بسم الله الرحمن الرحيم
Perioperative Cardiovascular Evaluation and Care for Noncardiac Surgery

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A stepwise approach

Step 1: Urgent surgery

Step 2: Active or Unstable cardiac conditions

Step 3: What is the risk of the surgical procedure?

Step 4: What is the functional capacity of the patient?

Step 5: In patients with moderate or low functional capacity consider the risk of surgical procedure

Step 6: Consider cardiac risk factors

Step 7: Consider non invasive tests
### Active Cardiac Conditions for Which the Patient Should Undergo Evaluation and Treatment Before Noncardiac Surgery

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

*May include stable angina in patients who are unusually sedentary. ‡The ACC National Database Library defines recent MI as more than 7 days but within 30 days)}
## Estimated Energy Requirements for Various Activities

<table>
<thead>
<tr>
<th>1 Met</th>
<th>Can You...</th>
<th>4 Mets</th>
<th>Can You...</th>
<th>≥ 10 Mets</th>
<th>Can You...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Take care of yourself?</td>
<td></td>
<td>Climb a flight of stairs or walk up a hill?</td>
<td></td>
<td>Participate in strenuous sports like swimming,...</td>
</tr>
<tr>
<td></td>
<td>Eat, dress, or use the toilet?</td>
<td></td>
<td>Walk on level ground at 4 mph (6.4 kph)?</td>
<td></td>
<td>bowling, dancing, doubles tennis, or throwing a...</td>
</tr>
<tr>
<td></td>
<td>Walk indoors around the house?</td>
<td></td>
<td>Do heavy work around the house like scrubbing...</td>
<td></td>
<td>baseball or football?</td>
</tr>
<tr>
<td></td>
<td>Walk a block or 2 on level ground at 2 to 3 mph (3.2 to 4.8 kph)?</td>
<td></td>
<td>Participate in moderate recreational activities like golf, bowling, dancing, doubles tennis, or throwing a baseball or football?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Mets</td>
<td>Do light work around the house like dusting or washing dishes?</td>
<td>≥ 10 Mets</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MET indicates metabolic equivalent; mph, miles per hour; kph, kilometers per hour. *Modified from Hlatky et al,11 copyright 1989, with permission from Elsevier, and adapted from Fletcher et al.12
## Cardiac Risk Stratification for Noncardiac Surgical Procedures

<table>
<thead>
<tr>
<th>Risk Stratification</th>
<th>Procedure Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular (reported cardiac risk often &gt; 5%)</td>
<td>Aortic and other major vascular surgery</td>
</tr>
<tr>
<td></td>
<td>Peripheral vascular surgery</td>
</tr>
<tr>
<td>Intermediate (reported cardiac risk generally 1%-5%)</td>
<td>Intraperitoneal and intrathoracic surgery</td>
</tr>
<tr>
<td></td>
<td>Carotid endarterectomy</td>
</tr>
<tr>
<td></td>
<td>Head and neck surgery Orthopedic surgery Prostate surgery</td>
</tr>
<tr>
<td>Low† (reported cardiac risk generally &lt;1%)</td>
<td>Endoscopic procedures</td>
</tr>
<tr>
<td></td>
<td>Superficial procedure</td>
</tr>
<tr>
<td></td>
<td>Cataract surgery Breast surgery Ambulatory surgery</td>
</tr>
</tbody>
</table>
Recommendations for Preoperative Noninvasive Evaluation of LV Function

• Class I (none)
• Class IIa
  – It is reasonable for patients with dyspnea of unknown origin to undergo preoperative evaluation of LV function. (C)
  – It is reasonable for patients with current or prior HF with worsening dyspnea or other change in clinical status to undergo preoperative evaluation of LV function if not performed within 12 months. (C)
• Class IIb
  – Reassessment of LV function in clinically stable patients with previously documented cardiomyopathy is not well established. (C)
• Class III
  – Routine perioperative evaluation of LV function in patients is not recommended. (B)
Recommendations for Preoperative Resting 12-Lead ECG

