Across the globe, more than 10 crore patients undergo noncardiac surgery annually. Unfortunately, 0.5–1% of them develop a cardiac complication with 25% of these patients succumbing to it; mortality being primarily due to myocardial ischemia, myocardial dysfunction or arrhythmia. The elevated perioperative risk is multifactorial and could be due to increased sympathetic tone, a proinflammatory state, hypercoagulability and hypoxia during the first few days after surgery.

This may be in a patient with known cardiac disease or in whom the problem is identified only during the preoperative work-up as is the case quite frequently encountered in our country. Hence the purpose of preoperative evaluation is not to give “medical clearance” alone, but to assess their medical status and make recommendations to improve both perioperative and long-term prognosis. From a cardiac perspective, preoperative assessment should address the following:

- Preoperative risk evaluation which broadly consists of assessment of patient-related factors and surgery-specific risks
- Pharmacological intervention which should address the underlying cardiac condition and medicines, prophylaxis for deep vein thrombosis (DVT) and infective endocarditis whenever required.

Preoperative Risk Evaluation

There are five steps involved in preoperative evaluation:

1. Clinical information—a focused history to assess clinical risk factors which include (1) history of (H/o) ischemic heart disease [current angina, prior myocardial infarction (MI) or prior revascularization] (2) history of compensated or prior heart failure (3) history of cerebrovascular disease (4) diabetes mellitus (DM) (5) renal insufficiency.

2. Basic investigations—investigations should be tailored according to each patient, but preliminary tests include blood study, ECG and a chest X-ray. An echocardiogram may be done if the clinical risk profile and physical examination warrant.

3. Risk stratification based on
   a. Cardiac predictors
   b. Functional capacity of the patient
   c. Surgical procedure.

Cardiac predictors: Cardiac predictors of increased perioperative cardiovascular risk show in Table 1.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Cardiac predictors of increased perioperative cardiovascular risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>• Acute or recent MI (acute meaning &lt; 7 days; recent meaning &gt; 7 days but &lt; 30 days)</td>
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<tr>
<td></td>
<td>• Unstable or severe angina (Canadian class III–IV)</td>
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<tr>
<td></td>
<td>• Decompensated heart failure</td>
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<tr>
<td></td>
<td>• Significant arrhythmia (high grade AV block, symptomatic ventricular arrhythmia in the presence of heart disease, SVT with uncontrolled heart rate)</td>
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<tr>
<td></td>
<td>• Severe valvular disease</td>
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<tr>
<td>Intermediate</td>
<td>• Mild angina pectoris (Canadian class I or II)</td>
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<tr>
<td></td>
<td>• Previous MI by history or pathological Q wave</td>
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<tr>
<td></td>
<td>• Compensated or prior heart failure</td>
</tr>
<tr>
<td></td>
<td>• Diabetes mellitus (particularly insulin dependent)</td>
</tr>
<tr>
<td></td>
<td>• Renal insufficiency</td>
</tr>
<tr>
<td>Minor</td>
<td>• Advanced age</td>
</tr>
<tr>
<td></td>
<td>• Abnormal ECG (LVH, LBBB, ST-T abnormalities), rhythm other than sinus</td>
</tr>
<tr>
<td></td>
<td>• Low functional capacity</td>
</tr>
<tr>
<td></td>
<td>• History of stroke</td>
</tr>
<tr>
<td></td>
<td>• Uncontrolled systemic hypertension</td>
</tr>
</tbody>
</table>

Major predictors—presence of a major predictor (an active cardiac condition) mandates intensive management, which may result in delay or cancellation of surgery unless it is urgent.

Intermediate—they are well validated markers of enhanced risk of perioperative cardiac complications and justify careful assessment of the patient’s current status.

Minor predictors—though they are markers of cardiovascular disease, they have not proven to independently increase perioperative risk.

Functional capacity of the patient: It is based on the patient’s ability to perform certain daily tasks. Several scales have been designed; the Duke Activity scale being the most popular one (Table 2).

