of Risk for Coronary Artery Disease and Functional Capacity (1)

- Potential Goal, when indicated:
  - Provide objective measure of functional capacity
  - Identify presence of preoperative myocardial ischemia or cardiac arrhythmias
  - Estimate perioperative cardiac risk and long-term prognosis
Assessment of Risk for Coronary Artery Disease and Functional Capacity (2)

- **Specific Approaches:**
  - Exercise stress testing.
  - Nonexercise stress testing:
    - Dobutamine stress echocardiography.
    - Myocardial perfusion imaging.
  - Ambulatory electrocardiographic monitoring.
Assessment of Risk for Coronary Artery Disease and Functional Capacity (3)

Recommendations:
- Test of choice is exercise ECG testing
  - Provides estimate of functional capacity
  - Detects myocardial ischemia through ECG changes and hemodynamic response
Implications of Risk Assessment Strategies on Costs

- Potential benefit:
  - Identifying unsuspected CAD
  - Decreasing morbidity/mortality

- Risk:
  - Morbidity/mortality from test
  - Cost of screening
  - Cost of treatment
Recommendations for Coronary Angiography in Perioperative Evaluation

Class I: Patients with suspected or known CAD

- Evidence for high risk of adverse outcome based on noninvasive test results
- Angina unresponsive to adequate medical therapy
- Unstable angina, particularly when facing intermediate-risk or high-risk noncardiac surgery
- Equivocal noninvasive test results in patients at high-clinical risk undergoing high-risk surgery
Recommendations for Coronary Angiography in Peri-operative evaluation

Class IIa

1. Multiple markers of intermediate clinical risk and planned vascular surgery (noninvasive testing should be considered first).
2. Moderate to large region of ischemia on noninvasive testing but without high-risk features and without lower LVEF.
4. Urgent noncardiac surgery while convalescing from acute MI.
Class IIb

1. Perioperative MI.

2. Medically stabilized class III or IV angina and planned low-risk or minor
Class III
1. Low-risk noncardiac surgery with known CAD and no high-risk results on noninvasive testing
2. Asymptomatic after coronary revascularization with excellent exercise capacity (> 7 METs).
3. Mild stable angina with good left ventricular function and no high-risk noninvasive test results.
4. Noncandidate for coronary revascularization owing to concomitant medical illness, severe left ventricular dysfunction (e.g., LVEF less than 0.20), or refusal.
5. Candidate for liver, lung, or renal transplant more than 40 years old as part of evaluation for transplantation, unless noninvasive testing reveals high risk.
Preoperative Therapy (1)

- **Recommendation: Preoperative CABG**
  - No randomized clinical trials documenting decreased incidence of perioperative cardiac events
  - Patients with prognostic high risk coronary anatomy in whom long-term outcome would likely be improved. (ACC/AHA CABG Guidelines)
  - Noncardiac elective surgical procedure of high or intermediate risk.
Preoperative Therapy (2)

- Recommendation: Preoperative percutaneous coronary intervention (PCI)
  - No randomized clinical trials documenting decreased incidence of perioperative cardiac events
  - No prospective studies to determine optimal period of delay after PCI before noncardiac surgery
  - Delay of 2-4 weeks after PCI with stent placement supported by observational study
Preoperative Therapy (3)

- **Recommendations:** Medical Therapy.
  - Few randomized trials
  - Studies suggest B-blockers reduce perioperative ischemia and may reduce risk of MI and death
  - *Alpha-agonists may also reduce cardiac events when administered perioperatively*
Preoperative Therapy with B-Blockers

Class I.

1. B-blockers required in recent past to control symptoms of angina or patients with symptomatic arrhythmias or hypertension
2. Patients at high cardiac risk owing to the finding of ischemia on preoperative testing who are undergoing vascular surgery
3. Class IIa. Preoperative assessment identifies untreated hypertension, known coronary disease, or major risk factors for coronary disease
4. Class III. Contraindications to B-blockade
Preoperative Therapy with B-Blockers

- Start pre-op, titrate to HR<60 bpm
- Short acting beta-blockers provide more flexible dosing
- Give orally, if possible, with IV supplementation when patient NPO
Preoperative Therapy with Alpha2-Agonists

- **Class I:** None
- **Class IIb:**
  - Alpha2 agonists: perioperative control of hypertension, or known CAD or major risk factors for CAD
- **Class III:**
  - Contraindications to alpha2 agonists.
If valvular heart surgery indicated, then should be performed before elective noncardiac surgery.

