Where to begin

- Three elements must be assessed to determine the risk of cardiac events
  - Patient specific clinical variables
  - Exercise capacity
  - Surgery-specific risk

The 2007 American College of Cardiology/American Heart Association (ACC/AHA) guidelines on perioperative cardiovascular evaluation for noncardiac surgery
History

- History of previous coronary heart disease, heart failure (HF), aortic stenosis, severe hypertension, and peripheral artery disease (PAD)

- Symptoms
  - Angina, heart failure, dyspnea

- Clinical course

- Exercise tolerance

The 2007 American College of Cardiology/American Heart Association (ACC/AHA) guidelines on perioperative cardiovascular evaluation for noncardiac surgery
Functional capacity

- The assessment of functional ability provides valuable prognostic information, since patients with good functional status have a lower risk of complications.

- Perioperative cardiac and long-term risk is increased in patients unable to meet a 4-MET demand during most normal daily activities.

Workload estimation

- Can take care of self, such as eat, dress or use the toilet (1 MET)
- Can walk up a flight of steps or a hill (4 METs)
- Can do heavy work around the house such as scrubbing floors or lifting or moving heavy furniture (between 4 and 10 METs)
- Can participate in strenuous sports such as swimming, singles tennis, football, basketball, and skiing (>10 METs)

Bruce Protocol
Standard (3 minute stages)

- Stage 0  1.7 mph/0% grade/2 METs
- Stage 0.5  1.7 mph/5% grade/3 METs
- Stage 1  1.7 mph/10% grade/5 METs
- Stage 2  2.5 mph/12% grade/7 METs
- Stage 3  3.4 mph/14% grade/10 METs
- Stage 4  4.2 mph/16% grade/13 METs
- Stage 5  5.0 mph/18% grade/15 METs
- Stage 6  5.5 mph/20% grade/18 METs
- Stage 7  5.5 mph/22% grade/20 METs
Increased risk

- Increased risk of postoperative cardiopulmonary complications after major noncardiac surgery
- inability to climb two flights of stairs or walk four blocks
- Must take into account functional limitations


Who is at lowest risk

- Good functional status
- Absence of known cardiovascular disease
- Low score on one of the multifactorial risk indices
- This group has a very low rate of major complications, even in patients undergoing major vascular surgery

Physical examination

- RED FLAGS
  - Evidence of HF
  - Murmur suspicious for aortic stenosis
  - Symptoms suggestive of unstable angina

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Resting electrocardiogram

- **RED FLAGS**
  - Presence of Q waves or significant ST segment elevation or depression has been associated with an increased incidence of perioperative cardiac complications.


Baseline testing

- Preoperative resting 12-lead ECG in patients with at least one clinical risk factor scheduled to undergo vascular surgery OR those patients scheduled to undergo intermediate-risk surgery with known cardiovascular disease, peripheral artery disease or cerebrovascular disease

- A less strong recommendation was given for those scheduled to undergo vascular surgery with no clinical risk factors OR those scheduled to undergo intermediate risk surgery with at least once clinical risk factor

CLINICAL PREDICTORS OF PERIOPERATIVE RISK

- Major predictors
  - When a major risk factors are present intensive management is mandated, which may result in delay or cancellation of surgery unless it is emergent.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Recent MI or Severe Angina  
(Major Predictors)

- There are two unstable coronary syndromes which are associated with a major perioperative risk: recent myocardial infarction (MI), and unstable or severe angina.

- Recent MI is defined as occurring greater than seven days but ≤30 days. Although there are no adequate clinical trials on which to base firm recommendations, it appears reasonable to wait at least four to six weeks after MI to perform elective surgery in such patients.
Major Risk Factor

- Severe angina (Canadian Cardiovascular Society [CCS]) class III or IV is associated with a major risk of perioperative complications

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Significant Arrhythmias

(Major Predictors)

- High-grade atrioventricular block
- Sustained ventricular tachycardia
- Nonsustained ventricular tachycardia in the presence of underlying heart disease
- Supraventricular arrhythmias with an uncontrolled ventricular rate.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Clinical Predictors

- Ischemic heart disease including mild angina (CCS class I or II) or prior MI by history or pathologic Q wave
- Compensated or prior heart failure (HF)
- Diabetes mellitus
- Renal insufficiency (preoperative creatinine >2.0 mg/dL)
- Cerebrovascular disease

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
**ACC/AHA guideline summary: Clinical predictors of increased perioperative cardiovascular risk (myocardial infarction, heart failure, death)**

