Paediatric Cardiac Surgery and Principles of Post Operative Care

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Aim

To refresh and update current knowledge of critical care nurses in relation to paediatric cardiac surgery and principles of post operative care

Objectives

By the end of this session you should be able to:

- Have a sound understanding of the principles of post operative care and possible complications
- Discuss the effects of cardiac surgery and cardiopulmonary bypass on the heart and other organ systems
Cardiac Surgery

The goals of post op cardiac management are to optimise cardiopulmonary support through external monitoring and prevent secondary injury to the myocardium and other organs.

Cardiopulmonary Bypass (CPB)

HISTORY

- First successful ASD repair on a mechanical extracorporeal oxygenator by Gibbon in 1953
- 1954 trialled cross circulation with a child’s parent
- 1971 Barratt-Boyes started using hypothermic arrest
- Further and ongoing improvements in perfusion techniques as well as myocardial and brain protection.

CPB Components

- Tubing
- Pumps (roller and centrifugal)
- Oxygenator
- Cannula
- Cardioplegia
Passive venous drainage from venous cannula

Pump flows of 100-120ml/kg/min (can increase >200ml/kg/min)

Oxygenator

Heat exchanger

Filter

Return to aortic cannula

Venous cannulation
IVC/ SVC or RA appendage

Aortic cannulation
Ascending aorta

A cardioplegia cannula will also be inserted into the heart
CPB - Circuit and Cannulation

Circuit Prime and Haemodilution
- Circuit prime may be 3x the blood volume of a neonate
- Effects of haemodilution are markedly enhanced in babies compared to adults
  - Decreased plasma protein levels
  - Decreased coagulation factors
  - Decreased haemoglobin

Cardioplegia
- Cold (4°C) injected into aortic root
- Isotonic crystalloid solution, high in K+ and Mg
- Induces cardiac arrest and preserves the myocardium
Cross Clamps
- Clamp above the coronaries to prevent cardioplegia leaking into the systemic circulation

Circulatory Arrest
- Bypass cannula removed and circulation halted completely to allow a clear view
- Can be tolerated for around 50-60 minutes at 18-20°C

Hypothermia
- Deep hypothermia is 18°C
- Moderate hypothermia is 30-32°C
- Reduces tissue oxygen requirements by 50-75% and reduces negative effects of reduced perfusion

Anti-Coagulation
- Heparin boluses to maintain ACT > 400s
- Reversed with protamine

Extra Corporeal Life Support (ECLS)
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- Extra-Corporeal Membrane Oxygenation (ECMO) provides temporary life support to patients with severe but potentially reversible cardiac or respiratory failure. It refers to the delivery of oxygen by “extracorporeal” measures, and literally means by mechanical bypass that takes place outside of the body.
- If they go on in theatre they use the same cannula as used for bypass.
- If it is an emergency they can use the neck or femoral or reopen the chest and recanulate.
- Any designated cardiac centre must offer ECLS and ECPR
- ECLS initiated by perfusionists but led on the unit by experienced PIC nurses.
- Nurses follow standing orders and tight prescriptions
- Study days every 8 weeks to practice emergency procedures

Minimum time on ECLS 3-5 days (can begin wean after 72hrs)

- No maximum time although greater risk of the following the longer the run:
  - Air entrapment
  - Clots (especially around connectors
  - Infection risk
  - Sedation toxicity

Bedside nurse I effectively caring for a standard level 3 post op cardiac patient

Post Op Complications associated with Cardiopulmonary bypass

Associated Problems from:

- Cannulation and cross clamping
- Exposure to the CPB circuit
- Ischemia, emboli and hypoperfusion
- Accessing the chest and collapsing the left lung
- Exposure to drugs and blood products
- Hypothermia
Further Post Op Complications associated with Cardiac Surgery

- Arrhythmias
- Surgical Bleeding
- Low Cardiac Output state
- Obstruction of stent/shunt
- Infection
- Cardiac tamponade
- Cardiac arrest

Effects of cardiac surgery and cardiopulmonary bypass on other organ systems

- Cardiovascular system
- Respiratory
- Neurological system
- Renal system
- Endocrine

Effects on cardiovascular system

- Arrhythmias
- Stunned myocardium
- Low cardiac output
- Hypertension/Hypotension
- Systemic oedema resulting from fluid shift following haemodilution
- Increased capillary permeability due to endothelial damage
- Myocardial ischemia due to air embolus, non pulsatile flow or hypotension
- SIRS response
Arrhythmias

Assessing Rhythm

- Rate
  Normal for age, Too fast, Too slow? Regular or irregular?

- Complexes
  Can you see PQRST?

- Are QRS Complexes Narrow or Broad?

- Is child shocked? Has ECG or Arterial/ Pulse/ CVP Waveforms changed?

