Cardiology

Aortic incompetence

Mitral stenosis

Pacemaker management

Heart block management

AICDs
Aortic incompetence

Aetiology
Acute
Endocarditis, aortic dissection, connective tissue disease, trauma

Pathophysiology
Acute
Sudden volume load on LV
↑ LVEDP, PAOP
Sympathetic response: ↑ HR, vasoconstriction
May cause acute decompensation and failure

Chronic
Progressive LV enlargement and hypertrophy
High compliance, high output
Late decompensation (10-20 years)

Classification
Regurgitant flow: < 3 l/min mild, 3-6 l/min moderate, > 6 l/min severe
Or by contrast findings on aortogram

Features
Tachycardia: ↓ regurgitation, LVEDV, ↑ coronary perfusion
Relatively little increase in myocardial O₂ demand until late
Volume work increases O₂ demand less than pressure work

Management
Responsive to pressors, but vasodilators may increase forward flow
Diastolic hypotension and bradycardia to be avoided (↓ coronary perfusion)
IABP contraindicated (enhances retrograde flow)

Valve replacement
Retrograde flow of pump blood may distend LV until aortic clamping
Anterograde cardioplegia may be difficult
Mitral stenosis

Aetiology
Usually rheumatic heart disease

Clinical features
Symptomatic early, slow progression
Marked worsening with ↑ demand for CO (pregnancy) or development of AF

Severity
Pressure gradient not useful (dependent on HR, CO...)
Valve area (normal 4-6 cm²)
   - Mild: 1.5-2.5 cm²
   - Moderate: 1-1.5 cm²
   - Severe: <1 cm²

Anaesthetic management
Heart rate maintained low-normal in sinus rhythm
Bradycardia → ↓ CO due to low SV
Tachycardia → ↓ CO due to slow diastolic filling
AF → sudden decompensation, especially with rapid ventricular rate

Maximal tolerated LAP without pulmonary oedema
Risk of complications from PA catheter
   - Pulmonary hypertension: ↑ risk of PA rupture, unreliable PAOP
Risk of RV failure with pulmonary hypertension
   - Septal deviation impairs LV filling
   - Prevent with NO, lowering PVR
Pacemaker management

Identification code (5 letters)
- Chamber paced: O, Atrium, Ventricle, Dual
- Chamber sensed: O, Atrium, Ventricle, Dual
- Mode of response: O, Triggered, Inhibited, Dual
- Antitachycardic function: O, Pacing, Shock, Dual
- Programmability: O, Program, Multi-program, Communicating, Rate-response

Modes

Asynchronous
- AOO, VOO, DOO: pacing regardless of underlying activity
- Fall-back mode only as wasteful of battery and may compete with intrinsic rhythm

Single chamber demand
- AAI, VVI: single chamber pacing inhibited by intrinsic activity
- Simple single-lead pacemakers
- AAI requires intact A-V conduction
- VVI does not maintain A-V synchrony

Dual chamber
- A-V synchronous (VAT, VDD)
- A-V sequential (DVI)
- Universal (DDD)
  - Operate in AAI, VDD or DVI as required
- A-V inhibited (DDI)
  - Used where atrial tachycardia causes rapid ventricular pacing in DDD

Rate responsive
- Provide exercise response in patient who are pacemaker-dependent
- Various sensors used
  - Temperature, SvO$_2$, respiratory rate or minute volume, QT interval, vibration, acceleration

Antitachycardia functions
- Simple shock devices
  - Recognize sustained tachycardia
  - Deliver 25-30 J shocks up to five times
- Tiered (dual) therapy devices
  - Pacing for bradycardia
  - Overdrive pacing for atrial tachycardia
  - Low energy cardioversion for VT
  - High energy defibrillation for VF
- Generate palpable but not dangerous voltage at the body surface

Issues
- Maintain stable heart rate and rhythm throughout surgery

Preoperative

History
- Reason for pacemaker insertion
- Symptomatic arrhythmias or IHD
- Medications
- Other illnesses
- Type of pacemaker, who manages it, last tested, history of problems
- Previous anaesthetics

Examination
- Routine, focusing on cardiorespiratory examination
- Identify location of box

Investigation
- ECG
  - Identify rhythm, presence of pacing spikes
Consultation
Cardiologist to determine pacing mode, rate-responsiveness

**Rate-responsiveness and antitachycardia functions must be switched off prior to surgery**

Premedication
Continue cardiac medications

Transport
Avoid excess movement if movement-responsive

Preparation
Chronotropic medications available, external pacemaker may be available
Atropine, isoprenaline

Routine access and monitoring
Additional heart rate monitor not susceptible to diathermy interference
Precordial stethoscope or palpable pulse
ECG leads short: can act as antennae
“Cardiac protected” theatre required

Intraoperative
Sensing pacemakers can be affected by myopotentials, movement, diathermy

Induction
Suxamethonium fasciculations produce myopotentials
Excess ventilation simulates exercise in movement-responsive pacemakers
No requirement for prophylactic antibiotics

Maintenance
Position so that pacemaker is not a pressure area

Diathermy
Problems
Direct damage to pacemaker from current
Microshock (VF) from current through lead
Inhibition of pacemaker by current if in demand mode

