GUIDELINE

Patent Ductus Arteriosus (PDA) Management Following Surgical Closure

Scope (Staff):	Nursing and Medical Staff
Scope (Area):	NICU KEMH, NICU PCH, NETS WA

Child Safe Organisation Statement of Commitment

CAHS commits to being a child safe organisation by applying the National Principles for Child Safe Organisations. This is a commitment to a strong culture supported by robust policies and procedures to reduce the likelihood of harm to children and young people.

This document should be read in conjunction with this disclaimer

Refer to the following guidelines for general PDA management, post-op management and complications:

- Cardiac: Routine Post-Operative Care
- Cardiac: Complications Management Following Surgery
- Patent Ductus Arteriosus (PDA)

Contents

Aim

This guideline concentrates on the particulars of management of post-surgical PDA closure and provides guidance for postoperative monitoring and management of infants admitted to NICU after surgical closure of PDA.

Risk

Risk of delayed recognition of post-PDA ligation complications and postoperative complications specific for PDA ligation syndrome can cause adverse neonatal outcomes.

Background

- PDA is one of the most common congenital heart defects, accounting for 5%-10% of all congenital heart diseases and is most commonly seen in preterm infants. The main reason to treat PDA is to mitigate the risk of cardiac and systemic sequelae such as prolonged ventilator dependency, increased incidence of chronic lung disease, pulmonary haemorrhage or hypertension, necrotizing enterocolitis, impaired renal function, and intraventricular haemorrhage.
- Treatment options include conservative, medical, and surgical approaches. Refer to the PDA Guideline.
- Most PDAs are managed either conservatively or with medical treatment (Indomethacin or Ibuprofen or Paracetamol) particularly in preterm infants. The closure rate of PDA in preterm infants receiving medical therapy is 40-90%. Infants who are born at term with PDA are often less responsive to medical treatment.
- Reasons to consider surgical closure are haemodynamic significance, inability to wean respiratory support and cardiovascular instability. In our centre, surgical closure in preterm infants is considered for a large PDA which fails to respond to two or more courses of medical treatment or if medical therapy is contraindicated. Operative mortality rates approach zero in term babies/older children. Mortality rates in premature infants are low in the immediate post-op period (about 3%) and about 94% survive to hospital discharge. The reported incidence of post-operative complications is about 20-25%.

Key Point

Surgical closure is only considered after a cardiac multidisciplinary team discussion involving neonatologist, paediatric cardiologist, cardiothoracic surgeon, cardiac anaesthetics, and the family.

Surgical Procedure

At PCH, the most common surgical approach in the neonatal period is ligation of the PDA through poster-lateral thoracotomy. The ductus could be either clipped, ligated with suture or if very large divided and oversewn. Transcatheter device closure is currently a less frequently used approach in neonates at PCH.

Perioperative optimisation

1. Maintain Euvolemia. Aggressive fluid restriction or diuretic therapy has little impact on shunt volume.
2. Ventilatory stability preoperatively on similar setting for 6-8 hours. No specific respiratory strategy has been associated with improved outcomes surround PDA ligation.
3. Setting of relative adrenal insufficiency:
    - Stress dose hydrocortisone should be considered for infants already receiving preoperative steroids for lung disease or hypotension.
    - Test for random blood cortisol level: preoperative assessment of adrenal performance may facilitate early administration hydrocortisone.