Catheter balloon valvuloplasty may offer amelioration of severe mitral or aortic stenosis who require urgent noncardiac surgery.
Preoperative Intensive Care (1)

- **Goal**
  - Optimize and augment oxygen delivery in patients at high risk

- **Hypothesis**
  - Indices derived from pulmonary artery catheter and invasive blood pressure monitoring can be used to maximize oxygen delivery, which leads to reduction in organ dysfunction
Preoperative Intensive Care (2)

Recommendation:

- Based on scant evidence, preoperative preparation in intensive care unit may benefit certain high risk patients, particularly those with decompensated HF.
### General Guidelines for Perioperative Prophylaxis for Venous Thromboembolism*

<table>
<thead>
<tr>
<th>Type of Patient/Surgery</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor surgery in a pt &lt;40 yo w/ no correlates of venous thromboembolism risk</td>
<td>Early ambulation</td>
</tr>
<tr>
<td>Moderate-risk surgery in a pt &gt;40-60 yo w/ No correlates of thromboembolism risk</td>
<td>ES; low dose subq heparin [LDH] (2 h preop &amp; q 12 h after), or IPC (intraop &amp; postop)</td>
</tr>
<tr>
<td>Major surgery in pt &lt;40-60 yo w/ clinical conditions associated w/ venous thromboembolism risk, &gt;60 yo without increased risk</td>
<td>LDH (q 8 h) or LMWH. IPC if prone to wound bleeding</td>
</tr>
</tbody>
</table>

ES: Elastic Stockings; LDH: Low Dose Heparin (subQ); LMWH: Low Molecular Weight Heparin; IPC: Intermittent Pneumatic Compression

### Perioperative Prophylaxis for Venous Thromboembolism (2)

<table>
<thead>
<tr>
<th>Type of Patient/Surgery</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high-risk surgery in a pt w/ multiple clinical conditions associated with thromboembolism risk</td>
<td>LDH, LMWH, or dextran combined w/ IPC. In selected pts, periop warfarin (INR 2.0-3.0) may be used.</td>
</tr>
<tr>
<td>Total hip replacement</td>
<td>LMWH (postop, subq twice daily, fixed dose unmonitored) or warfarin (INR 2.0-3.0, started preop) or immed after surgery) or adjusted dose unfractionated heparin (started preop). ES or IPC may provide addn’l efficacy.</td>
</tr>
</tbody>
</table>

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### Perioperative Prophylaxis for Venous Thromboembolism (3)

<table>
<thead>
<tr>
<th>Type of Patient/Surgery</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total knee replacement</td>
<td>LMWH (postop, subq, twice daily, fixed dose unmonitored) or IPC.</td>
</tr>
<tr>
<td>Hip fracture surgery</td>
<td>LMWH (preop, subq, fixed dose unmonitored) or warfarin (INR 2.0-3.0). IPC may provide additional benefit.</td>
</tr>
<tr>
<td>Intracranial neurosurgery</td>
<td>IPC w/ or w/o ES. Consider additional of LDH or LMWH in high-risk pts.</td>
</tr>
</tbody>
</table>

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## Perioperative Prophylaxis for Venous Thromboembolism (4)

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<thead>
<tr>
<th>Type of Patient/Surgery</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute spinal cord injury with lower-extremity paralysis</td>
<td>LMWH for prophylaxis. Warfarin may also be effective. ES and IPC may have benefit when used with LMWH.</td>
</tr>
<tr>
<td>Patients with multiple trauma</td>
<td>LMWH when feasible, serial surveillance with duplex ultrasonography may be useful. In selected very high-risk pts, consider prophylactic caval filter. If LMWH not feasible, IPC may be useful.</td>
</tr>
</tbody>
</table>

ES: Elastic Stockings; LDH: Low Dose Heparin (subQ); LMWH: Low Molecular Weight Heparin; IPC: Intermittent Pneumatic Compression
Anesthetic Considerations and Intraoperative Management (1)

- No study clearly demonstrated improved outcome from use of:
  - Regional versus general anesthesia
  - Pulmonary artery catheter
  - Intraoperative Nitroglycerin
  - ST-Segment Monitoring
  - Transesophageal echocardiography
  - Prophylactic placement of intra-aortic balloon counterpulsation device
Recommendations for Intraoperative Nitroglycerin

**Class I:** High-risk patients previously taking nitroglycerin who have active signs of myocardial ischemia without hypotension.

