Postoperative cardiac intensive care

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Management of the cardiovascular system

Cardiac rhythm

In most patients heart rate should be maintained at 90–100 beats/min. Abnormal patterns within the first 24 hours include relative bradycardia (70–80 beats/min), sinus tachycardia (>110 beats/min) and, particularly after aortic valve surgery, atrioventricular conduction block. Bradycardias are usually managed with pacing via epicardial wires that are inserted perioperatively (ventricular leads +/− atrial leads). Atropine or isoprenaline infusion can be used as temporary measures.

Atrial tachydysrhythmias, most commonly atrial fibrillation, are unusual in the first 24 hours after surgery, but occur more frequently after 48 hours. Patients with poor left ventricular compliance benefit most from maintenance of atrioventricular synchrony. If there is doubt in the diagnosis an 'atrial' ECG can be performed by substituting atrial epicardial leads for the upper limb leads in a standard 12-lead ECG. The resulting ECG produces an exaggerated atrial depolarization trace, making differentiation of atrial arrhythmias easier (Figure 1). Administration of adenosine is an alternative method of differentiating supraventricular arrythmias, and can be effective therapy if the atrial dysrhythmia is supraventricular tachycardia. Initial management of tachyarrhythmia includes administration of potassium chloride (target plasma concentration 4.5–5.0 mmol/litre), magnesium sulphate and correction of hypoxia, hypercarbia, acidaemia, tamponade and ischaemia.

DC cardioversion should be considered as first-line treatment for patients who are haemodynamically compromised. Amiodarone is the usual drug treatment for new-onset atrial fibrillation. Prolonged atrial fibrillation requires anticoagulation (increasing the risks of pericardial collection) and subsequent DC cardioversion, preceded by transoesophageal echocardiography (TOE) to exclude intracardiac thrombus. Ventricular arrhythmias are uncommon after cardiac surgery and usually imply recent or continuing myocardial ischaemia.

Temporary pacing systems must be checked daily to ensure adequate pacing thresholds and to assess underlying rhythm. The use of two independent artificial pacing systems (usually a long-standing transvenous system and a temporary epicardial system) simultaneously is not to be recommended because of the risk of one system being inhibited by the output of the other, which may be failing to obtain mechanical capture.

Temporary pacing wires (and left atrial lines) should be removed early in a normal working day in order to reduce the incidence of cardiac tamponade occurring out of hours.

Management of low cardiac output

Ideally, all patients would receive cardiac output monitoring in the peri- and postoperative periods, but this is usually reserved for high-risk patients such as those with poor ventricular function or pulmonary hypertension. Cardiac output is monitored with the primary goal of maintaining adequate tissue perfusion. Oxygen-transport-related goal-directed therapy in cardiac surgical patients has been shown to decrease morbidity and length of hospital stay but has not been adopted widely. The pulmonary artery catheter (PAC) has traditionally been the gold standard of cardiac output measurement. In some patients, for anatomical or surgical reasons, PAC insertion is either contraindicated or thermodilution would be inaccurate. Recently, several less invasive cardiac output monitoring techniques have been marketed with the aim of avoiding the potential risks associated with PACs. These include oesophageal Doppler monitors and pulse contour analysis; however, concurrent use of an intra-aortic balloon pump precludes the use of both these techniques. TOE is useful for guiding haemodynamic management in difficult cases.

In this patient group, maintaining an adequate preload is important. However, reduced myocardial compliance may mean that the filling pressures (central venous pressure and pulmonary artery occlusion pressure) do not adequately reflect preload. There is continued uncertainty about the optimal haematocrit following cardiac surgery. For patients without cyanotic heart disease, the authors usually maintain haemoglobin concentration above 8 g/dl.

Myocardial depression postoperatively leads to reduced compliance and contractility, but usually resolves rapidly. Poor or deteriorating cardiac index (<2.2 litre/min/m^2) should be addressed to prevent tissue hypoperfusion. Signs of end-organ dysfunction are not sensitive indicators of early hypoperfusion, but there should be a high index of suspicion in patients with persisting metabolic acidosis, core to peripheral temperature gradient more than 2°C, oliguria, tachycardia, obtundation or hypotension. Important causes to identify and treat rapidly are arrhythmias, decreased preload (hypovolaemia, tamponade, tension pneumothorax), pump failure (myocardial ischaemia, valve failure, myocardial stunning) and increased afterload (hypertension, hypothermia, pain).

Tamponade and ventricular dysfunction may be associated with hypotension and raised jugular or central venous pressure. Diagnosis may be aided by pulmonary artery catheterization and echocardiography, although transthoracic views are often inadequate in identifying posterior pericardial collections, and TOE may be required. Tamponade cannot always be excluded by TOE and, if there is any doubt about the diagnosis in a patient with progressive deterioration, re-sternotomy should be performed urgently.

Choice of inotropic support for impaired left ventricular function is a variable area of practice with little evidence base.