Postoperative complications specific for PDA ligation surgery

1. Immediate post-op complications: pneumothorax, haemorrhage, risk of infection
2. Postoperative hypotension:
    - Immediate (0-4 hours post-op): likely due to volume loss or adrenal dysfunction. Adrenal dysfunction is thought to be due to developmental immaturity of the hypo-thalamic-pituitary-adrenal axis and adrenal hypoperfusion due to chronic ductal steal.
    - Post PDA ligation syndrome (PLCS) (4-12 hours post op). PLCS is a rare but serious complication characterized by cardiovascular and pulmonary maladaptation after surgical correction of PDA. The clinical components of PLCS include oxygenation failure (up to 60%), ventilatory failure (up to 45%), and systemic hypotension (up to 35%). Risk factors reportedly associated with PLCS include younger age (<28 days) at ligation, lower birth weight (< 1 Kg), younger gestational age, larger size of PDA, and higher level of preoperative cardiorespiratory support.
3. Left vocal cord palsy due to close anatomical proximity of left recurrent laryngeal nerve to the PDA, neuropraxia of left recurrent laryngeal nerve is frequently seen. This can present postoperatively with feeding issues, stridor, hoarse cry, tracheal tug, or oxygen desaturation. In most cases, the vocal cord palsy improves within 3-6 months. In a small proportion of infants, the left recurrent laryngeal nerve is completely paralysed or severed during operation and the damage is long lasting. The prevalence rate for left vocal cord palsy varies based on centre specific practice of routine screening. In an Australian study, about 30 % of infants are reported to have symptomatic vocal cord palsy post PDA ligation. Therefore, it is important to screen for vocal cord paralysis and follow up to review improvement. The screening of vocal cord paralysis could be done with minimum invasive method of awake flexible nasal endoscopy at bedside by ENT or non- invasively through vocal ultrasound.
4. Pulmonary oedema in setting of high systemic blood pressure.
5. Chylothorax due to accidental damage to thoracic duct or due to inflammatory response.

6. Other rare complications: Accidental ligation of left pulmonary artery or aorta especially in extremely preterm infants, recanalization of PDA, bleeding, aneurysm of PDA.

Immediate Post-Op Management

1. See Cardiac: Routine Post-Operative Care for post-op cardiac/surgical management.
2. Optimise pain management and sedation
3. Ventilation:
    - Check for endotracheal tube position by repeating chest Xray.
    - Consider antibiotics for risk of sepsis.
    - As lung deflation occurs intraoperatively for cardiac surgery: consider larger tidal volume and higher inflation pressures to immediate post-operatively.
    - Subsequently, optimise PEEP/PIP as post PDA ligation there is relative decrease in venous return to right side of heart. Note: often pre-operatively infant is on higher PEEP or PIP given increase pulmonary blood flow/High output state.
    - Extubation is dependent on underlying lung disease in preterm infants, postoperative complications, and pain relief.
4. Fluid and Feeding
    - Monitor for hemodynamic shift from high output state to relatively lower output state. Euvolemia is recommended, consider giving normal total fluid rate (TFR) for age.
    - Feeding is commenced and cautiously graded up, given the risk of NEC in setting of chronic ductal steal due to large PDA.
5. Circulation: Aim for early recognition of hypotension/hypertension **(Fig 1 and 2)**

Figure 1: Physiological changes following ligation of a hemodynamically significant ductus arteriosus. *(adopted and cited from: Giesinger RE, Bischoff AR, McNamara PJ. Anticipatory perioperative management for patent ductus arteriosus surgery: Understanding postligation cardiac syndrome. Congenital Heart Disease. 2019; 14: 311–316)*