<table>
<thead>
<tr>
<th>Major predictors that require intensive management and may lead to delay in or cancellation of the operative procedure unless emergent</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Unstable coronary syndromes including unstable or severe angina or recent MI</td>
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<td>• Decompensated heart failure including NYHA functional class IV or worsening or new-onset HF</td>
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<td>• Significant arrhythmias including high grade AV block, symptomatic ventricular arrhythmias, supraventricular arrhythmias with ventricular rate &gt;100 bpm at rest, symptomatic bradycardia, and newly recognized ventricular tachycardia</td>
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<td>• Severe heart valve disease including severe aortic stenosis or symptomatic mitral stenosis</td>
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**Other clinical predictors that warrant careful assessment of current status**

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• History of ischemic heart disease</td>
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<td>• History of compensated heart failure or prior heart failure</td>
</tr>
<tr>
<td>• Diabetes mellitus</td>
</tr>
<tr>
<td>• Renal insufficiency</td>
</tr>
</tbody>
</table>

Obese patient

- The estimation of risk is more difficult in obese patients due to the uncertain significance of certain components of the history (dyspnea) and physical examination (lower-extremity edema). The generally poor exercise capacity of the obese further complicates risk assessment.

Obese patient

- 2009 scientific advisory on cardiovascular evaluation and management of severely obese patients undergoing surgery from the AHA states that specific tests should be performed only if the results will change management.

Obese patient

- A baseline recommendation includes
  - A 12 lead electrocardiogram (ECG) is reasonable in all obese patients with at least one risk factor for CHD (diabetes, smoking, hypertension, or hyperlipidemia) or poor exercise tolerance.
  - A chest radiograph (posteroanterior and lateral) should be obtained on all severely obese patients prior to surgery, as the sensitivity and specificity (for the diagnosis of cardiopulmonary disease) of the physical examination is decreased.

Emergency surgery is associated with particularly high risk, as cardiac complications are two to five times more likely than with elective procedures.

### ACC/AHA guideline summary: Cardiac risk stratification for noncardiac surgical procedures

<table>
<thead>
<tr>
<th>High risk</th>
<th>Reported risk of cardiac death or nonfatal myocardial infarction (MI) often greater than 5 percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aortic and other major vascular surgery</td>
</tr>
<tr>
<td></td>
<td>Peripheral artery surgery</td>
</tr>
<tr>
<td>Intermediate risk</td>
<td>Reported risk of cardiac death or nonfatal MI generally 1 to 5 percent</td>
</tr>
<tr>
<td></td>
<td>Carotid endarterectomy</td>
</tr>
<tr>
<td></td>
<td>Head and neck surgery</td>
</tr>
<tr>
<td></td>
<td>Intraperitoneal and intrathoracic surgery</td>
</tr>
<tr>
<td></td>
<td>Orthopedic surgery</td>
</tr>
<tr>
<td></td>
<td>Prostate surgery</td>
</tr>
<tr>
<td>Low risk*</td>
<td>Reported risk of cardiac death or nonfatal MI generally less than 1 percent</td>
</tr>
<tr>
<td></td>
<td>Ambulatory surgery</td>
</tr>
<tr>
<td></td>
<td>Endoscopic procedures</td>
</tr>
<tr>
<td></td>
<td>Superficial procedure</td>
</tr>
<tr>
<td></td>
<td>Cataract surgery</td>
</tr>
<tr>
<td></td>
<td>Breast surgery</td>
</tr>
</tbody>
</table>

* Do not generally require further preoperative cardiac testing.

Revised Goldman cardiac risk index (RCRI)

<table>
<thead>
<tr>
<th>Six independent predictors of major cardiac complications[^1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-risk type of surgery (examples include vascular surgery and any open intraperitoneal or intrathoracic procedures)</td>
</tr>
<tr>
<td>History of ischemic heart disease (history of MI or a positive exercise test, current complaint of chest pain considered to be secondary to myocardial ischemia, use of nitrate therapy, or ECG with pathological Q waves; do not count prior coronary revascularization procedure unless one of the other criteria for ischemic heart disease is present)</td>
</tr>
<tr>
<td>History of HF</td>
</tr>
<tr>
<td>History of cerebrovascular disease</td>
</tr>
<tr>
<td>Diabetes mellitus requiring treatment with insulin</td>
</tr>
<tr>
<td>Preoperative serum creatinine &gt;2.0 mg/dL (177 μmol/L)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rate of cardiac death, nonfatal myocardial infarction, and nonfatal cardiac arrest according to the number of predictors[^2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>No risk factors - 0.4 percent (95% CI: 0.1-0.8)</td>
</tr>
<tr>
<td>One risk factor - 1.0 percent (95% CI: 0.5-1.4)</td>
</tr>
<tr>
<td>Two risk factors - 2.4 percent (95% CI: 1.3-3.5)</td>
</tr>
<tr>
<td>Three or more risk factors - 5.4 percent (95% CI: 2.8-7.9)</td>
</tr>
</tbody>
</table>

References:
Peri-operative Beta Blockers

- Beta blockers reduce ischemia by decreasing myocardial oxygen demand due to increased catecholamine release.
- They may also help prevent or control arrhythmias.
- Patients who take beta blockers chronically for management of angina are at risk of ischemia with withdrawal of beta blockade.
- Acute withdrawal of a beta blocker pre or postoperatively can lead to substantial morbidity and even mortality.

