Pediatric Cardiac Postoperative Care: Important Nursing Considerations

Interdisciplinary Sign-out

- **Interdisciplinary team**
  - Intensive care unit bedside nurse
  - Anesthesia
  - Cardiac surgery
  - Intensive care unit doctor

- **Report**
  - Diagnosis and preoperative condition
  - Intraoperative procedure
  - Medications
  - Postoperative imaging studies

- “Close the loop”: summarize plan
Assessments and Invasive Monitoring

- Understand anatomy and surgical repair
- Establish a baseline
- Ensure quality of data
  - Vital signs
  - Invasive monitoring
    - Pressures, wave forms, blood return
    - Transducers calibrated
    - Position of central catheters
  - Chest radiograph evaluated
- Electrocardiogram (ECG)

Invasive Hemodynamic Monitoring

- Arterial blood pressure
- Central venous pressure
- Right atrial (RA) \( \geq 6-8 \text{ mmHg} \)
- Left atrial (LA) \(<12-14 \text{ mmHg}\)
- Pulmonary artery (PA) \(10-20\text{mmHg (mean)}\)
Hemodynamic Monitoring
Right Atrium

• Right atrial catheter
  – Systemic venous return
  – Intravascular volume
  – Right heart issues
• Increased saturation
  – High cardiac output
  – Left to right shunting
  – Overwhelming sepsis
• Decreased saturation
  – Low cardiac output

Hemodynamic Monitoring
Left Atrium

• Left atrial catheter
  – Pulmonary venous return
  – Intravascular volume
  – Left ventricular preload
  – Left ventricular afterload
  – Left ventricular function
  – Intracardiac shunting
• Decreased saturation
  – Right to left shunt
  – Pulmonary venous desaturation
Hemodynamic Monitoring
Pulmonary Artery

- Pulmonary artery catheter
  - Right ventricular function
  - Obstruction of right ventricular outflow
  - Pulmonary vascular reactivity
  - Venous pressure in the lungs
  - Left sided heart filling pressures

- Decreased saturation
  - Low cardiac output

- Increased saturation
  - Left to right shunt

Cardiac Output

Cardiac Output = 

Heart rate \times \text{Stroke Volume}

\[
\text{Rate} \quad \text{Rhythm}
\]

\[
\text{Preload} \quad \text{After load}
\]

\[
\text{Contractility}
\]
Questions?

Nursing Physical Exam

- **Cardiac output**
  - Peripheral perfusion and temperature
  - Urine output
  - Arrhythmias
- **Respiratory**
  - Breath sounds
  - Ventilation
Nursing Physical Exam

• Neurologic
  – Pupil response
  – Level of consciousness

• Pain and sedation
  – Vital signs
  – Developmentally appropriate pain scales

• Gastrointestinal
  – Abdominal girth
  – Bowel sounds
  – Liver assessment

Nursing Physical Exam

• Renal
  – Electrolytes
  – Postoperative fluids: ½ maintenance after bypass

• Skin integrity
  – Turn patient every 2 hours
  – Infant: occiput
  – Older patient: sacrum and lower back
Hemostasis

- Surgical versus non-surgical bleeding
  - Coagulation studies
  - Correction of abnormal coagulation and hematologic studies
  - Volume replacement
  - Avoid hypertension
- Temperature
- Chest tubes patent

Cardiac Tamponade

- Signs and symptoms
  - Sudden ▲ or ▼ in chest tube drainage
  - ↑ Heart rate
  - ↑ Intracardiac filling pressures (↑RA and ↑LA) and central venous pressure
  - ↓ Blood pressure or narrow pulse pressure (late sign)
Cardiac Output and End Organ Perfusion

- Mixed venous oxygen saturation
  - Early indicator of myocardial dysfunction
  - Arterial–venous oxygen gradient ≥ 30%
- Serum lactate
- Acid–base balance
- End organ perfusion

Low Cardiac Output Etiology

- Post–cardiopulmonary bypass (CPB)
  - Inflammatory response
  - Myocardial ischemia related to aortic cross-clamp
  - Reperfusion injury
  - Inadequate myocardial protection
  - Alterations in pulmonary vascular resistance (PVR) and systemic vascular resistance (SVR)
  - Ventriculotomy
- Arrhythmias
- Cardiac tamponade
- Residual cardiac lesion
Residual Anatomic Lesions

• Potential sources
  – Residual aortic arch obstruction
  – Unrecognized structural defects (residual ventricular septal defect)

• Diagnostic data
  – Intracardiac catheters
  – Laboratory studies and vital signs
  – Echocardiogram
  – Cardiac catheterization

Thermoregulation

• Rewarming
  – Vasodilation
  – Preload

• Increased Temperature
  – Metabolic demand
  – Oxygen consumption
  – Exacerbates neurological injury
Maintain Cardiac Output

- Preserve myocardial function and minimize oxygen consumption
- Maintain adequate preload
  - Hemodynamic monitoring (intra cardiac filling pressures, central venous pressure)
  - Heart rate
  - Peripheral perfusion
  - Volume replacement