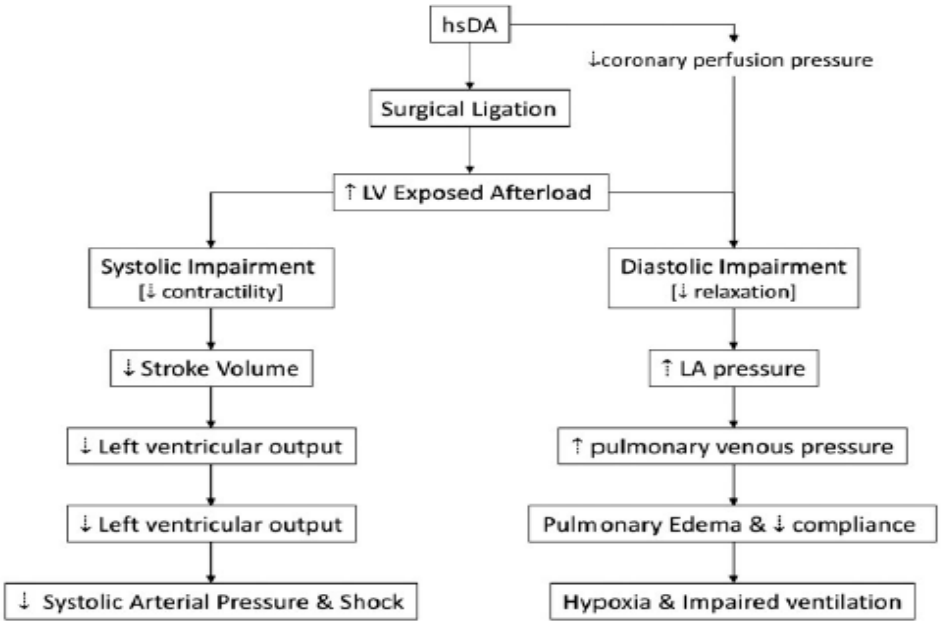
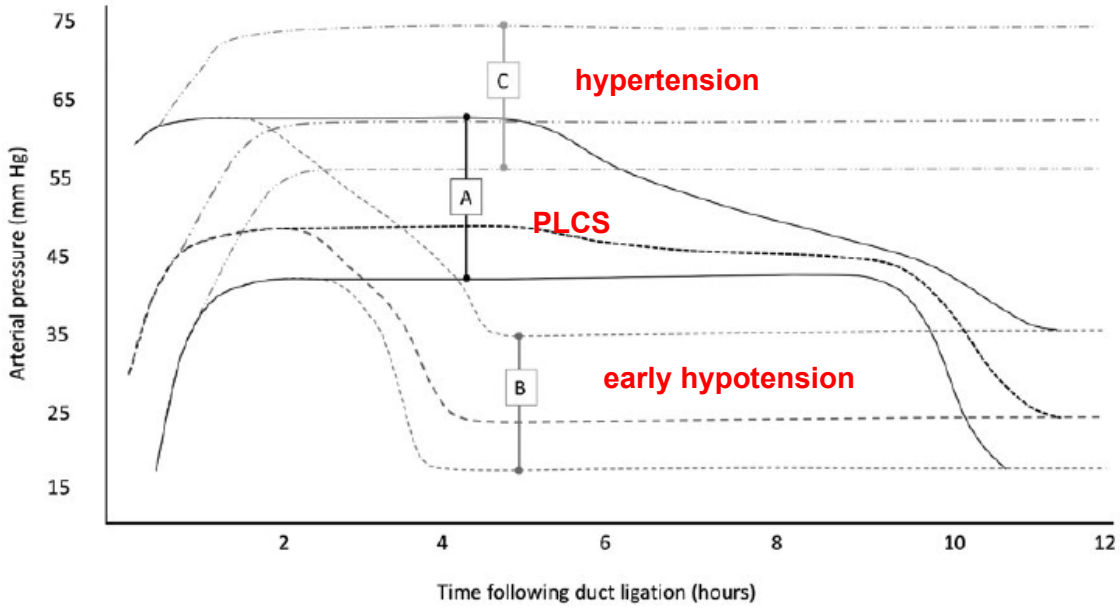


Figure 2: Blood pressure changes post-operative *(adopted and cited from: Giesinger RE, Bischoff AR, McNamara PJ. Anticipatory perioperative management for patent ductus arteriosus surgery: Understanding post ligation cardiac syndrome. Congenital Heart Disease. 2019; 14: 311–316)*



A: Post-PDA ligation syndrome (PLCS): progressive decline in systolic arterial pressure followed by rapid decompensation in both mean and diastolic pressure due to left heart failure.

B: Early hypotension: severe drop in both systolic and diastolic arterial pressure which may be due to impaired left ventricular pre-load. Look for haemorrhage, pneumothorax or adrenal insufficiency.

C: Hypertension: Sustained high mean and diastolic arterial pressure with normal pulse pressure which may result in pulmonary oedema and hypoxia.

Targeted management of hypotension based on pathophysiology

Preventive strategy: Targeted neonatal echocardiography in discussion with cardiology team, if available, performed at <1 hr postoperatively to estimate LVO (left ventricular output). See Fig 3

- LV output less than 200 mL/kg/min is a sensitive predictor of cardio-respiratory instability and need for inotropic support. Discuss starting prophylactic milrinone with on call neonatal and cardiology consultant, if considered safe to do so.
- If early (<1 hr) postoperative echocardiography not possible, the administration of prophylactic intravenous milrinone to infants based on perioperative risk factors may be considered.
- A starting dose of 0.33 mcg/kg/min. Reported to decrease rate of PLCS from 44 to 11 % in a study.

0-2 hours post-op

Optimise ventilation, consider decreasing Mean Airway Pressure (MAP) to facilitate venous return.