POISE

Trial Design: POISE was a randomized trial of metoprolol (n = 4,174) or placebo (n = 4,177) in patients undergoing noncardiac surgery. Study drug was given 2 to 4 hours prior to surgery and for the next 30 days. Primary endpoint was major CV events (defined as CV death, MI, or cardiac arrest through 30 days).

Results
- Primary endpoint of CV death, MI, or cardiac arrest ↓ in metoprolol (Figure), driven by ↓ nonfatal MI (3.6% vs. 5.1%, HR 0.70, p = 0.0007)
- Total mortality ↑ in metoprolol group (Figure) as did stroke (1.0% vs. 0.5%, HR 2.17, p = 0.005)
- Metoprolol group also had ↑ rates of significant hypotension (15.0% vs. 9.7%, p < 0.0001) and significant bradycardia (6.6% vs. 2.4%, p < 0.0001)

Conclusions
- Among patients undergoing noncardiac surgery, treatment with beta-blocker metoprolol was associated with reduction in primary endpoint of CV death, MI, or cardiac arrest at 30 days compared with placebo, but total mortality and stroke were increased with metoprolol
- Prior studies with prophylactic beta-blocker in patients undergoing vascular surgery have shown mixed results
- While post-surgical CV event rate was high, given increased risk of death, stroke, and severe hypotension with metoprolol, routine prophylactic therapy does not appear to be a safe approach to reducing CV events in this population.

Presented at AHA 2007
Risk Models

- NSQIP database risk model — The American College of Surgeons’ National Surgical Quality Improvement Program database

- Used to determine risk factors associated with intraoperative/postoperative myocardial infarction or cardiac arrest (MICA).

- Among over 200,000 patients who underwent surgery in 2007, 0.65 percent developed perioperative MICA. On multivariate logistic regression analysis, type of surgery, dependent functional status, abnormal creatinine, American Society of Anesthesiologists’ class, and increased age were identified as predictors of MICA.

- A risk model was developed using these five risks factors and subsequently validated on a 2008 data set (n = 257,385). The risk model had a relatively high predictive accuracy (C statistic of 0.874), and outperformed the RCRI (C statistic of 0.747). An easy to use calculator was developed from this model.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
### American Society of Anesthesiologists Physical Status Classification System

<table>
<thead>
<tr>
<th>ASA</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A normal healthy patient</td>
</tr>
<tr>
<td>2</td>
<td>A patient with mild systemic disease</td>
</tr>
<tr>
<td>3</td>
<td>A patient with severe systemic disease</td>
</tr>
<tr>
<td>4</td>
<td>A patient with severe systemic disease that is a constant threat to life</td>
</tr>
<tr>
<td>5</td>
<td>A moribund patient who is not expected to survive without the operation</td>
</tr>
<tr>
<td>6</td>
<td>A declared brain-dead patient whose organs are being removed for donor purposes</td>
</tr>
</tbody>
</table>

ASA Physical Status Classification System is reprinted with permission of the American Society of Anesthesiologists, 520 N. Northwest Highway, Park Ridge, Illinois 60068-2573.
Detsky modified risk index

- Detsky and coworkers added angina and pulmonary edema to the original Goldman variables:
  - Unstable angina within three months prior to surgery
  - Stable angina occurring with minimal physical activity
  - Recent pulmonary edema

- These were assigned a high number of points, thereby contributing to an increased risk

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
# Detsky modified cardiac risk index

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary artery disease</td>
<td></td>
</tr>
<tr>
<td>Myocardial infarction &lt;six months earlier</td>
<td>10</td>
</tr>
<tr>
<td>Myocardial infarction &gt;six months earlier</td>
<td>5</td>
</tr>
<tr>
<td>Canadian Cardiovascular Society angina classification*</td>
<td></td>
</tr>
<tr>
<td>Class III</td>
<td>10</td>
</tr>
<tr>
<td>Class IV</td>
<td>20</td>
</tr>
<tr>
<td>Alveolar pulmonary edema</td>
<td></td>
</tr>
<tr>
<td>Within one week</td>
<td>10</td>
</tr>
<tr>
<td>Ever</td>
<td>5</td>
</tr>
<tr>
<td>Suspected critical aortic stenosis</td>
<td>20</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td></td>
</tr>
<tr>
<td>Rhythm other than sinus or sinus plus atrial premature beats on</td>
<td>5</td>
</tr>
<tr>
<td>electrocardiogram</td>
<td></td>
</tr>
<tr>
<td>&gt;Five premature ventricular contractions on electrocardiogram</td>
<td>5</td>
</tr>
<tr>
<td>Poor general medical status, defined as any of the following:</td>
<td>5</td>
</tr>
<tr>
<td>PO2 &lt; 60 mm Hg, PCO2 &gt; 50 mm Hg, serum potassium &lt; 3.0 meq/L, blood</td>
<td></td>
</tr>
<tr>
<td>urea nitrogen &gt; 50 mg/dL (17.9 mmol/L), serum creatinine &gt; 2.9 mg/dL</td>
<td></td>
</tr>
<tr>
<td>(260 μmol/L), bedridden</td>
<td></td>
</tr>
<tr>
<td>Age &gt;70 years</td>
<td>5</td>
</tr>
<tr>
<td>Emergency surgery</td>
<td>10</td>
</tr>
</tbody>
</table>