**Class IIb:** Prophylactic agent for high-risk patients, particularly when nitrate therapy required to control angina. (Consider side effects of vasodilation)

**Class III:** Patients with signs of hypovolemic or hypotension.
Anesthetic Considerations and Intraoperative Management (3)

Recommendations for Perioperative ST-Segment Monitoring

Class IIa
1. When available, proper use of computerized ST-segment analysis in patients with known CAD or undergoing vascular surgery may provide increased sensitivity to detect myocardial ischemia during the perioperative period and may identify patients who would benefit from further postoperative and long-term interventions.

Class IIb
1. Patients with single or multiple risk factors for CAD.

Class III
1. Patients at low risk for CAD.
Choice of anesthetic and intraoperative monitoring best left to discretion of anesthesia care team
Post operative myocardial ischemia:
- Strongest predictor of perioperative cardiac morbidity.
- May go untreated until overt symptoms of cardiac failure develop.
- Diagnosis of perioperative MI has short and long-term prognostic value.
- 30% to 50% perioperative mortality and reduced long-term survival.
Perioperative Surveillance: Intraoperative and Postoperative Use of Pulmonary Artery Catheters

Class IIa: Patients at risk for major hemodynamic disturbances most easily detected by a pulmonary artery catheter undergoing procedure likely to cause these hemodynamic changes in setting with experience in interpreting results (e.g., suprarenal aortic aneurysm repair in a patient with angina).

Class IIb: Either patient’s condition or surgical procedure (but not both) places patient at risk for hemodynamic disturbances.

Class III: No risk of hemodynamic disturbances
Perioperative Surveillance: Potential Myocardial Infarction (1)

- Patients without evidence of CAD:
  - Surveillance restricted to those who develop perioperative signs of cardiovascular dysfunction
Perioperative Surveillance: Potential Myocardial Infarction (2)

- Patients with known or suspected CAD, and undergoing high or intermediate risk procedure:
  - ECGs at baseline, immediately after procedure, and daily x 2 days
  - Cardiac troponin measurements 24 hours postoperatively and on day 4 or hospital discharge (whichever comes first)
Perioperative Surveillance: Arrhythmia/Conduction Disease (1)

- Often due to remedial noncardiac problems:
  - Infection
  - Hypotension
  - Metabolic derangements
  - Hypoxia.
Perioperative Surveillance: Arrhythmia/Conduction Disease (2)

- Cardioversion not recommended in patients without hemodynamic compromise until precipitating causes corrected or modified.

- Electrical cardioversion for supraventricular or ventricular arrhythmias causing hemodynamic compromise.
Postoperative Therapy/Future Management

- Treatment of Perioperative MI
  - ACC/AHA guidelines for ACS and AMI, with consideration of post-op conditions
  - Coronary reperfusion for ST elevation MI
  - Treat risk factors for secondary prevention
Postoperative Therapy/Future Management

- Assessment and management of risk factors for:
  - CAD
  - Heart failure
  - Hypertension
  - Stroke
  - Peripheral vascular disease
  - Other cardiovascular disease
Conclusions (1)

- Perioperative evaluation and management results from good communication between surgeon, anesthesiologist, primary care physician, and consultant
Conclusions (2)

- Further cardiac testing and treatments same as in nonoperative setting, considering:
  - The urgency of the noncardiac surgery
  - Patient-specific risk factors
  - Surgery-specific considerations
Conclusions (3)

- Use Preoperative Tests When:
  - Clinical assessment suggests intermediate risk and surgical risk not low
  - Surgical risk is high
  - Results will affect patient management
Conclusions (4)

- Perioperative evaluation goals:
  - Accurately estimate perioperative risk
  - Lowering perioperative cardiac risk, if possible
  - Assess long-term risk
  - Address modifiable coronary risk factors