



This guideline is currently undergoing content review. Ownership/endorsement will change from Neonatology Coordinating Group to Paediatric Critical Care when the review is completed. The content remains current throughout this review process. (27/05/2024)

CLINICAL GUIDELINE	
Cardiac: Routine Post-Operative Care	
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](#)

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Ventilation

All post-op cardiac neonates require ventilation for pain relief and 'lung disease'.

Arrival Back From Theatre

- Starting ventilation parameters will depend on pre-op and intra-operative requirements. Higher PEEP levels may be required to reverse any atelectasis. **PC-AC with or without VG is appropriate; ensure tidal volumes of at least 5ml/kg; Inspiratory Times should be at least 0.5 sec** in near term infants.
- Review ETT size, length, taping, un-cuffed or cuffed (? inflated), leak.
- CXR within 15-30 minutes of return from theatre to check tubes, lines, lungs and heart. Repeat with any 'significant' cardio-respiratory instability.

Blood Gases/SaO₂

- In most babies, aim for the usual NICU ABG and SaO₂ ranges.
- Babies with PPHN may benefit from lower PaCO₂ 35-40 mmHg.

- Those with excessive pulmonary flow may benefit from mild hypercarbia.
- If there is a residual R→L shunt, e.g. Blalock-Taussig (BT) Shunt, lower SaO₂ range can be expected; discuss with cardiology.
- Frequency of ABGs: 2 hourly immediately post-op; then 4 hourly. Check ABG if there is any cardio-respiratory instability.

Weaning Ventilation

Wean in the usual way and plan extubation when:

- Patient is haemodynamically stable.
- No excessive drain losses.
- Stable ABGs and FiO₂ < 0.4.
- Adequate analgesia, but not overly sedated.
- No other active processes e.g. abdominal distension/fluid overload.

CVS

Cardiac Output (CO)

Low cardiac output (CO) is relatively common post cardiac surgery. Maintaining CO is essential for maintaining oxygen delivery to all major organs.

CO = HR x Stroke Volume

Neonates have very little ability to increase their stroke volume, and so an increase CO is achieved by increasing HR.

Blood Pressure

Blood pressure alone is NOT a reliable indicator of cardiac output. Physiological BP is a product of flow (CO) x systemic vascular resistance (SVR).

BP can be maintained by peripheral vasoconstriction to redistribute CO to vital organs and conversely, hypotension may occur with adequate cardiac output in a tachycardic, vasodilated child.

Four Categories of Low Cardiac Output

1. Decreased Preload

The preload equates to the end-diastolic volume (EDV). According to Frank-Starling Law, muscle contraction is proportional to the initial length of the muscle fibre; therefore, as ventricular EDV increases, the force of contraction increases. Note: excessive preload leads to decreased myocardial performance and cardiac failure.

Causes of Decreased Preload

- Hypovolaemia: blood loss and 3rd space losses e.g. into abdomen.
- Cardiac tamponade (also affects contractility).
- Pneumothorax.

2. Rhythm disturbances

More common following open cardiac surgery.

- Bradycardia (especially if fixed stroke volume and neonates).
- Tachycardia (decreased filling time, poor sub-endocardial perfusion).
- Loss of atrial contraction/synchrony.

3. Contractility

Poor contractility may be due intra operative cardiac damage or chronic volume or pressure overload and metabolic derangements e.g. acidosis, hypoglycaemia, low calcium or magnesium.

4. Increased Afterload

Afterload is the impedance to ventricular ejection. Raised with PPHN, systemic hypertension or ventricular outflow obstruction and leads to reduced stroke volume.