**Class I:** 0 to 15 points  
**Class II:** 20 to 30 points  
**Class III:** more than 30 points

* Canadian Cardiovascular Society classification of angina:  
  I: Asymptomatic.  
  II: Angina with strenuous exercise.  
  III: Angina with moderate exertion.  
  IV: Angina with walking one to two level blocks or climbing one flight of stairs or less at a normal pace.  
  IV: Inability to perform any physical activity without development of angina.

Fleisher-Eagle Criteria

- Fleisher and Eagle emphasized six factors, the first five of which are also in the revised cardiac risk index, associated with increased cardiac risk in patients undergoing noncardiac surgery, including vascular surgery:
  - Ischemic heart disease (angina or prior MI)
  - Heart failure
  - High-risk surgery (including intraperitoneal, intrathoracic, and suprainguinal vascular procedures)
  - Diabetes mellitus (especially insulin-requiring)
  - Renal insufficiency
  - Poor functional status (defined as the inability to walk four blocks or climb two flights of stairs)

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Aortic Stenosis

- Most of the risk indices did not include aortic stenosis as a risk factor
- However, moderate-to-severe aortic stenosis appears to be a significant risk factor for adverse cardiac outcomes after noncardiac surgery.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Risk Models

- **RCRI**
  - Has been in use for over 10 years
  - Familiar to providers

- **NSQIP model**
  - Validated in a large cohort
  - Somewhat higher predictive accuracy than the RCRI
  - Developed from a cohort of CAD patients Tx with more contemporary strategies

- **Bottom line= Become familiar with one model and use it regularly**

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
NONINVASIVE CARDIAC TESTING

- Risk indices provide useful guidelines but are not sufficiently precise to estimate risk, particularly in patients at intermediate risk.

- Noninvasive testing with either stress testing, resting echocardiography, or both permits further stratification in patients deemed to be at intermediate risk after clinical evaluation.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Testing

- Exercise is usually the preferred stress
- Exercise tolerance is an important predictor of outcome that appears to be more important than the ECG response.
- Pharmacologic stress testing can be used in patients who cannot exercise.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
DECREASE-II trial

- 770 patients scheduled to undergo major vascular surgery (mostly for abdominal aortic aneurysm or peripheral artery disease)
- Randomly assigned to pharmacologic stress testing or no testing.
- Patients with positive tests and extensive ischemia could be managed with preoperative revascularization.
- All patients received perioperative beta blocker therapy, with dose adjustment with a goal resting heart rate between 60 to 65 beats/min.
DECREASE-II trial

- The incidence of the primary end point of cardiac death or nonfatal myocardial infarction at 30 days after surgery was similar between the non-testing and stress testing groups (1.8 versus 2.3 percent; odds ratio 0.78; 95% CI 0.3-2.1)
The authors concluded that preoperative stress testing can be safely omitted in intermediate risk patients who have stable or no clinical coronary disease in whom beta blockers are given aiming at tight heart rate control. However, only 34 patients randomized to stress testing had extensive ischemia and few (six patients) had complete revascularization.
Algorithms

- Three major algorithms have been proposed by the ACC/AHA, Fleisher and Eagle, and the American College of Physicians (ACP). The ACC/AHA guidelines and the Fleisher-Eagle approach are largely based upon the criteria in the revised cardiac risk index (RCRI)

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Risk Status

- The importance of underlying risk status as a determinant of the value of stress testing can be illustrated by the following calculations with dobutamine echocardiography, which has a reported sensitivity and specificity of 85 and 70 percent, respectively, for predicting perioperative death or nonfatal MI.

- A patient with two RCRI risk factors may have a 2 percent pretest probability of a cardiac complication. A positive dobutamine stress test results in a modest increase in posttest probability to 5 percent.