LOOK at the child........do you need assistance??

Common Post Op Arrhythmias

JET (Junctional ectopic tachycardia)

Most common with Tetralogy Of Fallots, AVSD, Arterial Switch or TAPVD repair

- Malignant Rhythm, caused by trauma to AV node or bundle of his, Ectopic focus emits impulses at fast rate 160-260

- Atrial/ Ventricular dissociation occurs

- Low Cardiac Output Follows

Treatment

- Over Pacing – gain capture then slowly reduce rate

- Cooling to 35°C

- Adequate sedation +/- Muscle Relaxant

- Antiarrhythmic – Amiodarone

- Optimise electrolytes

- Vasoactive drugs to support cardiac function
Common Post Op Arrhythmias

Junctional (nodal)

- Absent P waves caused by failure of SA node.
- If failure persistent AV node may take over as main pacemaker with a relatively slower rate.

Treatment

- Treatment often not required if child asymptomatic
- Can pace atrium until SA node recovers

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Common Post Op Arrhythmias

Heart block

1st degree heart block
2nd degree heart block
3rd degree (complete) heart block

Treatment

Temporary Pacing
May require permanent pacing system

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What are these???

How would you treat these rhythms?
### Effects on cardiovascular system

**Cardiac Tamponade**
- What causes this?
- How is this treated?

**Pulmonary hypertensive crisis**
- What causes this?
- How is this treated?

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<tr>
<th>Effect on cardiovascular system</th>
<th>Cardiac Tamponade</th>
<th>Pulmonary hypertensive crisis</th>
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<tr>
<td>Cause of fluid collecting within the pericardial sac, which impedes adequate diastolic relaxation and cardiac filling and impairs myocardial function.</td>
<td>Treatment: Open pericardotomy to remove fluid and therefore the pressure.</td>
<td>Characterised by an acute rise in PA pressure followed by a reduction in cardiac output and a fall in atrial O$_2$ saturation. Treatment: Prophylaxis: avoiding factors known to cause rise in PVR Rapid hand ventilation with 100% fio2, boluses of IV sedation (morphine/fentanyl), muscle relaxants, use of NO.</td>
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### Effects on respiratory system

- Pulmonary Oedema: ARDS secondary to SIRS
- Decreased lung compliance
- Hypoperfusion VQ mismatch
- Lung collapse
- Increased PVR
  - How would you recognise this?
  - How would you manage this?
Effects on neurological system

- Impaired concentration, agitation, disorientation & confusion in up to 75% adults post bypass.
  - Emboli (gas, debris, calcium)
  - Poor cerebral perfusion
  - Cerebral haemorrhage
  - Phrenic nerve palsy
  - Spinal cord infarctions

Effects on renal system

- Renin-angiotensin-aldosterone activation and vasopressin release from poor renal perfusion
- Increased ADH release
- Renal injury due to haemolysis

How do we treat renal failure post operatively?

Effects on endocrine system

- Raised adrenaline and noradrenaline levels
- Hyperglycaemia due to impaired insulin release
Care of the post op cardiac patient

Airway-
- ETT size and length
- Equal breath sounds on auscultation

Breathing-
- SpO2 within acceptable range given procedure
- Is NO in use
- Chest movement, ventilation mode and settings
- Arterial blood gas analysis
- CXR (ETT position, lung inflation, lines, drains, wires.

Circulation-
- Heart rate and rhythm
- BP/CVP/LAP/RAP/PAP and their wave forms
- Drugs- inotropes?
- Drains- confirm position and monitor losses. Are they patent?
- Pacing wires in situ? Is child being paced? What is their underlying?
- Bloods FBC/clotting/u&e
- Blood gas analysis
- Temperature

Central Nervous System
- Pupil size and reaction to light
- NIRS
- Bolus and infusion of opiates, monitor effects
- Muscle relaxants may be required

Metabolic State
- Mixed gas analysis
- Close monitoring of glucose
### Care of the post op cardiac patient

**Fluid Management**

- Maintenance fluids restricted
- Assess urine output aiming for 0.5-1ml/kg/hr initially
- To assess if fluid management is effective:
  - Peripheral perfusion (cap refill, pulses)
  - Assess preload via CVP/LAP
  - Assess urea and electrolytes
  - Assess ongoing fluid loss through drains
- Fluid boluses to be given in 5-10mls/kg and assessed as given
- Nutritional support through enteral feed should be started within 48hrs

### Summary

- Cardiac surgery with or without the use of cardiopulmonary bypass carries many potential complications
- Each cardiac case is individual and children can respond to procedures very differently
- Cardiac surgery and cardiopulmonary bypass have many effects on other organ systems in the body. These should be anticipated and identified through appropriate patient assessment.