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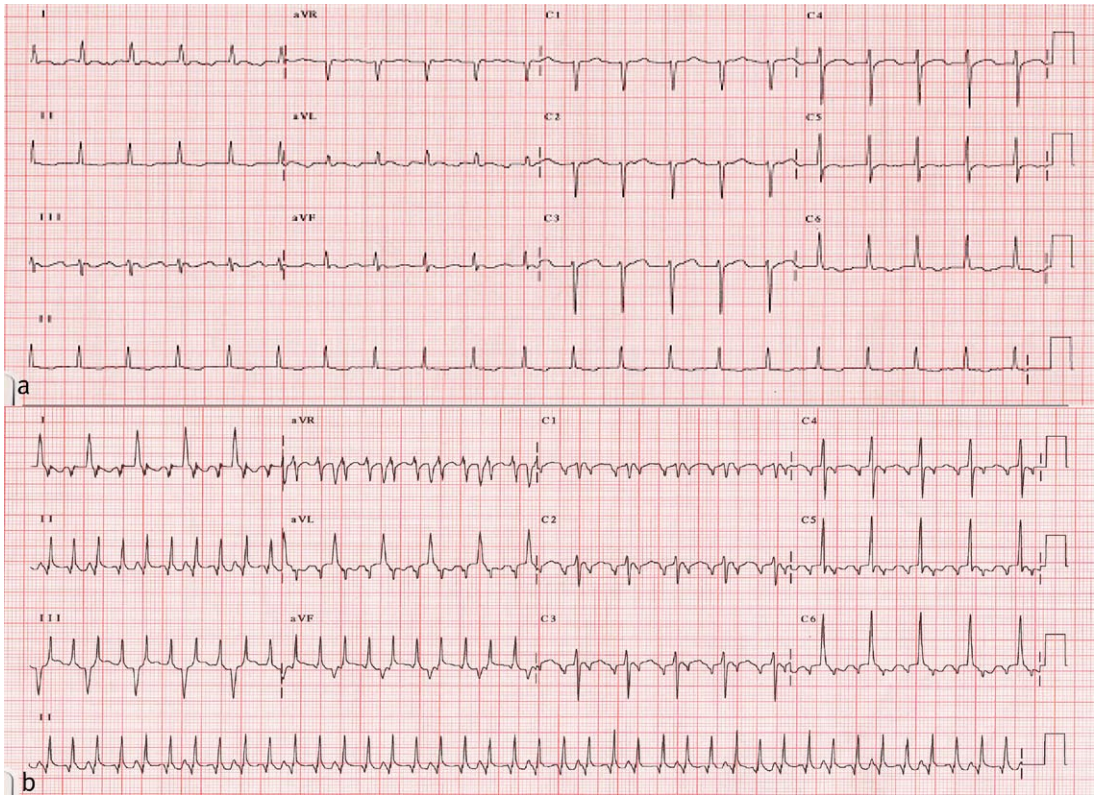

Figure 1 (a) Surface standard 12-lead ECG demonstrating narrow complex tachycardia. **(b)** Atrial ECG at same time showing atrial flutter with 2:1 block. The patient was subsequently cardioverted successfully.

For patients with mild-to-moderate ventricular impairment, dopamine, up to 5 μg/kg/min, is often used following cardiac surgery. In most patients, dopamine is weaned off within 24–48 hours. The immunomodulatory and pituitary effects of dopamine make it unsuitable for long-term use. Dopamine also produces an excessive tachycardia at the onset of treatment in some patients. Dopamine has no specific reno-protective effects, and any improvement of glomerular filtration rate is related to increased cardiac output. However, because of its ease of use, dopamine remains a widely used inotropic agent.

For patients with moderate-to-severe impairment of ventricular function a phosphodiesterase inhibitor (e.g. milrinone) is commonly used. The vasodilatory effects of milrinone usually necessitate concomitant administration of noradrenaline to maintain an adequate systemic arterial blood pressure. The half-life of milrinone is prolonged in patients with renal failure. Adrenaline may be used for the management of moderate-to-severe impairment of ventricular function. Undesirable effects include peripheral vasoconstriction and increased glucose and lactate concentrations. Levosimendan is a novel inodilator, acting by calcium sensitization (positive inotropic effect) and potassium ATP-channel activation of vascular smooth muscle cells (vasodilatation). Unlike other inotropic agents levosimendan does not increase myocardial oxygen consumption, and randomized trials in cardiac surgical patients are awaited. Additional options for the management of impaired left ventricular function include the use of an intra-aortic balloon pump (IABP) or ventricular assist device.

Increased systemic vascular resistance is common in the postoperative period. Pain, hypothermia, hypercarbia, hypoxia and the rebound effects of discontinuing preoperative antihypertensive therapy should be considered and treated. The risks of untreated hypertension include myocardial ischaemia, and breakdown of suture lines and anastamoses. In the case of the latter (particularly aortic root replacement), strict upper limits for systolic blood pressures should be set and antihypertensive therapy commenced (e.g. sodium nitroprusside) if these limits are exceeded.

Specific problems

Right ventricular dysfunction remains a significant problem following cardiac surgery. It is a particular issue in certain cardiac surgical settings: cardiac transplantation, congenital heart disease, mitral valve disease with pulmonary hypertension, and coronary artery disease. Usually, it is minor and does not delay weaning from mechanical ventilation. However, some patients with elevated pulmonary vascular resistance (PVR) are at risk of acute right ventricular failure. Measures used to manage raised PVR include avoidance of hypercarbia, maintaining good oxygenation, and adjusting the ventilator settings to minimize mean airway pressures (low positive end expiratory pressure (PEEP), short inspiratory:expiratory (I:E) ratios). Pulmonary vasodilators such as inhaled nitric oxide or nebulized prostacyclin may be used. More recently, oral sildenafil (a phosphodiesterase-5 inhibitor) has been found to be an effective agent for the treatment of postoperative pulmonary hypertension, and may facilitate the weaning of inhaled pulmonary vasodilators. Weaning and extubation can stress a failing right ventricle, and these patients often need to be weaned slowly and may require tracheostomy. Evidence of right ventricular failure (tachycardia, rising central venous pressure, oliguria, low cardiac output, respiratory distress) should prompt early re-sedation and endotracheal intubation. Severe right ventricular failure can be supported with a temporary right ventricular assist device.