Cardiac surgery

Management of pericardial tamponade post bypass surgery

Preparation for going onto and coming off cardiopulmonary bypass

Post-bypass bleeding

Patient assessment for cardiac surgery

Anaesthesia for cardiac surgery

Priorities in valve disease

Doses

Anaesthesia in the post-transplant patient
Management of pericardial tamponade post bypass surgery

Issues
- Emergency complication of bypass surgery requiring immediate surgical consultation
- Simultaneous diagnosis and management
- Accumulation of blood in enclosed pericardial space limits atrial and ventricular filling

Features
- Fall in cardiac output
- Hypotension, narrow pulse pressure
- High filling pressures
  - ↑ PAOP, CVP
- Failure of mediastinal drainage
  - Large volume drainage early followed by clots

Management
- ABCDE priorities
  - Secure airway, ventilate with 100% O₂
  - Support circulation
    - High filling pressures, tachycardia
- Surgical intervention
  - Remove clot from pericardium in theatre if there is time for transfer

Anaesthesia
- Reanaesthetizing post-bypass patient

Preparation
- Routine check of anaesthetic machine and equipment
- Pressor and dilator drugs, heparin for bypass
- Check Hb, platelets, coagulation status, acid-base status
- Notify blood bank
- Haemodynamic support
  - IV fluid, pacing to 90-140 min⁻¹
  - Continue inotropes from ICU

Monitoring
- Invasive monitoring (arterial and PA catheter) usually in situ
- TOE may give useful information about tamponade and ventricular function

Induction
- Fentanyl 10-20 µg/kg, pancuronium
  - Consider sux if reintubation required (may be difficult)
- Small dose of thiopentone or ketamine

Maintenance
- High degree of vigilance for complications, arrhythmias
- May require going onto bypass
- Monitoring of Hb, ABG, coagulation

Postoperative
- Return to ICU intubated and ventilated
Preparation for going onto and coming off cardiopulmonary bypass

Check list for bypass

Before cannulation

Anticoagulation

Heparin dose 300-400 U/kg
ACT > 300 s

Haemodynamics

Systolic BP < 100 mmHg
ECG recorded
CVP adequate for caval cannulation

Ventilation

Compliance recorded
ABG and acid-base satisfactory

Before running on CPB

Anaesthesia and paralysis confirmed
CPB circuit has no bubbles, correctly connected and clamps off
IV fluid ceased and urine recorded

First minutes of CPB

Adequate flows and pressures
Obvious oxygenation of aortic cannula blood
Cease ventilation when arrested
Continue ABG, ACT measurement

During CPB

Anticoagulation

Maintain ACT > 400 s
Inspect circuit and reservoir for fibrin

ABG, acid-base

\( P_{\text{V}}O_2 > 40 \) mmHg, \( S_{\text{V}}O_2 > 60\% \)
Hct 18-22%

Haemodynamics

MAP 40-90 mmHg, PAP < 15 mmHg, CVP < 0
Quiescent ECG

Temperature

Monitor hypothermia and rewarming

Neurological

Facial oedema, pupils, EEG (if monitored), paralysis

Renal

UO > 1 ml/kg/h, no haemolysis

Pump

Pressure and flow appropriate
Venous return appropriate
Fluid balance

Coming off CPB

Rewarming

Neurological unresponsiveness
Adequate ACT, normal ABG, pH, electrolytes
Vasodilation for even rewarming
Defibrillation ± pacing

Prior to coming off

ABG, Hct, K+
Core and peripheral temperatures
Suitable rhythm
Controlled MAP
Filling, vasodilation, CVP, PAP

Cardiac surgery 3.D.1.3 James Mitchell (December 24, 2003)
Reinflate lungs, Valsalva
Vent arterial air, verify with TOE

Weaning CPB
Preload
  CVP, PAOP
  Filling and vasodilation
Ventricular function
  dP/dt on arterial trace
  CO, TOE
  Inotropes if indicated
Return of reservoir blood ± haemodilution blood

After discontinuation
Protamine to normalize ACT
Correction of coagulopathy, thrombocytopenia if indicated
Haemodynamic management (pacing, filling, inotropes, vasodilation)
Maintenance of anaesthesia
Preparation for ICU transfer
Post-bypass bleeding

Issues

- Postoperative patient with multiple possible causes of impaired haemostasis
- Usually in ICU setting
- May be an emergency depending on severity: simultaneous diagnosis and management

Priorities

- ABCDE if necessary (tamponade, rapid bleed)
- Aim for haemodynamic stability, assessment, correction of abnormalities
- In practice, treatment may be empirical in order to achieve stability

Assessment

- History
  - Medical problems (e.g. renal failure, hepatic dysfunction)
  - Preoperative drug therapy (e.g. aspirin, warfarin)
  - Operative detail: duration of CPB, transfusion requirement
- Examination
  - Rate, source and nature of bleeding (general vs localized, arterial vs haemoserous)
  - Relation to position if drain tube losses only
- Tests
  - ACT prior to leaving theatre
  - APTT, INR, platelets
  - DIC screen
  - Thromboelastography