- **Class I:** recommended for pts with:
  - At least 1 clinical risk factor* who are undergoing vascular surgical procedures. (B)
  - Known CHD, peripheral arterial disease, or cerebrovascular disease who are undergoing intermediate-risk surgical procedures. (C)
- **Class IIa:** reasonable in persons with no clinical risk factors who are undergoing vascular surgical procedures. (B)
- **Class IIb:** may be reasonable in patients with at least 1 clinical risk factor who are undergoing intermediate-risk operative procedures. (B)
- **Class III:** Preoperative and postoperative resting 12-lead ECGs are not indicated in asymptomatic persons undergoing low-risk surgical procedures. (B)

*Clinical risk factors include history of ischemic heart disease, history of compensated or prior HF, history of cerebrovascular disease, DM, and renal insufficiency.
Preoperative Coronary Revascularization With CABG or Percutaneous Coronary Intervention in stable cardiac patients

- Prophylactic myocardial revascularization prior to high-risk surgery may be considered in patients with overt ischaemic heart disease

- Prophylactic myocardial revascularization prior to intermediate-risk surgery in patients with proven ischaemic heart disease is not recommended

- Prophylactic myocardial revascularization prior to low-risk surgery in patients with proven ischaemic heart disease is not recommended
Cardiac evaluation and care algorithm for noncardiac surgery
Step 1: Need for emergency noncardiac surgery?
- Yes → Operating room → Perioperative surveillance and postoperative risk stratification and risk factor management
- No

Step 2: Active cardiac conditions?
- Yes → Evaluate and treat per ACC/AHA guidelines → Consider operating room
- No

Step 3: Low-risk surgery?
- Yes → Proceed with planned surgery
- No

Step 4: Good functional capacity (at least 4 METs) without symptoms?
- Yes → Proceed with planned surgery
- No or unknown

Step 5: Three or more clinical risk factors?
- Yes → Vascular surgery
  - Consider testing if it will change management
- One or two clinical risk factors?
  - Yes → Intermediate-risk surgery
    - Proceed with planned surgery with heart rate control or consider noninvasive testing if it will change management
  - No → Vascular surgery
    - Proceed with planned surgery
- No clinical risk factors?
  - Proceed with planned surgery
Step 1: Need for emergency noncardiac surgery?
- Yes → Operating room → Perioperative surveillance and postoperative risk stratification and risk factor management
- No →
  Step 2: Active cardiac conditions?*
    - Yes → Evaluate and treat per ACC/AHA guidelines → Consider operating room
    - No →
      Step 3: Low-risk surgery?
        - Yes → Proceed with planned surgery
        - No →
          Step 4: Good functional capacity (at least 4 METs) without symptoms?†
            - Yes → Proceed with planned surgery
            - No or unknown →
              Step 5: Three or more clinical risk factors‡
                - Vascular surgery
                  - Consider testing if it will change management
                - One or two clinical risk factors‡
                  - Intermediate-risk surgery → Proceed with planned surgery with heart rate control§ or consider noninvasive testing if it will change management
                - No clinical risk factors‡ →
                  - Vascular surgery
                  - Intermediate-risk surgery
Step 2: Active or unstable cardiac condition(s):
Unstable/severe angina- Recent MI (< 30 days +ischemia) → **No** → Step3
overt heart failure, severe arrhythmias, severe valv. disease

† Postpone the procedure
† Treatment options to be discussed in a multi-disciplinary team involving all perioperative care physicians

[Diagram showing flowchart with decision points and outcomes]

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**Step 1**
Need for emergency noncardiac surgery?
- Yes → Operating room → Perioperative surveillance and postoperative risk stratification and risk factor management
- No

**Step 2**
Active cardiac conditions?*
- Yes → Evaluate and treat per ACC/AHA guidelines → Consider operating room
- No

**Step 3**
Low-risk surgery?
- Yes → Proceed with planned surgery
- No

**Step 4**
Good functional capacity (at least 4 METs) without symptoms?†
- Yes → Proceed with planned surgery
- No or unknown

**Step 5**
Three or more clinical risk factors‡
- Vascular surgery
  - Consider testing if it will change management
- Intermediate-risk surgery
- Vascular surgery

One or two clinical risk factors‡
- Intermediate-risk surgery
- Proceed with planned surgery with heart rate control§ or consider noninvasive testing if it will change management