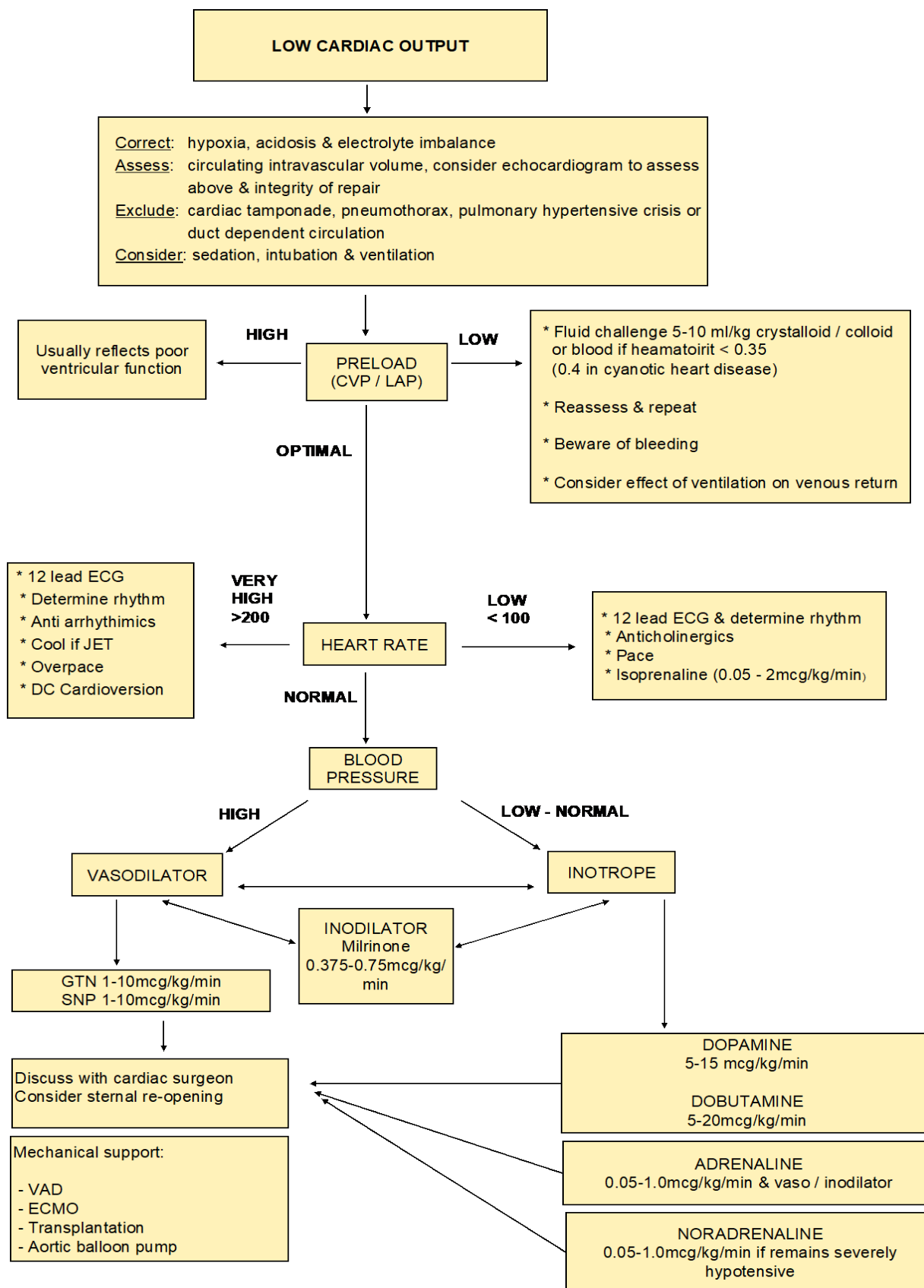
Note: vasoconstriction secondary to increased sympathetic activity or iatrogenic e.g. Noradrenaline; residual mechanical obstruction e.g. Coarctation.

Diagnosis of Decreased CO

	Low CO	Adequate CO
Peripheral perfusion	Central capillary refill >2 seconds	Central capillary refill <2 seconds
Core-peripheral temperature gradient	>3°C	<3°C
Pulses	Impalpable or weak peripheral pulses	Full peripheral pulses
Urine output	<1ml/kg/hr	>1ml/kg/hr
Mental status	Agitated / lethargic / little activity	Active / alert
Arterial pressure waveform	Small area under curve and dicrotic notch soon after peak	Large area under curve and dicrotic notch occurs later
Metabolic acidosis	Base excess >-5	Base excess <-5
Lactate	Lactate >4	Lactate <4
Blood pressure (normal mean 40-55)	Maybe normal (early on) or low (later)	Normal

An **echocardiogram** can differentiate the causes and direct treatment.

