Preoperative assessment for cardiac surgery

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Abstract

Anaesthetic challenges in cardiac surgery are multifaceted. Since patients present with compromised cardiovascular reserve and multiple co-morbidities, a thorough preoperative assessment and meticulous anaesthetic plan is essential. This targets anaesthetic history, physical examination and analysis of investigations, routine and specific to the cardiovascular system. Special models exist for risk stratification to aid perioperative planning, surgical decision making, benchmarking and quality assurance. This article provides an overview of history, examination and preoperative management of patients undergoing cardiac surgery. Scoring systems and practical investigations are reviewed.

Keywords Cardiac surgery; investigations; preoperative assessment; risk assessment; scoring systems

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Introduction

In cardiac surgery severity of underlying disease and operation complexity carry increased risk. Progress has reduced this in routine procedures but it persists in older patients with more challenging surgery. Currently, the unadjusted mortality for isolated coronary artery bypass grafting (CABG) is 2% and for isolated aortic valve replacement is 3−3.5%.[1] However, more complicated surgery (e.g. mitral valve replacement with CABG) still carries a mortality of 8−11%.[1]

Meticulous assessment necessitates: history, physical examination, relevant investigations and plan development. Patient awareness regarding perioperative care and pain management is essential.

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Learning objectives

After reading this article, you should be able to:
- undertake a detailed preoperative assessment in patients undergoing cardiac surgery
- recognize risk scoring in cardiac surgery
- identify and manage factors influencing perioperative outcome
- appreciate currently available routine and specific investigations
- formulate anaesthetic plans and obtain informed consent based on shared decision making

The aims of preoperative anaesthetic evaluation are:
- Appreciation of pathophysiology and anaesthetic implications.
- Multidisciplinary optimization of underlying medical conditions.
- Risk stratification and quantification for shared decisions and informed consent.
- Appropriate resource allocation including staff, equipment and postoperative care facilities.
- Establishment of patient rapport, enabling concerns to be raised and anxiety alleviated.

History and examination

This includes medical and medication history, physical examination and case notes review.

History

Cardinal symptoms of cardiac disease are breathlessness, chest pain, palpitations, syncope and peripheral oedema. It is important to distinguish between respiratory and cardiac causes of breathlessness and chest pain. The risk factors associated with cardiac surgery can be classified as cardiac, non-cardiac and surgical.[2]

Cardiac risk factors

Though many exist the principal cardiac risk factors are:
- myocardial ischaemia
- congestive cardiac failure
- atherosclerosis
- arrhythmias.

Myocardial ischemia presents as angina or its equivalent. Central chest pain with or without radiation is described as pressure or heaviness and a squeezing, burning or choking sensation. It is typically precipitated by exertion and emotional stress, lasts 1−5 minutes and is relieved by rest or nitrates.

The Canadian Cardiovascular Society classification (CCS) grades angina include:
- ***Grade 1***: Stable angina develops upon strenuous, rapid and/or prolonged exertion during work or recreation but it is not induced by ordinary physical activity, such as walking and climbing stairs.

- **Grade 2**: Characterized by slight limitation of ordinary activity. It is induced by walking or climbing stairs rapidly, walking uphill, post prandial exertion, emotional stress or walking more than two blocks.
- **Grade 3:** Marked limitation of ordinary physical activity. It is induced by walking one or two blocks and climbing one flight of stairs in normal conditions and at a normal pace.
- **Grade 4**: Pain and discomfort accompany any physical activity and may occur at rest.

Higher grades exacerbate perioperative morbidity, and presence of myocardial infarction and haemodynamic instability categorize surgical urgency[2]:

- **Minimal risk**: No myocardial infarction or haemodynamic instability. Surgery is scheduled as elective.
- **Intermediate risk**: Myocardial infarction present without haemodynamic instability. Commence antiplatelet therapy and low molecular weight heparin. Surgery is scheduled as urgent.
- **High risk**: Ongoing acute myocardial ischemia or infarction with haemodynamic instability. Emergency revascularization is indicated.