- A patient with four RCRI risk factors may have a 9 percent pretest probability of a cardiac complication. A positive dobutamine stress test increases the posttest probability to about 20 percent, while a negative test reduces the posttest probability to about 2 percent.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
### ACC/AHA guideline summary: Exercise or pharmacologic stress testing prior to noncardiac surgery

<table>
<thead>
<tr>
<th>Class IIIa - The evidence or opinion is in favor of benefit from exercise or pharmacological stress testing prior to noncardiac in the following setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>• For evaluation of patients scheduled to undergo vascular surgery with three or more clinical risk factors and poor functional capacity (&lt;4 METS) if it will change management</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class IIIb - The weight of evidence or opinion is less well established for the benefit of exercise or pharmacological stress testing prior to noncardiac surgery in the following settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>• For evaluation of patients scheduled to undergo intermediate-risk surgery with at least one clinical risk factor and poor functional capacity (&lt;4 METS) if it will change management</td>
</tr>
<tr>
<td>• For evaluation of patients scheduled to undergo vascular surgery with at least one clinical risk factor and good functional capacity (≥4 METS)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class III - There is evidence and/or general agreement that exercise or pharmacological stress testing prior to noncardiac surgery is not useful in the following settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>• For evaluation of patients scheduled to undergo intermediate-risk surgery with no clinical risk factors</td>
</tr>
<tr>
<td>• For evaluation of patients scheduled to undergo low-risk noncardiac surgery</td>
</tr>
</tbody>
</table>

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ACC/AHA guideline summary: Preoperative noninvasive evaluation of left ventricular (LV) function

<table>
<thead>
<tr>
<th>Class IIa</th>
<th>The evidence or opinion is in favor of benefit from preoperative noninvasive evaluation of LV function prior to noncardiac surgery in the following settings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Patients with dyspnea of unknown origin</td>
<td></td>
</tr>
<tr>
<td>• Patients with current or prior heart failure with worsening dyspnea or other changes in clinical status who have not undergone testing within 12 months</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class IIb</th>
<th>The weight of evidence or opinion is less well established for the benefit of preoperative noninvasive evaluation of LV function</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Routine evaluation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class III</th>
<th>There is evidence and/or general agreement that preoperative noninvasive evaluation of LV function prior to noncardiac surgery is not useful in the following setting:</th>
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<tbody>
<tr>
<td>• Routine testing</td>
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</tr>
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</table>

 Patients with ACTIVE cardiac conditions (eg, unstable coronary syndromes, decompensated heart failure, significant arrhythmias, or severe valvular stenosis) not undergoing emergency surgery should first be managed according to ACC/AHA guidelines.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Patients without active cardiac symptoms undergoing low risk surgery OR those with good functional capacity (MET level \( \geq 4 \)) require no preoperative testing aside from an ECG.
### ACC/AHA guideline summary: Preoperative 12-lead rest electrocardiogram (ECG) prior to noncardiac surgery

<table>
<thead>
<tr>
<th>Class I - There is evidence and/or general agreement that a preoperative rest ECG should be obtained in the following setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Patients with a least one clinical risk factor who require vascular surgical procedures</td>
</tr>
<tr>
<td>- Patients with atherosclerotic cardiovascular disease scheduled for intermediate-risk procedures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class IIa - The evidence or opinion is in favor of usefulness of a preoperative rest ECG in the following setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Patients with no clinical risk factors who require vascular surgical procedures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class IIb - The evidence or opinion is less well established for the usefulness of a preoperative rest ECG in the following settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Patients with at least one clinical risk factor scheduled to undergo intermediate-risk procedures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class III - There is evidence and/or general agreement that preoperative rest and postoperative ECGs are not useful in the following setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Asymptomatic patients who are scheduled for a low-risk operative procedures.</td>
</tr>
</tbody>
</table>

Patients with poor or unknown functional capacity, or potential cardiac symptoms who are scheduled to undergo intermediate risk or vascular surgery are managed according to the number of clinical risk factors. For such patients, heart rate control with beta blockade may be of benefit.

ACC/AHA Guidelines: Stable Patients

- In patients with one or two clinical risk factors, it is reasonable to proceed to surgery, unless testing will alter management.

ACC/AHA guideline summary: Clinical predictors of increased perioperative cardiovascular risk (myocardial infarction, heart failure, death)

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</tr>
<tr>
<td>• Diabetes mellitus</td>
</tr>
<tr>
<td>• Renal insufficiency</td>
</tr>
</tbody>
</table>


ACC/AHA Guidelines: Stable Patients

- In patients with three or more clinical risk factors scheduled to undergo intermediate risk surgery, it is reasonable to proceed without noninvasive testing, unless that testing will alter management.

ACC/AHA Guidelines: Stable Patients

- In patients with three or more clinical risk factors scheduled to undergo vascular surgery, the guidelines suggest noninvasive testing if it will alter management.