2-4 hours post-op

- Consider hydrocortisone early in management.
- If predominant drop in diastolic blood pressure: give bolus of 10ml/kg of 0.9% normal saline bolus.
- If predominant drop in systolic blood pressure, add dobutamine to support cardiac contractility.

4-12 hours post-op

Consider adrenaline (epinephrine)/ dobutamine as shown in **Figure 3**. Hydrocortisone is considered in unresponsive or progressive hypotension.

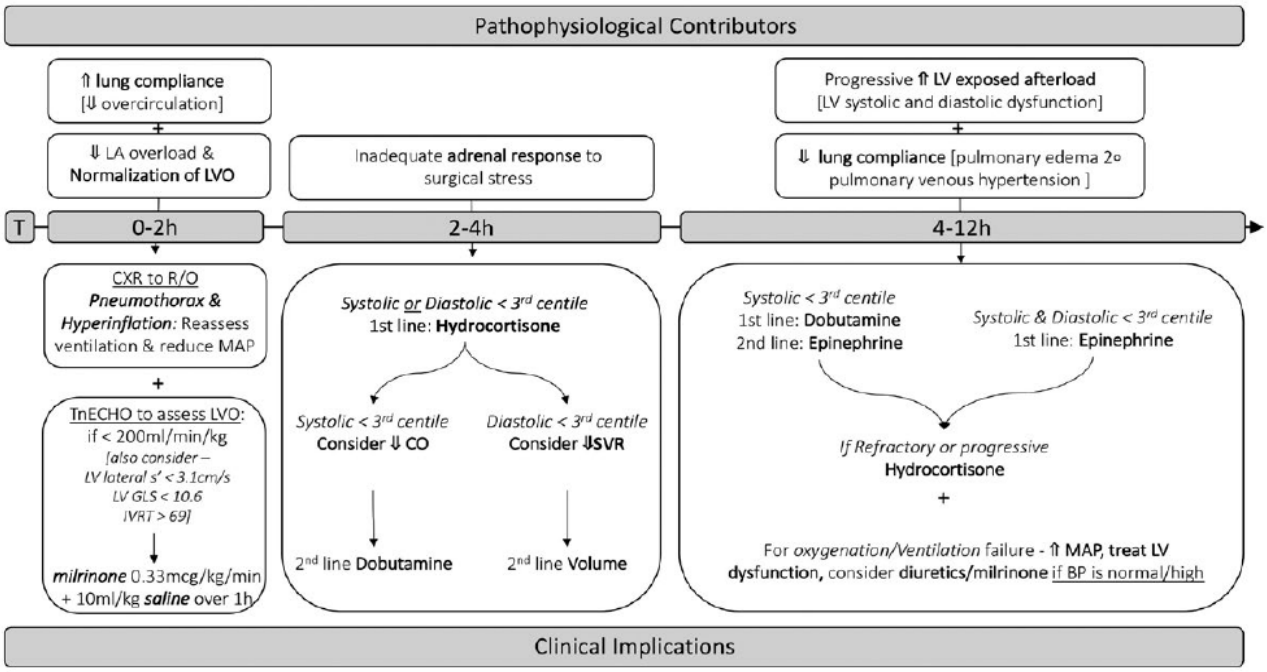


Figure 3: Individualise management based on underlying pathophysiology*. (adopted and cited from: Giesinger RE, Bischoff AR, McNamara PJ. Anticipatory perioperative management for patent ductus arteriosus surgery: Understanding postligation cardiac syndrome. Congenital Heart Disease. 2019; 14: 311–316)*

Follow-Up

- Ultrasound of vocal cord before discharge in all to screen for vocal cord palsy
- If clinical concerns of symptomatic vocal cord palsy such as stridor, bedside oxygen desaturation, feeding concerns, additional referral for ENT review as inpatient.
- Refer to Follow-Up Program Groups.

Related CAHS internal policies, procedures and guidelines

Chylothorax: Postoperative Management (health.wa.gov.au) (Intranet Only)

King Edward Memorial Hospital - Neonatal Medication Protocols (health.wa.gov.au)

Pain Assessment and Management

Follow Up Program (health.wa.gov.au)

References and related external legislation, policies, and guidelines

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