Management

- Surgical haemostasis
- Reversal of residual heparinization
- Replacement of platelets and desmopressin
- Replacement of clotting factors
- Prevention of secondary fibrinolysis, DIC
Patient assessment for cardiac surgery

Epidemiology
   IHD in 20% of adult surgical patients, 70% of vascular patients
   Perioperative AMI has 15-70% mortality

Cardiovascular
   History, examination
      Angina, exercise tolerance, dyspnoea, palpitations
      Hypertension
   Medication, previous procedures
   Other vascular disease: aneurysms, carotid or peripheral disease
      Signs of cardiac failure or valve dysfunction
   ECG, exercise ECG
      HR and BP at which ischaemia was evident
   Leads which showed ischaemia best
   Evidence of ventricular dysfunction
   Echocardiography
      Condition of aorta and coronaries, LV function, valve function
      Regional wall motion abnormalities
      Stress echo has good discriminatory power
   Coronary angiogram
      Static test, no indication of exercise ischaemia
      Location of lesions → ECG leads to monitor
      Results of previous revascularization procedures
      LVgram indicates LV function (not best test)
   Radionuclide angiography
      Perfusion defects ± stress, ventricular ejection
   Cardiac catheter
      Valve function and gradients, ventricular pressure, output
      Quantification of shunts
   Other tests
      FBE, U&E, LFT, XM, ABG (sometimes at induction)
      Of questionable value: clotting, urinalysis

Noncardiac disease of interest
   Condition should be optimized before elective surgery
   Endocrine
      Obesity, thyroid dysfunction, adrenal dysfunction, phaeo
      Diabetes
         Autonomic lability, silent ischaemia, slowed gastric emptying
   Haematological
      Anaemia, coagulopathy, haemolytic conditions
   Respiratory
      Smoking, asthma, COAD, infection, pulmonary embolism
   Other
      Renal failure, cirrhosis, peptic ulcer disease, drug dependence, connective
      tissue diseases

Medications
   Decision to continue or cease in consultation with cardiologist
   Continue
      Antianginals, β-blockers, antidysrhythmics, most antihypertensives
   Usually continue
      Aspirin, Ca²⁺ channel blockers, digoxin, most other agents
   Maybe cease
      ACE inhibitors (worsen hypotension)
   Usually cease
      Diuretics, oral hypoglycaemics (substitute insulin)
Other preparation
Consent
Height, weight, BSA
Washing, shaving, fasting
Anaesthesia for cardiac surgery

Premedication
Anxiolytic and sedative, avoid hypotension and marked hypercarbia
- Diazepam 0.1-0.2 mg/kg plus morphine 0.1 mg/kg
- or lorazepam and fentanyl, or Omnopon and scopolamine
Reduced risk of ischaemia
- Nitrate, β-blocker, clonidine

Monitoring
Routine
- SpO$_2$, ECG with ST analysis, arterial line, PA catheter (CVC in some units), temperature (core and peripheral), IDC with burette, large peripheral IV
- All in place before induction
Priorities: volume status and contractility assessment to guide therapy
- If indicated
  - Oesophageal stethoscope can monitor HR, breathing without interference
  - PA catheter (unless routine) for CO, PAOP
  - TOE
  - Cerebral function monitor for deep hypothermia

Bedside tests
- ABG, Na+, K+, Hb, glucose, ACT (? thromboelastography)

Induction
Traditional
- Fentanyl 10-30 µg/kg, pancuronium 0.1 mg/kg, propofol minimum required dose
Additional drugs
- Antibiotics, ε-aminocaproic acid or aprotinin, Mg$^{2+}$
- Heparin pre-bypass
- Pressors and vasodilators as required

“Fast track”
- Propofol, isoflurane, fentanyl or remifentanil
- Requires normothermia, haemodynamic stability and coagulation at end of case

Thoracic epidural
- Improved analgesia, ↓ stress response
- Risks unknown, may be no better than β-blockade

Off-bypass CAGS
- Conventional anaesthetic, grafts performed on beating heart
- Requires low CO, low O$_2$ demand during grafting as coronary vessel is occluded
  - Fill, posture head down, reduce heart rate

Maintenance
- Usually air, O$_2$, isoflurane ± propofol infusion for bypass

Bypass
- **Going onto and coming off bypass**
- Venous return usually from SVC and IVC
  - Total or partial bypass
- Additional input from sucker and LV vent if present
- Reservoir in bypass machine
- Oxygenator (membrane or bubble)
- Heat exchanger
- Pump (usually non-occlusive roller)
- Bubble catcher and filter
- Arterial infusion usually ascending aorta
  - Output commonly set at typical CO for patient (≈5 l/min)
  - MAP set by dilator/pressor infusion (≈70 mmHg)
Management of pH, PCO₂