Stress Testing

- Exercise ECG testing is usually the preferred stress test since, as noted below, exercise tolerance is an important predictor of outcome that appears to be more important than the ECG response.

- Exercise ECG testing is usually performed with perfusion imaging or echocardiography since imaging can better identify high-risk features that would warrant referral for angiography (e.g., reversible large anterior wall defect, multiple reversible defects, ischemia occurring at a low heart rate, extensive stress-induced wall motion abnormalities, transient ischemic dilatation).

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Stress Testing

- Concurrent imaging is essential if the resting ECG has abnormalities that can interfere with the detection of ischemia during exercise stress. These include preexcitation (Wolff-Parkinson-White) syndrome, a paced ventricular rhythm, more than 1 mm of ST depression at rest, complete left bundle branch block, and patients taking digoxin or with ECG criteria for left ventricular hypertrophy, even if they have less than 1 mm of baseline ST depression.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Stress Testing

- A possible exception to the preference for exercise stress occurs in patients with an aortic aneurysm, since exercise increases systolic pressure and heart rate. Despite this theoretical concern, exercise stress appears to be safe in patients with abdominal aortic aneurysms, particularly those less than 6.0 cm in diameter. Pharmacologic stress testing is preferred in patients with abdominal aortic aneurysms ≥6.0 cm in diameter or aneurysms that are symptomatic. It is appropriate to control hypertension prior to stress testing in patients with aneurysms.

- Limited data exist upon which to make recommendations for stress testing in patients with thoracic aortic aneurysms, but a similar approach to that for abdominal aortic aneurysms seems reasonable.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Inability to exercise

- A meta-analysis evaluated the sensitivity and specificity of the different noninvasive tests for predicting perioperative death or nonfatal MI in patients undergoing major vascular surgery. The following values were obtained:
  - Exercise ECG — sensitivity 74 percent, specificity 69 percent
  - rMPI, mostly dipyridamole stress — sensitivity 83 percent, specificity 49 percent
  - Dobutamine echocardiography — sensitivity 85 percent, specificity 70 percent

Stress Testing

- When pharmacologic stress testing is indicated, the choice between tests should be based upon local experience and availability and the relative safety of the different procedures in the individual patient.

- Vasodilator/nuclear perfusion imaging is usually preferred in patients with known cardiac arrhythmias, since dobutamine can induce atrial or ventricular arrhythmias.

- Dobutamine echocardiography is preferred in patients with bronchospastic lung disease and in those with severe carotid stenosis, because vasodilator agents can induce bronchospasm and a decrease in blood pressure. It is also preferred when information about left ventricular function or valvular heart disease is desired. Dobutamine appears to be safe in patients with abdominal aortic aneurysms.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Stress Testing

- Stress testing has a very high negative predictive value for postoperative cardiovascular events (between 90 and 100 percent) but a low positive predictive value (between 6 and 67 percent, with a value of 18 percent in a review of five large studies of thallium perfusion imaging). Thus, stress testing is more useful for reducing estimated risk if negative (or normal) than for identifying patients at very high risk if positive.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013
UpToDate
Stress Testing

- Exercise stress testing without myocardial imaging is the standard method for determining functional capacity and for the detection of myocardial ischemia. Exercise tolerance appears to be more important than the ECG response to exercise.

- Inability to perform moderate exercise or to achieve greater than 85 percent of predicted maximal heart rate during exercise treadmill testing is associated with a high risk of a postoperative cardiac event, even in the absence of diagnostic ischemic ECG changes.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Stress Testing

- The predictive value of DSE appears to vary with patient risk, having limited utility in patients at very low risk and in lower risk patients taking a beta blocker.

- In contrast, DSE provided additional prognostic information in patients who had three or more clinical risk factors. In addition, patients with \( \geq 5 \) segments involved had more cardiac events than those with limited stress-induced ischemia (one to four segments) (36 versus 3 percent). Among such patients taking a beta blocker, those with stress-induced ischemia had a significantly higher risk of a cardiac event at 30 days (10.6 versus 2 percent without ischemia).

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Stress Testing

• Hypotension during DSE is another factor associated with an adverse cardiovascular outcome (cardiac death, infarction, and ischemia) in the perioperative period. In one series of 300 patients, a hypotensive response was observed in 28 percent; with a multivariate analysis, hypotension was a significant predictor of a cardiac event (odds ratio 4.1)

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Transthoracic Echocardiogram

- The main indications for preoperative resting TTE are similar to those in nonsurgical patients (e.g., to evaluate valve function in patients with a murmur or left ventricular systolic function, especially in patients with heart failure of unknown cause).

- The 2007 ACC/AHA guidelines on perioperative cardiovascular evaluation and care for noncardiac surgery (not changed in the 2009 focused update) recommended assessment of LV function in patients with current heart failure or prior heart failure with worsening dyspnea, as well as those with dyspnea of unknown origin.