No clinical risk factors‡
- Proceed with planned surgery
### Step 3: Risk of surgical procedure: 30-day CV death and MI

<table>
<thead>
<tr>
<th>Low risk &lt; 1%</th>
<th>Intermediate risk &lt; 1-5%</th>
<th>High risk &gt; 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast</td>
<td>Abdominal</td>
<td>Aortic &amp; major vascular surgery</td>
</tr>
<tr>
<td>Dental</td>
<td>Carotid</td>
<td>Peripheral vascular surgery</td>
</tr>
<tr>
<td>Endocrine</td>
<td>Peripheral arterial angioplasty</td>
<td></td>
</tr>
<tr>
<td>Eye</td>
<td>Endovascular aneurysm repair</td>
<td></td>
</tr>
<tr>
<td>Gynaecology</td>
<td>Head and neck surgery</td>
<td></td>
</tr>
<tr>
<td>Reconstructive</td>
<td>Neurological</td>
<td></td>
</tr>
<tr>
<td>Orthopaedic- minor (knee surgery)</td>
<td>Orthopaedic major (hip &amp; spine)</td>
<td></td>
</tr>
<tr>
<td>Urologic</td>
<td>Pulmonary/renal/liver transplant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urologic- major</td>
<td></td>
</tr>
</tbody>
</table>
Step 3: Risk of surgical procedure

- Low risk of surgical procedure
  Identify risk factors & provide recommendations on lifestyle & medical treatment according to the ESC guidelines for postoperative care

- Intermediate or High Risk of surgical procedure

Surgery

Step 4
Step 1: Need for emergency noncardiac surgery?  
  - Yes → Operating room → Perioperative surveillance and postoperative risk stratification and risk factor management
  - No

Step 2: Active cardiac conditions?  
  - Yes → Evaluate and treat per ACC/AHA guidelines → Consider operating room
  - No

Step 3: Low-risk surgery?  
  - Yes → Proceed with planned surgery
  - No

Step 4: Good functional capacity (at least 4 METs) without symptoms?  
  - Yes → Proceed with planned surgery
  - No or unknown

Step 5: Three or more clinical risk factors?  
  - Yes → Vascular surgery
  - No or unknown → One or two clinical risk factors?  
    - Yes → Intermediate-risk surgery
    - No or unknown → No clinical risk factors?  
      - Yes → Vascular surgery
      - No or unknown → Proceed with planned surgery

Consider testing if it will change management
  - Proceed with planned surgery with heart rate control or consider noninvasive testing if it will change management
Step 4: Functional capacity of the patient scheduled for intermediate or high-risk surgery

- **Good**: climb two flight of stairs/run short distance

Coronary artery disease: or risk factor(s)
- Statin therapy - titrated low dose of β-blocker regimen can be initiated before surgery

└── Surgery

- **Moderate or poor**

└── Step 5
Step 1
Need for emergency noncardiac surgery?
   Yes → Operating room → Perioperative surveillance and postoperative risk stratification and risk factor management
   No

Step 2
Active cardiac conditions?*
   Yes → Evaluate and treat per ACC/AHA guidelines → Consider operating room
   No

Step 3
Low-risk surgery?
   Yes → Proceed with planned surgery
   No

Step 4
Good functional capacity (at least 4 METs) without symptoms?†
   Yes → Proceed with planned surgery
   No or unknown

   Three or more clinical risk factors‡
      → Vascular surgery
         → Consider testing if it will change management
   One or two clinical risk factors‡
      → Intermediate-risk surgery
      → Proceed with planned surgery with heart rate control§ or consider noninvasive testing if it will change management
   No clinical risk factors‡
      → Vascular surgery
      → Proceed with planned surgery
Step 5: Intermediate or High-risk surgery with a moderate or less, functional capacity

- Intermediate: abdominal/carotid
  - Statin therapy
  - Titrated low dose β-blocker
  - ACE-inhibitors if systolic LV dysfunction
  - ≥ 1 cardiac risk factors → Baseline ECG

  Surgery

- High risk (aortic/peripheral vascular)