Treatment of Decreased CO



Adapted from 'Paediatric Intensive Care'

- A Duncan: Peri-operative management of infants with congenital heart disease

Shunts

Blalock-Taussig shunts can be too big (flood the lungs) or too small (continued cyanosis). Sometimes this can be due to a persistent PDA, not closed at shunt creation. In some cases this requires urgent reoperation.

Hypotension

A low BP should never be treated alone without consideration of the other indications of low cardiac output – [refer to above Flow Chart](#).

Hypertension

Refer to [Cardiac: General Complications Management Following Surgery](#).

Fluids, Electrolytes and Nutrition

Post-Operative Fluid Therapy

Post-operative salt and water overload are invariable, especially bypass surgery. Fluid overload also relates to pre-operative status, duration of surgery, the presence of 'capillary leak syndrome', post-operative myocardial and renal function.

- Day 1 post non-bypass surgery requires fluid restriction of 60-80 mL/kg/day of 10% Dex + 0.18% saline (+ potassium). Post bypass restrict to 50 mL/kg/d.
- Fluid restriction includes drugs and infusions, but not volume expanders/blood products. After Day 1 fluids can be liberalised daily by 10-20 mL/kg/day.

Volume Replacement - 'Filling'

- Acute fluid loss (bleeding/drain losses) within the first 12 hours post-op should be replaced with equal volumes of fluid (crystalloid/colloid/fresh whole blood).
- Type of replacement fluid depends on the haematocrit. Babies with persisting cyanotic lesion require a higher Hb than those with a non-cyanotic lesion.
- Normal CVP is 2-10 mmHg. Fluid volume replacement should be the lowest possible to achieve adequate CO, rather than targeting a 'high end' CVP reading. Regular assessment and judicious fluid replacement should be used to anticipate intravascular depletion and prevent circulatory collapse.
- Excessive fluid replacement to correct hypotension or low CVP can lead to fluid overload and to excess lung water and exacerbate PPHN or heart failure.
- Neuromuscular blockade can lead to oedema by impairing lymphatic drainage.

Fluid Balance

- Record hourly urine output. Maintain urine output at 1 mL/kg/hr.
- Monitor daily fluid balance and correlate to clinical status.
- Consider replacing NGT losses of >10 mL/kg with 0.9% saline.
- Drain losses should be replaced 'mL for mL' every 6 hours; type of fluid replaced varies according to Hb, type of fluid draining clinical status.

Electrolyte Homeostasis

- Sodium, potassium, calcium and magnesium levels should be checked immediately post-op and then daily.
- **Serum potassium** may change rapidly due to changes in cardiac output, tissue metabolism, acid base status, urine output and blood products. The arterial K should be kept **3.5-4.5 mmol/L** to optimise cardiac performance.
- Note: Arterial K may be 0.5mmol/L lower than venous capillary samples.

For treatment of Hyperkalaemia and/or Hypokalaemia refer to [Cardiac: General Complications Management Following Surgery](#)

Calcium Disturbance

- Maintain ionised Ca levels 1-1.3 mmol/L; improves cardiac contractility.
- Higher ionised Ca levels may increase systemic vascular resistance.
- Low ionised Ca level may be due to blood products (citrate) and bypass.
- Infants with 22q11 deletion are more prone to hypocalcaemia.
- Hypocalcaemia is frequently associated with low magnesium levels.

Note: Ca is lowered by excess heparin in the sample.

For treatment of Hypocalcaemia refer to [Cardiac: Complications Management Following Surgery](#).