Precautions
No diathermy within 15 cm of pacemaker
Brief bursts of diathermy if interfering with pacing
Preferably bipolar diathermy with minimal current
Consider changing mode to asynchronous
Diathermy current distant from and at 90’ to pacemaker
Grounding plate distant, but not if head & neck surgery
Avoidance of N\(_2\)O with a recently implanted pacemaker
Expanding a gas pocket around the generator can cause loss of anode contact with a unipolar generator
Maintain temperature to avoid post-op shivering

Emergencies
Use of a ring magnet
In VVI will set a fixed rate
Effect is not predictable in programmable pacemakers

“Pacemaker syndrome”
Activation of VVI pacemaker causes hypotension
Loss of AV synchrony or retrograde conduction causes fall in CO
Atrial stretch causes reflex vasodilatation

Pacemaker failure
Interference from electrical activity or muscle potentials
Failure to capture due to electrolyte disturbance or drugs
Hypoxia, hypercarbia, ↑ intracellular K\(^+\), hypernatremia
Verapamil, ß-blockers, quinidine

Defibrillation
Paddles at least 12 cm from generator, orientated at 90’ to AICD electrodes
Management of heart block

Issues
- Risk of development of AV block with bradycardia
  - Is a prophylactic pacemaker required?
- Risk of associated cardiac disease

Preoperative
  Assessment
    Conduction defect
    - Symptoms: dizziness, drop attacks, palpitations
    - Cardiac examination: BP and HR, arrhythmia
    - Previous investigation: conduction studies, ECG
    Stability of disease
  Associated disease
    - History of Lev's or Lenegre's disease
    - Fibrosis of His bundle or terminal fibres
    - Cardiac surgery or His ablation
    - Cardiomyopathy
    - IHD
    - Previous investigations: stress test, echo, coronary angiogram etc.
    Drug therapy either treating or causing block
      - e.g. digoxin, propranolol, quinidine, procainamide, verapamil
  General assessment
    - Level of function
    - Routine anaesthetic assessment
  Investigation
    - ECG, U&E, specific investigations as indicated
  Consultation
    - Discussion with treating cardiologist
    - Optimize medication regimen
    - Defer surgery if time is needed
    - Decision whether preoperative pacing is required
      - Not usually necessary unless unstable and symptomatic
      - If unstable, insert transvenous pacing wire under LA

Premedication
  - Continue usual cardiac drugs
  - Anxiolytic, sedative premedication

Consent
  - Discuss possible requirement for temporary pacing

Anaesthetic plan
  - Regional with avoidance of hypotension preferable to GA

Intraoperative
  Preparation
    - Routine anaesthetic equipment prepared
    - Drugs and equipment for rapid conversion to GA if necessary
    - Chronotropes available for CHB: atropine, isoprenaline
    - Transvenous or external pacing equipment available

Monitoring
  - Routine, plus
    - 5 lead ECG monitor prior to block insertion
    - Large bore IV access

Induction
  - Low spinal or epidural catheter
    - Depending on likely duration of surgery and stability of disease
  - Preloading with fluid
Pressors drawn up

Emergencies

Heart block with nodal rhythm
- Usually responsive to atropine

Heart block with ventricular escape
- Usually accompanied by bradycardia, hypotension
- Immediate transvenous or external pacing if available
- Otherwise
- Airway control and ventilation with 100% O₂ if unconscious
- IV fluid
- Rate support with isoprenaline and atropine until
- Insertion of transvenous pacing wire
AICDs

History
1980 First implanted in a human
1985 FDA approval of first devices
    Required sternotomy, epicardial patches
    Battery lasted 18 months
1986 Transvenous approach first used
    Modern devices similar to pacemaker in size with years of battery life

Structure
Leads for sensing and pacing/shock
Control circuits
Battery
Capacitor for holding shock charge (0.5-20 J)

Indications
Spontaneous VT/VF episodes
    While on medical therapy or where medical therapy is impractical
Detection of arrhythmia
    Sensing lead picks up ECG
    Analysis for backup dual chamber pacing, plus
    Rate
    Onset of tachycardia (faster in VT than SVT)
    Stability (more constant R-R in VT than AF or VF)
    Duration (decide when to deliver a shock)

Anaesthesia for insertion
Patient assessment
    Usually fragile with CAD, previous AMI or cardiomyopathy
    Often on antidysrhythmics
    Need normal electrolytes
Procedure
    Subpectoral placement of generator with transvenous lead placement
    Local plus sedation for insertion
    Careful monitoring for arrhythmia and placement of pads for defibrillation
    Resuscitation drugs available
Testing
    Sensing and pacing functions as for any pacemaker
    Antitachycardia function requires induction of VF
    Brief GA (like DCR)
    R on T pacing until VF achieved
    Wait 10 s for delivery of shock
    Prepare to use external defibrillator if necessary

Precautions in patients with AICD
MRI
    AICD is an absolute contraindication
Resuscitation
    Usual resuscitation protocol
    AICD shock poses no risk to others
    Insufficient voltage on skin surface to cause harm
    Use of external defibrillator as necessary
    May damage AICD
    Needs to be checked after successful resuscitation
Anaesthesia
    Deactivation of antitachycardia function is necessary
    Risk of misinterpretation of interference as tachyarrhythmia
    Elective reprogramming by a technician before surgery is ideal
    Ring magnet disables antitachycardia functions in many models
“Pip” on R for 30 s then “Beep” means disabled
May be necessary in an emergency