Surgery-specific risks: The ACC/AHA task force report on perioperative cardiovascular evaluation classifies the surgical procedures into high, intermediate and low-risk based on the anticipated mortality (Table 3).
Cardiology

TABLE 2 | Functional capacity of the patient

| 1-4 METS (poor functional capacity) | • Eat, dress or use the toilet |
| • Walk indoors around the house |
| • Do light housework such as washing dishes |
| 4-10 METS (moderate functional capacity) | • Climb a flight of stair or run a short distance |
| • Heavy work such as vacuuming or lifting heavy furniture |
| • Play games such as golf or doubles tennis |

More than 10 METS
• Participate in strenuous activities like swimming, basketball, singles tennis or skiing

TABLE 3 | Surgery-specific risks

| High (cardiac risk > 5%) | • Emergency procedures |
| • Aortic and other major vascular surgery |
| • Peripheral vascular surgery |
| • Anticipated prolonged surgical procedures associated with large fluid shift and/or blood loss |
| Intermediate (risk 1–5%) | • Carotid endarterectomy |
| • Head and neck surgery |
| • Intraperitoneal and intrathoracic surgery |
| • Orthopedic surgery |
| • Prostate surgery |
| Low (risk < 1%) | • Endoscopic procedures |
| • Superficial procedure |
| • Cataract surgery |
| • Breast surgery |

- All patients who have a major cardiac risk predictor and are scheduled for an elective surgery should have their procedure postponed or cancelled and will need further cardiac evaluation
- Patients with low risk cardiac predictor can be wheeled to the operation theatre directly; noninvasive testing is not indicated
- All emergency and life saving procedures have to be performed irrespective of the cardiac risk, with implementation of the cardiac risk reducing intervention postoperatively.
- Patients undergoing intermediate-risk surgery who have good functional capacity may be operated, while those with poor functional capacity have to undergo noninvasive cardiac testing
- Noninvasive testing—should be done in the following subset of patients where further testing will influence our decision making
- Patients with an active cardiac condition requiring noncardiac surgery
- Patients with more than or equal to three clinical risk factors and poor functional capacity requiring vascular surgery
- Patients with 1–2 clinical risk factors and poor functional capacity requiring vascular or intermediate-risk surgical procedure.

5. Diabetes mellitus requiring insulin therapy
6. Serum creatinine more than 2 mg/dL

Just by noting whether these risk factors are present or not, risk stratification can be done.

(0, 1 risk factor: low-risk, 2–3: moderate risk, >3: high-risk). Rate of cardiac death, nonfatal MI, and nonfatal cardiac arrests according to the number of predictors are as follows:
- No risk factors: 0.4%
- 1 risk factor: 1%
- 2 risk factors: 2.4%
- More than or equal to 3 risk factors: 5.4%

Flow chart 1 shows stepwise approach for preoperative cardiac evaluation of a patient undergoing noncardiac surgery.

PHARMACOLOGICAL INTERVENTION

Beta Blockers
Best studied drug with early studies showing benefit. However recent trials failed to demonstrate mortality benefit except in select cases. Points to remember include:
- Continue them in all patients who are already on beta blockers
- Administer in all high-risk patients undergoing vascular surgery
- Use in patients undergoing vascular or intermediate-risk surgery if preoperative evaluation reveals CAD or if they have more than 1 clinical risk factor
- Beta blockers should ideally be started 7 days before surgery, don’t start on the day of surgery. Continue them indefinitely or atleast for 7 days
- Longer acting molecules like bisoprolol are preferred
- Bring heart rate to more than 70/min.

Statins
It should be continued in all patients who were already on statins. It is reasonable to start in all patients undergoing vascular surgery because of its pleotropic effects.

Anticoagulant Therapy
Stop oral anticoagulants 3–4 days before surgery. Substitute with low-molecular-weight heparin (LMWH) in selected cases (oral anticoagulation can be resumed after the procedure as soon as possible)
- Mechanical valve in the mitral position
- History of thromboembolism while not on anticoagulation or a recent episode (<1 year)
- Patients with more than or equal to 3 of the following risk factors—atrial fibrillation, previous thromboembolism, hypercoagulable condition, mechanical prosthesis and LV ejection fraction <30%)

Antiplatelet Therapy
This therapy withdraws thienopyridines and aspirin 1 week before the surgery. Aspirin may be safely continued in selected patients. A meta-analysis of 41 trials revealed that continued aspirin therapy increased the risk of nonfatal bleed by 1.5% whereas stopping aspirin resulted in a 3 fold increased risk of major cardiac events.