  Step 6
Step 6: Cardiac risk factors in high-risk surgery

1. Angina pectoris
2. MI
3. Heart failure
4. Stroke
5. Diabetes mellitus
6. Renal dysfunction

- **Number of risk factors ≤ 2**
  - Statin therapy
  - Titrated low dose β-blocker
  - ACE-inhibitors if systolic LV dysfunction

**Surgery**

- **Number of risk factors ≥ 3**

**Step 7**
Step 7: Preoperative testing
Consider also for patient counselling, surgery, and anaesthesia technique

Cardiac stress test

- Extensive ischaemia
- No or moderate stress-induced ischaemia

**Extensive ischaemia**
- Proceed with the procedure
- Statin therapy
- Titrated low dose β-blocker
- Systolic LV dysfunction: ACE-inhibitors

**Step 7b**

**Surgery**

Class I LOE B

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Step 7b: Extensive stress induced ischaemia

Cardiac stress test → Extensive ischaemia

- Individualized management
  - Benefit of the procedure
  - Predicted adverse outcome
  - Effect medication / revascularisation

Balloon Angioplasty
Surgery > 2 weeks
Aspirin

Bare metal stent
Surgery > 6 weeks
Dual antiplatelet treatment > 6 weeks-3 mo

Drug eluting stent
Surgery > 12 months
Dual antiplatelet treatment

Surgery

Class I, LOE B
Proposed approach to the management of patients with previous PCI who require noncardiac surgery
Treatment for patients requiring PCI who need subsequent surgery

- Acute MI, high-risk ACS, or high-risk cardiac anatomy
- Bleeding risk of surgery
  - Low → Stent and continued dual-antiplatelet therapy
    - (COR IIb/LOE C)
  - Not low
    - 14 to 29 days → Balloon angioplasty
      - (COR IIb/LOE C)
    - 30 to 365 days → Bare-metal stent
      - (COR IIa/LOE C)
    - Greater than 365 days → Drug-eluting stent
      - (COR IIb/LOE C)
Drug Eluting Stents (DES) and Stent Thrombosis

Premature discontinuation of dual antiplatelet therapy markedly increases the risk of catastrophic stent thrombosis and death or MI.

To eliminate the premature discontinuation of thienopyridine:

1. Before implantation of a stent,
   - In patients not expected to comply with 12 months of thienopyridine therapy, whether for economic or other reasons,
   - Or are likely to require invasive or surgical procedures within the next 12 months, consideration should be given to implantation of a baremetal stent or performance of balloon angioplasty with provisional stent implantation instead of the routine use of a DES.

Drug Eluting Stents (DES) and Stent Thrombosis

3. properly and thoroughly patient education about the reasons they are prescribed thienopyridines and the significant risks associated with prematurely discontinuing such therapy.

4. Patients should be specifically instructed before hospital discharge to contact their treating cardiologist before stopping any antiplatelet therapy, even if instructed to stop such therapy by another healthcare provider.

5. Healthcare providers who perform invasive or surgical procedures and who are concerned about periprocedural and postprocedural bleeding must be made aware of the potentially catastrophic risks of premature discontinuation of thienopyridine therapy. Such professionals who perform these procedures should contact the patient’s cardiologist if issues regarding the patient’s antiplatelet therapy are unclear, to discuss optimal patient management strategy.

Drug Eluting Stents (DES) and Stent Thrombosis

6. Elective procedures for which there is significant risk of perioperative or postoperative bleeding should be deferred until patients have completed an appropriate course of thienopyridine therapy (12 months after DES implantation if they are not at high risk of bleeding and a minimum of 1 month for bare-metal stent implantation).

7. For patients treated with DES who are to undergo subsequent procedures that mandate discontinuation of thienopyridine therapy, aspirin should be continued if at all possible and the thienopyridine restarted as soon as possible after the procedure because of concerns about late stent thrombosis.

