The principles of cardiac anaesthesia

Michael Charlesworth

Petr Martinovsky

Abstract

Despite the origins of cardiac surgery and anaesthesia involving experimentation and danger, modern practice has evolved to dramatically reduce risk and increase patient safety. Outcomes from cardiac surgery in the UK are consistently improving despite an aging population, increasing clinical complexity and an increasing incidence of chronic conditions such as anaemia and frailty. The management of bleeding is a great challenge to the surgeon and anaesthetist; knowledge of novel near-patient tests, blood products and their transfusion, blood conservation strategies and haemostatic agents is of paramount importance.

Keywords Bleeding; cardiac anaesthesia; cardiac surgery; haemostasis

Royal College of Anaesthetists CPD Matrix: 3G00

Learning objectives

After reading this article, you should be able to:

- describe the approach to preoperative assessment and optimization of patients scheduled for routine cardiac surgery
- understand each step in the perioperative management of patients for routine cardiac surgery
- appreciate the challenge of bleeding during and following routine cardiac surgery

Introduction

Mortality from cardiac surgery in the UK, recorded at 2.74% from all operations in 2013, is reducing year-on-year. Notwithstanding advances in percutaneous and minimally invasive techniques, open cardiac surgery remains a common intervention for patients with valvular or ischaemic heart disease. Despite the technical nature of practice, non-technical skills are of vital importance as teamwork and communication in theatre amongst all team members ensures that complications are minimized where possible or recognized without delay. Here we describe the core principles of cardiac surgery as a function of the patient journey from clinic to discharge from hospital.

Preoperative principles

The preoperative clinic

The clinic visit provides an early opportunity to gather important data about the patient in the weeks before surgery. Routine tests are undertaken, such as blood work, an ECG, transthoracic echocardiography and spirometry. Time is subsequently available to act on abnormalities.

The preoperative visit

Traditionally, the anaesthetist would see the patient the day prior to surgery though many patients are now admitted on the day of surgery and seen by the anaesthetist in the preoperative clinic. A thorough history is taken, the patient is examined and test results are reviewed. A full explanation of the course of anaesthesia, surgery and recovery is given and verbal consent is obtained.

Anaemia and cardiac surgery

Anaemia is common and associated with poor outcomes for all types of major surgery. Nevertheless, the investigation and treatment of anaemia in the community can be difficult to coordinate in a timely manner. Patients therefore continue to present with anaemia on the day of surgery, and blood conservation strategies are of growing importance.

Frailty and cardiac surgery

Life expectancy is increasing and so too are the number of frail patients presenting for cardiac surgery, more so for percutaneous procedures such as TAVI and MitraClip. Where frailty is concerned, determining who is likely to benefit from surgery or where the risk is considered to be unreasonable is problematic, as at present, quantifying frailty and applying it to the decision to proceed is an evolving science.

Risk stratification

Whilst many preoperative risk stratification systems exist to predict the operative mortality, only the EuroSCORE is applicable to cardiac surgery patients. EuroSCORE was developed from observational data in 20,000 patients in 128 hospitals and validated across Europe. The most recent version is the EuroSCORE II and the main risk factors incorporated are patient related such as age, gender, poor mobility, diabetes on insulin, and critical preoperative state; cardiac related such as NYHA and CCS grading, LV function, a recent MI, and pulmonary hypertension; and operation related such as urgency, type of surgery, and thoracic aortic surgery.

Perioperative principles

Premedication

The routine use of preoperative pharmacological anxiolytics is falling and arguably the best anxiolytic for cardiac surgery is the preoperative visit. In select patients with severe anxiety, a premedication such as temazepam or lorazepam is offered. With regards cardiovascular medication, all including beta-blockers and apart from ACE-inhibitors should be continued. PPIs and anti-reflux medication should also be given. Postoperative renal dysfunction is common and fasting guidelines encourage the intake of clear carbohydrate-containing fluid until 2 hours preoperatively. Despite this, it is common for patients to arrive in theatre having been nil by mouth for many hours and there are efforts currently underway to reduce this unnecessary fasting.

Michael Charlesworth *FRCA MSc is an ST6 Advanced Trainee in Cardiothoracic Anaesthesia at Lancashire Cardiac Centre, Blackpool, UK. Conflicts of Interest: none declared.*

Petr Martinovsky *FRCA FFICM is a Consultant in Cardiothoracic Anaesthesia and Intensive Care at Lancashire Cardiac Centre, Blackpool, UK. Conflicts of Interest: none declared.*

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Monitoring

In addition to routine monitoring (with a 5-lead CM5 ECG configuration), a large peripheral drip and an arterial line are inserted, usually in the left arm. The use of cerebral oximetry is increasing in cardiac surgery as it provides a continuous measure of the frontal cortex regional oxygen saturations. NAP5 demonstrated a relatively high incidence of awareness under general anaesthesia for cardiac surgery of about 1/8600 cases, and whilst depth of anaesthesia monitoring is not yet mandatory, its use for those with specific risk factors or a previous history of awareness is encouraged.