Congestive cardiac failure: Left ventricular failure is characterized by exertional dyspnoea, orthopnoea, paroxysmal nocturnal dyspnoea and fatigue. Coincidental pulmonary oedema presents as a wheezy cough with pink frothy sputum. Tachycardia, cyanosis, basal crepitations and a gallop rhythm may also exist. Right heart failure presents with pedal oedema, ascites and abdominal discomfort. A raised jugular venous pulsation, hepato-jugular reflux, tender hepatomegaly and pitting oedema may arise with an accentuated second pulmonary sound.

Heart failure may be diastolic or systolic or both. Diastolic heart failure is progressive and manifests as impaired left ventricular (LV) relaxation, increased LV stiffness with interstitial deposition of collagen and modified extracellular proteins.[3] Resultant ventricular arrhythmias my hasten death.

The New York Heart Association (NYHA) classification grades functional limitation:

- **Class I**: No limitation of physical activity. Ordinary physical activity does not cause fatigue, breathlessness or palpitation (includes asymptomatic left ventricular dysfunction)
- **Class II**: Slight limitation of physical activity. Comfortable at rest but ordinary physical activity causes fatigue, palpitations, breathlessness or angina ('mild' heart failure).
- **Class III**: Marked limitation of physical activity. Despite comfortable at rest, less than ordinary activity induces symptoms ('moderate' heart failure).
- **Class IV**: Inability to carry out any physical activity without discomfort. Congestive failure exists at rest and any physical activity worsens discomfort ('severe' heart failure)

The aetiology of congestive cardiac failure and assessment of left and right ventricular dysfunction guides use of monitoring, vasoactive infusions, anaesthetic agents and haemodynamic goals.

Atherosclerosis: Atheromatous plaques in the proximal aorta and carotid arteries herald perioperative stroke. Diabetes, hypertension, smoking and peripheral vascular disease exacerbate this. Beta blockers and statins ameliorate risk and cerebral pulse oximetry may optimize perioperative care.[2]

Arrhythmias: Atrial fibrillation (AF) is the mot common perioperative arrhythmia in valvular heart disease followed by supraventricular and ventricular arrhythmias. Patients report dizziness, palpitations, chest pain, light headedness and syncope. After myocardial infarction, damage to impulse formation and conduction can result in bradyarrhythmia and conduction disturbances.

Patients with bradyarrhythmias may have pacemaker and/or implantable cardioverter defibrillator devices (ICD). These need checking beforehand since electromagnetic interference may trigger anti-tachycardia shocks or inhibit anti-bradycardia pacing. Accordingly devices are best reprogrammed to asynchronous mode before surgery.[2]

Pacemakers are likewise reprogrammed and as perioperative myocardial insult may increase pacing capture threshold temporary epicardial pacing is best deployed.

Non-cardiac risk factors
Non-modifiable factors include female gender and old age. Potentially modifiable factors include pre-existing renal failure, anaemia, nutritional status (BMI <20 or >35 kg/m^2), central nervous system disorders, diabetes mellitus and chronic pulmonary disease.[2]

Renal insufficiency: Pre-existing renal insufficiency enhances risk of acute kidney injury (AKI) necessitating postoperative renal replacement therapy. Cardiac surgery's entailment of aortic cross clamping, non-pulsatile cardiopulmonary bypass, increased blood product and vasopressors usage is contributory. This complicates recovery in up to 30% of patients and increases mortality five fold. Renal replacement therapy is required in 2−5% of such patients and is associated with 50% mortality.[4] Preoperative calculation of creatinine clearance may evaluate renal risk better than serum creatinine.

Nutrition: Preoperative nutritional status is an important predictor of morbidity and mortality. Low preoperative albumin levels, <20 mg/dL, parallel a raised risk of postoperative infection and prolonged mechanical ventilation. Likewise obesity poses many anaesthetic and surgical challenges.

Central nervous system disorders: Neurological injury is well recognized after cardiac surgery. Exacerbating factors include previous stroke with or without residual sequelae, hypertension, diabetic neuropathy, advanced age and carotid atherosclerosis. Intracerebral and extracerebral extension of atherosclerosis with atheromatous aortic disease and radiographic evidence of previous stroke are highly significant. Consequently it is vital to note preexisting deficits, optimize underlying conditions and if necessary seek vascular surgical advice.

Anemia: Preoperative anaemia, reported in 23−45% of patients, independently predicts adverse outcome.[5] Anaemia needs identification and treatment before elective surgery. This may warrant iron supplementation and erythropoietin stimulation. Blood