The process of estimating and reducing the risk of perioperative cardiac events (eg, cardiac death and nonfatal MI), includes the following four components:

- Defining the urgency of surgery. For instance, risk assessment may not alter the management of patients who need emergency surgery.
- Initial risk assessment.
- Refinement of initial risk assessment with noninvasive testing in selected patients.
- Efforts to reduce risk in high-risk patients (eg, beta blockers, revascularization). These therapeutic issues and those related to the perioperative evaluation and management of heart failure in relation to noncardiac surgery are discussed separately.

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Initial risk assessment

- The initial risk assessment consists of three steps:
  - Does the patient have a high-risk condition that is considered a major predictor of risk in the ACC/AHA guidelines? Such patients require intensive management and often a delay in or cancellation of surgery.
  - What is the surgery-specific risk of the planned operation?
  - What is the patient-specific risk?

Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
Summary

- 2007 ACC/AHA guidelines concluded that the evidence was in favor of benefit of preoperative stress testing for patients deemed to be at high risk (≥3 revised cardiac index criteria) and with poor functional capacity (<4 METS) who are scheduled for vascular surgery when such testing will change management.

Summary

- Stress testing has a very high negative predictive value for postoperative cardiovascular events (between 90 and 100 percent) but a low positive predictive value (between 6 and 67 percent, with a value of 18 percent in a review of five large studies of thallium perfusion imaging). Thus, stress testing is more useful for reducing estimated risk if negative (or normal) than for identifying patients at very high risk when positive.

-Jonathan B Shammash et al, Estimation of cardiac risk prior to noncardiac surgery. 2013 UpToDate
RISK FACTOR MODIFICATION
## Lipids

### TABLE 2. ATP III LDL-C Goals and Cutpoints for TLC and Drug Therapy in Different Risk Categories and Proposed Modifications Based on Recent Clinical Trial Evidence

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>LDL-C Goal</th>
<th>Initiate TLC</th>
<th>Consider Drug Therapy**</th>
</tr>
</thead>
<tbody>
<tr>
<td>High risk: CHD* or CHD risk equivalents† (10-year risk &gt;20%)</td>
<td>&lt;100 mg/dL (optional goal: &lt;70 mg/dL)∥</td>
<td>≥100 mg/dL#</td>
<td>≥100 mg/dL†† (&lt;100 mg/dL: consider drug options)‡‡</td>
</tr>
<tr>
<td>Moderately high risk: 2+ risk factors‡ (10-year risk 10% to 20%)§§</td>
<td>&lt;130 mg/dL¶¶</td>
<td>≥130 mg/dL#</td>
<td>≥130 mg/dL (100–129 mg/dL; consider drug options)‡‡</td>
</tr>
<tr>
<td>Moderate risk: 2+ risk factors‡ (10-year risk &lt;10%)§§</td>
<td>&lt;130 mg/dL</td>
<td>≥130 mg/dL</td>
<td>≥160 mg/dL</td>
</tr>
<tr>
<td>Lower risk: 0–1 risk factor§</td>
<td>&lt;160 mg/dL</td>
<td>≥160 mg/dL</td>
<td>≥190 mg/dL (160–189 mg/dL: LDL-lowering drug optional)</td>
</tr>
</tbody>
</table>
Lipids

TABLE 3. Recommendations for Modifications to Footnote the ATP III Treatment Algorithm for LDL-C

- Therapeutic lifestyle changes (TLC) remain an essential modality in clinical management. TLC has the potential to reduce cardiovascular risk through several mechanisms beyond LDL lowering.

- In high-risk persons, the recommended LDL-C goal is <100 mg/dL.
  - An LDL-C goal of <70 mg/dL is a therapeutic option on the basis of available clinical trial evidence, especially for patients at very high risk.
  - If LDL-C is ≥100 mg/dL, an LDL-lowering drug is indicated simultaneously with lifestyle changes.
  - If baseline LDL-C is <100 mg/dL, institution of an LDL-lowering drug to achieve an LDL-C level <70 mg/dL is a therapeutic option on the basis of available clinical trial evidence.
  - If a high-risk person has high triglycerides or low HDL-C, consideration can be given to combining a fibrate or nicotinic acid with an LDL-lowering drug. When triglycerides are ≥200 mg/dL, non-HDL-C is a secondary target of therapy, with a goal 30 mg/dL higher than the identified LDL-C goal.

- For moderately high-risk persons (2+ risk factors and 10-year risk 10% to 20%), the recommended LDL-C goal is <130 mg/dL: an LDL-C goal <100 mg/dL is a therapeutic option on the basis of available clinical trial evidence. When LDL-C level is 100 to 129 mg/dL, at baseline or on lifestyle therapy, initiation of an LDL-lowering drug to achieve an LDL-C level <100 mg/dL is a therapeutic option on the basis of available clinical trial evidence.