Glucose Homeostasis

- Check blood glucose level with each blood gas.
- Adjust maintenance Dextrose concentrations to keep blood glucose stable.
- Drug infusions should be made up with 10% glucose where possible.
- A glucose delivery rate of 4-8 mg/kg/min is sufficient for most patients.

Nutrition

- Enteral feeding should not occur on the first night post cardiac surgery.
- Delay feeds if there was/is a risk of poor gut perfusion peri operatively.
- Start early TPN if enteral feeds will be delayed.

Antibiotics

Routine: 24 hours of Cefazolin or Vancomycin and Gentamicin.

Analgesia, Sedation and Muscle Relaxants

Analgesia/Sedation: Usually morphine 10-20 mcg/kg/hr \pm midazolam 0.5-2 mcg/kg/min.

Frequently review pain scores and wean/escalate appropriately.

Midazolam has negative inotropic effects and may result in hypotension.

IV/oral paracetamol and oral chloral hydrate can help reduce morphine/midazolam.

Muscle Relaxation is usually weaned off on return from theatre.

Ongoing muscle relaxation may be required and should be discussed with consultant.

Vecuronium avoids tachycardia but may drop the BP and Pancuronium causes tachycardia and may increase the BP.

Blood Products

Packed Red Blood Cells (PRBC) are used for active bleeding or with anaemia. A transfusion of 4mL/kg increases Hb by approximately 1 g/dL.

- The haematocrit of PRBC is 0.5-0.75.
- The Na content is approximately 20 mmol/unit.
- The K content is 0.5-5.0 mmol/unit (up to 15 mmol/unit in old blood therefore best to use fresh blood in neonates and where possible).

If requested 1 unit can be split into 4 paediatric packs and kept for the same patient.

Blood must be started within 30 minutes of issue or stored in a designated, monitored satellite blood fridge and transfusion completed within 4 hours.

4% Human Albumin Solution is used as an alternative volume expander.

Platelets. Dose is 10 mL/kg over 30-60 mins, then re-check the platelet count.

Fresh Frozen Plasma (FFP) contains almost normal levels of stable clotting factors, albumin and immunoglobulin.

Used to treat active bleeding, massive transfusion or a coagulopathy (INR > 2.0); consider **vitamin K** 1mg IV with FFP or if INR 1.5-2.0).

Dose: 10-20 mL/kg over 30-60 minutes.

Note: Loss of clotting factors may occur with excessive loss of peritoneal and pleural fluid if replaced by saline alone (dilutional coagulopathy).

Cryoprecipitate contains higher levels of factor VIII, fibrinogen and vWF than FFP.

Indication: fibrinogen < 1.0 g/L; active bleeding; and massive transfusion.

Dose: 5 mL/kg immediately over 0.5-4 hours).

Also refer to [Critical Bleeding Protocol](#)

Lines

Intra-Arterial Catheter – Refer to [Peripheral Arterial Catheter](#) guideline

Central Venous Line - Refer to [Central Venous Access](#) guideline

Indicator of RV preload (see above) and RV performance.

Chest Drains

ICC's should be connected to continuous low suction of 15-20 cm H₂O on arrival back from theatre.

The amount of chest drainage should be measured and recorded:

- Every 15 minutes for first hour.
- Every 30 minutes for second hour.
- Then hourly if drainage minimal and decreasing.

Excessive drainage should be reported to the registrar.

Excessive drainage, >3ml/kg/hr, may be a surgical emergency and must be reported to the consultant and cardiac surgeon immediately.

The chest drain should be 'milked' regularly to ensure patency, essential to avoid intrathoracic collections. Drains removed only as ordered by the cardiac surgeon.

Removal of Chest Drains – Refer to [Intercostal Catheter \(ICC\) Insertion and Management](#) guideline


Related CAHS internal policies, procedures and guidelines

Neonatology Guideline

- [Cardiac: General Complications Management Following Surgery](#)
- [Central Venous Access](#)
- [Critical Bleeding Protocol](#)
- [Intercostal Catheter \(ICC\) Insertion and Management](#)
- [Peripheral Arterial Catheter](#)

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