Patients with Prior Percutaneous Coronary Intervention
Elective surgeries should be postponed accordingly to minimize the risk of stent thrombosis, while all emergency procedures need to be performed with continued antiplatelet therapy and explained risk. The following algorithm will guide us in deciding the timing of an elective surgery after PCI and associated antiplatelet management (Flow chart 2).
Section 4

Chapter 28  Cardiac Issues with Noncardiac Surgery

Flow chart 1: Stepwise approach for preoperative cardiac evaluation of a patient undergoing noncardiac surgery

Step 1

Need for emergency noncardiac surgery?
- Yes → Operating room (Class I, LoE C)
- No

Step 2

Active cardiac conditions
- Yes → Evaluate and treat per ACC/AHA guidelines (Class I, LoE B)
- No → Consider operating room

Step 3

Low risk surgery
- Yes → Proceed with planned surgery (Class I, LoE B)
- No

Step 4

Good functional capacity (MET level greater than or equal to 4) without symptoms
- Yes → Proceed with planned surgery (Class I, LoE B)
- No or unknown

Step 5

3 or more clinical risk factors
- Vascular surgery
  - Class IIa, LoE B
  - Consider testing if it will change management

1 or 2 clinical risk factors
- Intermediate risk surgery
  - Vascular surgery
  - Intermediate risk surgery

No clinical risk factors
- Class I, LoE B
  - Proceed with planned surgery

Flow chart 2: Percutaneous coronary intervention

Previous PCI

Balloon angioplasty
- Time since PCI <14 days → Delay for elective or nonurgent surgery
- >14 days >30–45 days → Proceed to the operation room with aspirin
- >30–45 days → Delay for elective or nonurgent surgery
- >365 days → Proceed to the operating room with aspirin

Bare-metal stent

Drug-eluting stent
- Time since PCI <365 days → Proceed to the operation room with aspirin

Delay for elective or nonurgent surgery

Proceed to the operation room with aspirin

Delay for elective or nonurgent surgery

Proceed to the operating room with aspirin
### Cardiology

**TABLE 4 | Risk category and recommended prophylaxis**

<table>
<thead>
<tr>
<th>Risk category</th>
<th>Recommended prophylaxis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk: Age &lt; 40, uncomplicated surgery, no additional risk factors</td>
<td>Early mobilization</td>
</tr>
<tr>
<td>Moderate risk: Surgery in patients with 40–60 years of age with no additional risk factor, minor surgery in patients with additional risk factors</td>
<td>Enoxaparin 30 mg/day</td>
</tr>
<tr>
<td>High risk: Surgery in patients &gt; 60 years of age, or 40–60 years with additional risk factor, minor surgery in patients with malignancy or previous VTE, knee/hip surgery or heparin-induced thrombocytopenia</td>
<td>Enoxaparin &gt; 30 mg/day</td>
</tr>
</tbody>
</table>

**Infective Endocarditis Prophylaxis**

_Cardiac Conditions Warranting Prophylaxis_
- Prosthetic heart valves
- Previous infective endocarditis
- Congenital heart disease (CHD)-unrepaired cyanotic CHD, repaired but with residual defect, during the first 6 months after a repair using device or prosthetic material
- Cardiac transplant recipients who develop cardiac valvulopathy.

**Procedures Requiring Prophylaxis**
This is to be given only to people who have the above cardiac conditions.
- Dental procedures involving manipulation of gingival mucosa, periapical region of tooth or perforation of the oral mucosa
- Tonsillectomy or adenoidectomy
- Invasive respiratory procedures requiring incision
- Procedures on infected skin or musculoskeletal tissue.

**Prophylactic Regimens**
Amoxicillin 2 g orally 1 hour before procedure; if patient is unable to take orally; ampicillin 2 g or ceftriaxone 1 g IV 30 minutes before the procedure. For patients allergic to penicillin; clindamycin 600 mg/cephalexin 2 g/azithromycin 500 mg 1 hour before procedure.

In our scenario, it is prudent to have a low threshold in giving infective endocarditis prophylaxis.

**Prophylaxis for Deep Vein Thrombosis**
Any surgery lasting more than 30 minutes, especially in the elderly and under general anesthesia carries a significant risk of DVT. Neurosurgery, major orthopedic surgery, oncologic and thoracic surgeries warrant DVT prophylaxis which include unfractionated or LMWH, compression stockings and limb exercises.

Low-molecular-weight heparin is better than unfractionated heparin. Though fondaparinux is slightly more effective than LMWH, it is associated with marginally higher bleeding rate; hence LMWH is preferred.

Three to four weeks of enoxaparin after hospital discharge in high risk patients like those with active malignancy, previous thromboembolism and patients undergoing major orthopedic surgery reduces venous thromboembolism by 50% (Table 4).²

**SUMMARY**
Preoperative evaluation not only helps us in preparing the patient for surgery but also gives us a chance to diagnose and treat his medical ailments if any. Risk stratification is primarily centered on the three predictors: cardiac risk factors, functional capacity of the patient and surgery-specific risks. A step wise approach will guide us in implementing the correct preoperative and postoperative treatment to the patient.

**REFERENCES**