Recommendations for Beta-Blocker Medical Therapy

**CLASS I:** Beta blockers should be continued

1. in patients undergoing surgery who are receiving beta blockers to treat angina, symptomatic arrhythmias, hypertension, or other ACC/AHA class I guideline indications. (*C*)
2. patients undergoing vascular surgery who are at high cardiac risk owing to the finding of ischemia on preoperative testing. (*B*)

**CLASS Iia:** Beta blockers are probably recommended

1. for patients undergoing vascular surgery in whom preoperative assessment identifies CHD. (*B*)
2. for patients in whom preoperative assessment for vascular surgery identifies high cardiac risk, as defined by the presence of more than 1 clinical risk factor.* (*B*)
3. 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. (*B*)
Recommendations for Beta-Blocker Medical Therapy

**CLASS IIb:** The usefulness of BB is uncertain

1. In intermediate-risk procedures or vascular surgery, in whom preoperative assessment identifies a single clinical risk factor.* (C)

2. In vascular surgery with no clinical risk factors who are not currently taking beta blockers. (B)

**CLASS III**

1. Beta blockers should not be given to patients undergoing surgery who have absolute contraindications to beta blockade. (C)
# Recommendations for Perioperative Beta-Blocker Therapy

<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: C</td>
</tr>
<tr>
<td>Intermediate risk</td>
<td>...</td>
<td>...</td>
<td>Patients without ischemia or no previous test: 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>Class IIa, Level of Evidence: B</td>
<td>Class I, Level of Evidence: C</td>
</tr>
</tbody>
</table>

*Class I indicates strong recommendation, Class II indicates moderate recommendation, and Class III indicates weak recommendation. Level of Evidence: A indicates high level of evidence, B indicates moderate level of evidence, and C indicates low level of evidence.
Recommendations for Statin Therapy

CLASS I
1. For patients currently taking statins and scheduled for noncardiac surgery, statins should be continued. (B)

CLASS IIa
1. For patients undergoing vascular surgery with or without clinical risk factors, statin use is reasonable. (B)

CLASS IIb
1. For patients with at least 1 clinical risk factor who are undergoing intermediate-risk procedures, statins may be considered. (C)
Intraoperative and Postoperative Use of ST-Segment Monitoring

CLASS IIa
• can be useful to monitor patients with known CAD or those undergoing vascular surgery, to detect myocardial ischemia during the perioperative period. (B)

CLASS IIb
• may be considered in patients with single or multiple risk factors for CAD who are undergoing noncardiac surgery. (B)
troponin measurement for Perioperative MI

**CLASS I:**
- in patients with ECG changes or chest pain typical of acute coronary syndrome. \( (C) \)

**CLASS IIb:** is not well established
- in patients who are clinically stable and have undergone vascular and intermediate-risk surgery. \( (C) \)

**CLASS III:**
- in asymptomatic stable patients who have undergone low-risk surgery. \( (C) \)
1. You are asked to evaluate a 55-year-old man with a history of prior myocardial infarction in preparation for an abdominal aortic aneurysm repair. A dobutamine stress echocardiogram has been ordered and shows the following.
A 70-year-old man with hypertension and a recently diagnosed solitary pulmonary nodule is scheduled for wedge resection. He is otherwise healthy, active, and regularly plays golf. His ECG reveals left ventricular hypertrophy with secondary repolarization changes consistent with a strain pattern. Your recommendation is

a. Stress echocardiography for risk stratification.
b. Clear the patient for surgery.
c. Coronary angiography.
d. Echocardiogram.
e. Stress SPECT thallium imaging.
An 80-year-old woman with hypertension and a history of “congestive heart failure” recently suffered a hip fracture and is in need of stabilization. She lives with family but is known to be inactive, primarily because of arthritis. Your recommendation is to do the following:

a. Clear the patient for the orthopedic procedure with beta-blocker prophylaxis and careful hemodynamic monitoring.

b. Coronary angiography.

c. Dobutamine stress echocardiography for risk stratification.

d. Echocardiogram, and if left ventricular function is normal, clear the patient for surgery.

e. Exercise stress SPECT thallium.
A 78-year-old woman with a history of chronic stable angina is scheduled for cataract surgery. Your recommendation is

- b. Coronary angiography.
- c. Clear the patient for cataract surgery.
- d. Echocardiogram, and if left ventricular function is normal, clear the patient for surgery.
- e. Exercise stress echocardiography
Your patient is a 55-year-old man who is in need of a fem-pop bypass for claudication. What do you recommend for risk stratification?

• a. Exercise ECG
• b. Angiography
• c. Dobutamine stress echocardiography
• d. Dipyridamole thallium
• e. Clinical evaluation
With best wishes