No temperature correction (alpha-stat) is conventional

Postoperative
Transfer to ICU
- Oxygen and means of ventilation
- Continuous monitoring (ECG, SpO₂, BP), pacemaker if necessary
- Infusion devices for drugs
- Assistance for emergencies
- Sedative, analgesic and resuscitation drugs
- Advance notice to ICU

Analgesia
- Narcotic infusion, PCA, oral adjuvant agents
<table>
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<th>Doses</th>
<th>Bolus</th>
<th>Infusion</th>
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<td><strong>Pressors</strong></td>
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<td>Methoxamine</td>
<td>2-100 mg</td>
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<td>Phenylephrine</td>
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<td>Ephedrine</td>
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<tr>
<td>Noradrenaline</td>
<td>1-10 µg</td>
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<td><strong>Inotropes</strong></td>
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<td>Dobutamine</td>
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<td>3·BW mg in 50 ml</td>
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<td>Dopamine</td>
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<td>Isoprenaline</td>
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<td><strong>Vasodilators</strong></td>
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<td>GTN</td>
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<tr>
<td>PGE₁</td>
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<tr>
<td>Hydralazine</td>
<td>5 mg</td>
<td>&lt;40 mg/h</td>
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Priorities in valve disease

Mitral stenosis
Severity by valve area: normal 4-6 cm², mild 1.5-2.5 cm², moderate 1-1.5 cm², severe ≤1 cm²
Sinus rhythm and normal heart rate are vital for output
Maximize LA pressure without pulmonary oedema
↑ risks with PA catheter in pulmonary hypertension
Pulmonary HT may cause RV failure

Mitral regurgitation
Severity by regurgitant fraction: >0.6 severe
Heart rate normal to high
Low SVR increases forward flow (limited by hypotension)
Maintain contractility without high preload (dilates LV)
Risk of ventricular rupture coming off bypass
Loss of chorda tendinae bracing ventricle and ↑ pressure work
IABP may be helpful

Aortic regurgitation
LV volume overload, gradual hypertrophy, sudden decompensation
Severity by regurgitant volume: mild 1-3 l/min, moderate 3-5 l/min, severe >6 l/min
Tachycardia reduces LV distension
Low SVR increases forward flow (limited by hypotension)
Contractility usually impaired
Aortic cross-clamp or LV vent may be required
Antegrade cardioplegia may be impossible
IABP contraindicated

Aortic stenosis
Severity by valve area (<1 cm² severe) or pressure gradient
High LVEDP (PAOP) to fill non-compliant ventricle
Sinus rhythm a high priority, normal heart rate
Myocardial O₂ balance is impaired by LV hypertrophy and low aortic root pressure
Vasodilation may severely impair coronary and cerebral perfusion

HOCM
Dynamic functional aortic outflow obstruction due to septal hypertrophy
Obstruction improves with reduced pressure gradient
Vasoconstriction, β-blockade, myocardial depressants
Maintain high preload
High incidence of arrhythmia
Anaesthesia in the post-transplant patient (BJA 1991; 67: 772-778)

Transplant types
- Heart, heart-lung, single lung

Complications
- Arrhythmia: including fatal VT, sign of rejection
- Infection related to immunosuppression
  - CMV, HSV, pneumonia with *Pneumocystis carinii*
- Neoplasia related to immunosuppression
- Depression, anxiety, thought disorder
  - May lead to rejection due to medication non-compliance
- Coronary vessel disease
  - Common (46% at 2 years) without pain (denervated)
  - Presents with lethargy and dyspnoea
  - Routine screening angiography and biopsies for rejection
- Lung rejection
  - Symptoms similar to infection: desturation, fever, leukocytosis, opacification

Anaesthesia issues
- Denervated heart
  - Rate 90-100 /min, no vagal or sympathetic response
  - Normal response to circulating catecholamines
  - No rate response to baroreceptors, Valsalva, carotid sinus, hypovolaemia, light anaesthesia
  - Dependent on intrinsic regulation of cardiac output
    - Preload dependent → stroke volume
    - Must maintain filling pressure
- Cardiac pharmacology
  - Little effect from cholinergic agents: atropine, neostigmine, suxamethonium
  - β adrenergic agents and glucagon remain effective
  - Antidysrhythmics and DC reversion remain effective
- Denervated lung
  - Relatively normal respiratory pattern and maintenance of gases
  - PCO₂ response may be blunted
  - No cough in response to irritation of bronchi
    - Extubate awake, encourage active physio
  - Uneven V/Q distribution
  - Bronchoconstriction can occur
- Usual drug regimen
  - Immunosuppression
    - Must be continued perioperatively
    - Steroid requires supplementation
    - Azathioprine
    - Cyclosporin: nephrotoxicity, hepatotoxicity, hypertension, ↑ NDB effect
- Evaluation
  - Consult with treating unit
  - Routine preoperative assessment
- Technique
  - GA or regional provided filling maintained
  - Meticulous aseptic technique
  - Routine prophylactic antibiotics (? also for line insertion)
  - Isoprenaline for bradycardia (not atropine)
  - Minimize lines, avoid right IJV (used for biopsies)
  - Vigorous physio post-op