Induction of anaesthesia

The choice of anaesthetic drugs and their doses are arguably of less importance than the manner in which the induction of anaesthesia is undertaken. Induction can cause haemodynamic instability and this may cause ischaemia through the imbalance of myocardial oxygen supply and demand. In revascularization surgery and surgery for aortic stenosis, the aims are to maintain a sufficient MAP and a sufficiently long diastolic filling period, thus avoiding hypotension and tachycardia and thereby maintaining optimal myocardial perfusion. Drugs are used to achieve this: opiates to blunt the response to intubation, the first incision and sternotomy; vasoconstrictors to maintain the blood pressure; and intravenous/inhalational anaesthesia to prevent awareness. Neuromuscular blockade is best achieved with a long-acting non-depolarizing cardiostable agent, such as rocuronium, vecuronium or pancuronium.

Maintenance of anaesthesia

Isoflurane is commonly used to maintain anaesthesia in the UK (or sevoflurane in North America) though others have used TIVA, or a combination of volatile and intravenous anaesthesia. Likewise, analgesia is provided through many different means.

Central venous catheter (CVC) placement

The CVC is usually placed with the patient asleep, following tracheal intubation, and with the right internal jugular vein commonly selected. For high-risk patients, the CVC can be placed awake, as vasopressors and inotropes may be required during or immediately following induction. Malplacement of central venous catheters contributes to significant morbidity and mortality and the use of ultrasound together with an anatomical puncture and needling technique should be encouraged. Checks should always be employed to ensure that the wire lies in the vein prior to dilation and the line should always be transduced following insertion. Some practitioners insert a large sheath into the same vessel for high volume administration or to allow later passage of a pulmonary artery catheter, though their use is decreasing.

Transoesophageal echocardiography (TOE)

Before the incision, the TOE probe is inserted in the mouth with great care, as cases of laryngeal and oesophageal trauma have been reported. Perioperative TOE allows the operator to qualitatively and quantitatively assess the anatomy and performance of the heart and associated structures, and its interpretation can strongly influence the course of surgery and postoperative care. Perioperative TOE is therefore an invaluable cardiac anaesthetic monitoring tool.

Intraoperative haemodynamics

Maintaining haemodynamic stability is of vital importance and fluid boluses, vasopressors, inotropes, antihypertensives, antiarrhythmics and ultimately direct cardiac defibrillation are used. The heart and surrounding structures may also be manipulated or lifted by the surgeons thus contributing to arrhythmias or hypotension, and communication between the surgeon and anaesthetist is necessary for this to be resolved.

Anticoagulation

Following the request of the surgeon, intravenous heparin is given through the central line at a dose of 300–400 IU/kg (3–4 mg/kg). Three minutes after the full dose of heparin is given, the activated clotting time (ACT) is measured and this must be greater than 480 seconds before the arterial and venous bypass cannula are inserted. **To insert the cardiopulmonary bypass (CPB) cannula before the ACT is greater than 480 seconds, and therefore before it is safe to initiate CPB, may lead to catastrophic thrombus formation in the CPB circuit and oxygenator.** When the right dose of heparin has been delivered and the ACT fails to rise above 480 seconds, a diagnosis of heparin resistance may be considered, though this is now rare as heparin infusions prior to surgery are no longer commonplace. If further heparin fails to raise the ACT, hereditary or acquired ATIII deficiency must be considered.

Initiation of CPB

Whilst the process of initiation of CPB occurs in a stepwise checklist manner, the importance of communication between the surgeon, the anaesthetist and the perfusionist cannot be underestimated. A period of relative hypotension may be required prior to cannulation of the aorta in order to prevent dissection. **It must be remembered that the administration of protamine during CPB will have grave consequences for the patient.**

Going on CPB:

- Deliver heparin to the central circulation.
- Ensure ACT >480 seconds prior to arterial and venous cannulation.
- Agree haemodynamic targets, vasoconstrictor usage, and anaesthesia mode with the perfusionist.
- Upon commencement of ‘full-flow’, assist the perfusionist in verifying central venous and arterial pressure traces by re-zeroing transducers and visualizing absence of a capnography trace. Where PA catheter has been employed, withdraw it at least 1 cm lest it becomes inadvertently wedged. If cerebral oximetry and or BIS are in use, ensure readings are also within the perfusionist’s line of sight. Place the ventilator in ‘heart–lung mode’, and silence relevant alarm tones on the monitor (apart from BIS and/or cerebral oximetry, if used). Continual presence of an anaesthesia team member is warranted throughout CPB.

Bleeding and haemostasis

Bleeding during or after cardiac surgery is a great challenge to the anaesthetist and a major cause of morbidity and mortality. Patients with a bleeding disorder are at high risk, as are those having re-do surgery or re-exploration for bleeding. The use of intraoperative cell salvage therapy is now routine and the use of antifibrinolytics such as tranexamic acid or aprotonin (Trasylol) have been shown to reduce the incidence of bleeding, though not without associated controversies. Tranexamic acid is the most

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