- Any person at high risk or moderately high risk who has lifestyle-related risk factors (e.g., obesity, physical inactivity, elevated triglyceride, low HDL-C, or metabolic syndrome) is a candidate for TLC to modify these risk factors regardless of LDL-C level.

- When LDL-lowering drug therapy is employed in high-risk or moderately high-risk persons, it is advised that intensity of therapy be sufficient to achieve at least a 30% to 40% reduction in LDL-C levels.

- For people in lower-risk categories, recent clinical trials do not modify the goals and cutpoints of therapy.
### Table 1. Classification and management of blood pressure for adults*

<table>
<thead>
<tr>
<th>BP Classification</th>
<th>SBP* mmHg</th>
<th>DBP* mmHg</th>
<th>Lifestyle Modification</th>
<th>Initial Drug Therapy Without Compelling Indication</th>
<th>Initial Drug Therapy With Compelling Indications (See Table 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;120</td>
<td>and &lt;80</td>
<td>Encourage</td>
<td>No antihypertensive drug indicated.</td>
<td>Drug(s) for compelling indications.‡</td>
</tr>
<tr>
<td>Prehypertension</td>
<td>120–139</td>
<td>or 80–89</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 1 Hypertension</td>
<td>140–159</td>
<td>or 90–99</td>
<td>Yes</td>
<td>Thiazide-type diuretics for most. May consider ACEI, ARB, BB, CCB, or combination.</td>
<td>Drug(s) for the compelling indications.‡ Other antihypertensive drugs (diuretics, ACEI, ARB, BB, CCB) as needed.</td>
</tr>
<tr>
<td>Stage 2 Hypertension</td>
<td>≥160</td>
<td>or ≥100</td>
<td>Yes</td>
<td>Two-drug combination for most (usually thiazide-type diuretic and ACEI or ARB or BB or CCB).</td>
<td></td>
</tr>
</tbody>
</table>

Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure
### Table 8. Clinical trial and guideline basis for compelling indications for individual drug classes

<table>
<thead>
<tr>
<th>Compelling Indication*</th>
<th>Diuretic</th>
<th>BB</th>
<th>ACEI</th>
<th>ARB</th>
<th>CCB</th>
<th>Aldo ANT</th>
<th>Clinical Trial Basis‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart failure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ACC/AHA Heart Failure Guideline,69 MERIT-HF,41 COPERNICUS,62 CIBIS,43 SOLVD,46 AIRE,45 TRACE,45 ValHEFT,67 RALES46</td>
</tr>
<tr>
<td>Postmyocardial infarction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ACC/AHA Post-MI Guideline,69 BHAT,70 SAVE,51 Capricorn,57 EPESUS53</td>
</tr>
<tr>
<td>High coronary disease risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ALLHAT,33 HOPE,36 ANBP2,36 LIFE,32 CONVINCE31</td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NKF-ADA Guideline,21,22 UKPDS,54 ALLHAT33</td>
</tr>
<tr>
<td>Chronic kidney disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NFK Guideline,22 Captopril Trial,55 RENAAL,56 IDNT,57 REIN,58 AASK59</td>
</tr>
<tr>
<td>Recurrent stroke prevention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROGRESS55</td>
</tr>
</tbody>
</table>

Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure
Figure 1. Algorithm for treatment of hypertension

**Lifestyle Modifications**

Not at Goal Blood Pressure (<140/90 mmHg)
(<130/80 mmHg for patients with diabetes or chronic kidney disease)

**Initial Drug Choices**

Without Compelling Indications

**Stage 1 Hypertension**
(SBP 140–159 or DBP 90–99 mmHg)
Thiazide-type diuretics for most. May consider ACEI, ARB, BB, CCB, or combination.

**Stage 2 Hypertension**
(SBP ≥160 or DBP ≥100 mmHg)
Two-drug combination for most (usually thiazide-type diuretic and ACEI, or ARB, or BB, or CCB).

With Compelling Indications

Drug(s) for the compelling indications
(See table 8)
Other antihypertensive drugs (diuretics, ACEI, ARB, BB, CCB) as needed.

**Not at Goal Blood Pressure**

Optimize dosages or add additional drugs until goal blood pressure is achieved. Consider consultation with hypertension specialist.
Diabetes Mellitus

- Therapy should target a A1C level of 6.5% or less for most nonpregnant adults.
- FPG should usually be less than 110 mg/dL and the 2-hour postprandial glucose concentration should be less than 140 mg/dL.
- In certain patients, a less stringent goal may be considered (A1C 7%-8%).

AACE Diabetes Care Plan Guidelines, Endocr Pract. 2011;17(Suppl 2)
Questions?