- Avoid ↑ Systemic vascular resistance (SVR) and pulmonary vascular resistance (PVR)
  - Causes of ↑ PVR
    - Excessive pulmonary blood flow (left to right shunt)
    - Inflammatory and ischemic response (cardiopulmonary bypass)
    - Edema
    - Prolonged ventilation
  - Causes of ↑ SVR
    - Left ventricular failure
    - Cardiopulmonary bypass
    - Hypoxia
    - Acidosis
    - Low body temperature
    - Pain
Maintain Cardiac Output

- Measures to decrease PVR and SVR
  - Appropriate ventilation and oxygenation
  - Adequate analgesia and sedation
  - Afterload reducing agents
    - Nitroprusside
    - Milrinone
- Improve cardiac contractility
  - Inotropic medications (ie. dopamine, dobutamine, epinephrine)
  - Maintain adequate acid-base balance
  - Maintain oxygenation
- Normal sinus rhythm

Milrinone

- Low cardiac output syndrome in 25% patients not treated with Milrinone
- 64% relative risk reduction in developing LCOS with Milrinone 0.75 mcg/kg/min

PRIMACORP trial

Hoffman, TM, et. al, 2003, Circulation, Feb 25
Myocardial Dysfunction in Infants Following ASO for TGA

- Average decrease in cardiac index (CI) by 33% from baseline
- CI < 2.0 L/min/m² in 25% of newborns
- Mortality is higher if CI < 2.0 L/min/m²

Wernovsky G. et al., 1995, Circulation; 92(8)

Low Cardiac Output

Wernovsky, G. et al., Circulation; 92(8), 1995
Cardiac Arrhythmias

- Occurs in 25% of patients after bypass
- Risk factors
  - Volume overload
  - Ventricular hypertrophy
  - Myocardial ischemia
  - Ventriculotomy
  - Multiple suture lines and surgical trauma
  - Electrolyte disturbances
- Diagnostic data: ECG and atrial wire tracing
- Treatment of Arrhythmias
  - Medications
  - Maintain normal electrolytes (K+, Mg, Ca++)
  - Hypothermia
  - Cardiac pacing

Pacing Wires
Pulmonary Hypertension

- Normal pulmonary pressure ~15 mmHg
- Pulmonary hypertensive crisis: ↓oxygen saturation, ↑heart rate with ↑blood pressure, then ↓blood pressure
- Common causes:
  - Hypoxemia and hypoventilation
  - Acidosis and hypercarbia (↑ CO\textsubscript{2})
  - Hypothermia
  - Alpha adrenergic inotropes (epinephrine)
  - Stress and pain

Pulmonary Hypertensive Crisis

- Treatment
  - Optimize ventilation (hyperventilation)
  - Provide 100% oxygen
  - Sedation, analgesia and/or paralysis
  - Alkalosis
  - Inhaled nitric oxide
Summary

- Interdisciplinary sign out is crucial to managing postoperative cardiac patients
- Thorough nursing assessment is required to monitor trends and changes
- Low cardiac output and other postoperative complications can be predicted. Appropriate management strategies can be implemented before a patient deteriorates
- Good clinical skills and excellent communication by the bedside nurse improve patient outcomes

Questions?
Case Study

Jack is a 1 month old, 4 kilogram infant who had ventricular septal defect repaired 2 hours ago

- Chest tube drainage: 40 ml/hour of bloody drainage (total=80ml in 2 hours)
- Transfused with 40 ml fresh frozen plasma, 40 ml packed red blood cells and 2 units of platelets

Case Study

Vital signs: **heart rate 180** (increased from 160); **right atrial pressure 16** mmHg (increased from 9 mmHg); blood pressure remains 75/40

Possible causes of the changes in vital signs are? Choose all that apply:

- Pain and agitation
- Cardiac tamponade
- Hypothermia
- Inotropic agents such as dopamine and epinephrine
Case Study

Jack’s chest tube drainage has suddenly stopped

- **Heart rate** has increased to 194,
- **Right atrial pressure** has increased to 24 mmHg
- **Blood pressure** is 48/32

What do these signs and symptoms represent?

- Cardiac tamponade

Case Study

The patient is in cardiac tamponade. What action should be taken immediately?

- This is a surgical emergency. The cardiac surgeon and team should be alerted for immediate surgical evacuation of blood from the chest
The patient stabilizes after evacuating blood from the chest. Vital signs return to baseline. Based on clinical research, when would you expect his cardiac output to be lowest?

- 1 to 2 hours after cardiopulmonary bypass
- 6 to 12 hours after cardiopulmonary bypass
- 18 to 24 hours after cardiopulmonary bypass
- 24 to 48 hours after cardiopulmonary bypass

Identify three or more interventions to optimize low cardiac output?

- Provide analgesia and sedation to decrease stress and maintain comfort
- Maintain preload, afterload and contractility
- Provide inotropic and afterload medications as needed; consider milrinone
- Avoid hyperthermia or fever
- Provide adequate ventilation; avoid hypoxemia and hypercarbia
- Maintain stable acid-base balance
Thank you