



CLINICAL PRACTICE GUIDELINE

Guideline coverage includes NICU KEMH, NICU PMH and NETS WA

# Cardiac: Blalock-Taussig Shunt (BT Shunt) Management Following Insertion

This document should be read in conjunction with the [Disclaimer](#)

## Contents

Surgical Procedure .....	2
Routine Post-Op Management Following Neonatal BT Shunt Insertion .....	2
Post-Op BT Shunt Complications.....	4
Low O <sub>2</sub> Saturations (< 70%) .....	4
High O <sub>2</sub> Saturations (> 85% in Air).....	5
Prior to Discharge.....	6
References.....	7

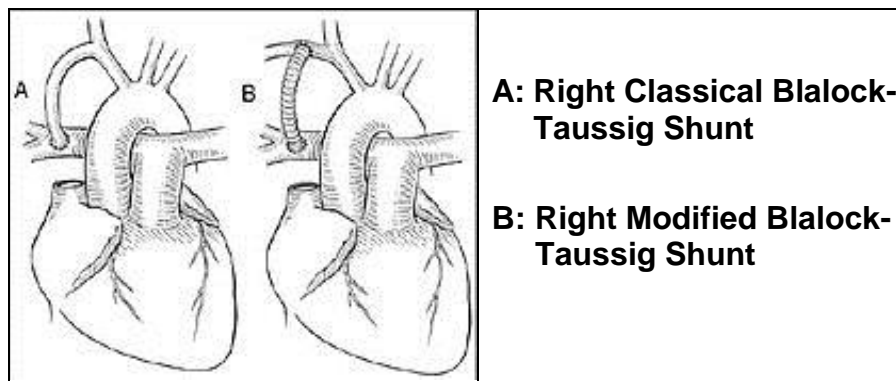
This guideline focuses on the specifics of the post-op management and complications of a neonate following the insertion of a BT shunt. For routine post-op cardiac care, general complications following cardiac surgery and for general information on tricuspid atresia/ pulmonary atresia and Tetralogy of Fallot, and their pre-op management please see separate guidelines.

The BT shunt is a systemic to pulmonary shunt which is a palliative procedure usually performed in neonates to establish a reliable pulmonary blood flow in patients with obstructed pulmonary blood flow e.g. tricuspid atresia, pulmonary atresia and severe Tetralogy of Fallot. The pulmonary blood flow will have been maintained pre-operatively by maintaining ductal patency with prostaglandin E1 (PGE1). The definitive operation/s is/are performed later when the child is larger.

## Surgical Procedure

**The Classical BT Shunt (CBTS)** was first performed in the 1940s and is created by division of the subclavian artery (left or right) and anastomosis to the ipsilateral pulmonary artery (PA). The main advantage is that the shunt grows with the patient and the main disadvantage is loss of pulses in the ipsilateral upper limb and resulting decreased growth and strength. The classical BT shunt is seldom used these days.

**The Modified BT Shunt (MBTS)** is now performed and consists of a Gore-Tex (PTFE) graft (3.5-5.0 mm diameter) interposed between the innominate or subclavian artery and the ipsilateral pulmonary artery (PA). This can be performed on the left or right side, but is routinely on the right side at PMH. It is usually a non-bypass procedure and is performed through a lateral thoracotomy.



Postoperatively, pulmonary and systemic vessels are fed from the same common source. The balance of systemic and pulmonary flows is of utmost importance, and is the principal determinant of systemic oxygen saturation ( $\text{SaO}_2$ ). Ideally the post-op  $\text{SaO}_2$  is 75-80%, and this gives a  $\text{Qp}:\text{Qs}$  ratio 1:1-1.8. Refer to [Cardiac: Neonatal Circulation Changes/Unbalanced Circulation](#).

## Routine Post-Op Management Following Neonatal BT Shunt Insertion

For more general post-op cardiac management, refer to [Cardiac: Routine Post-Operative Care](#) guideline.

### Respiratory

- Will require ventilation at least overnight.
- Routine neonatal ventilation strategy.
- Keep  $\text{SaO}_2$  70-85% (ideal 75-80%).
- Gradually wean oxygen therapy down to air if  $\text{SaO}_2 > 80\%$  (to avoid over-shunting).

- 2 hourly blood gases for 4 hours and then 4 hourly if stable.
- Consider weaning ventilation on day 2 if everything has been stable (consultant decision).

### **Prerequisites for Extubation**

- Stable SaO<sub>2</sub> 75-80% in room air and requiring minimal ventilation.
- Echo having shown adequately functioning shunt.
- Otherwise haemodynamically stable.
- Recent CXR showing clear lung fields and pleural spaces.

### **CVS**

- Check for shunt murmur when arrives back from theatre and again anytime when there are concerns over the patient, particularly if they have low SaO<sub>2</sub>.
- Aim for BP in normal range (Refer to [Monitoring: Blood Pressure Normal Limits](#)) unless otherwise ordered.
- If inotropic support required, 1<sup>st</sup> line dopamine, 2<sup>nd</sup> line noradrenaline if low diastolic pressure/over-shunting or adrenaline to support cardiac performance.
- An echocardiogram should be performed and documented in the notes by the cardiologist on NICU soon after theatre to assess shunt flow and LV function.

### **Causes of Hypotension/Low Cardiac Output**

- Hypovolaemia/bleeding.
- 'Over-shunting' causing unbalanced circulation (particularly low diastolic pressure).
- Over sedation.
- Tension pneumothorax.
- Shunt blockage.
- Septicaemia.

### **Fluids/Nutrition**

- Fluids should be restricted to 60-80 mL/kg/day on day 1. Then can then be increased by 10-20 mL/kg/day depending upon the clinical status of the patient.
- Beware of over-restriction causing intravascular depletion as this predisposes to shunt thrombosis.
- Feeds can be considered the day after surgery if everything has been stable.
- If there are concerns of 'over-shunting' and a poor systemic output, feeds should be withheld as there is a risk of NEC.

### **Antibiotics**

- Refer to [Cardiac: Routine Post-Operative Care](#).

### **Analgesia/Sedation**

- The patient should be well sedated and provided with good analgesia on the first post-operative night. Use morphine as per post-op protocol. Midazolam is usually not needed in neonates, but if it is used beware of hypotensive effect. Refer to [Post-Operative: Analgesia](#). Can start to be weaned the following day depending upon the clinical status of the patient.

## Anticoagulation

- Anticoagulation with heparin to prevent BT shunt thrombus is controversial. It is not routinely used in every case at PMH. The decision to use heparin is on a case-by-case basis and should be discussed with the cardiac surgeon on returning from theatre. The heparin infusion should be commenced at a rate of 10 units/kg/hr (can use up to 20 units/kg/hr). Changes in APTT are not usually targeted.
- Aspirin 3-5 mg/kg once a day is commenced once on feeds.

## Haemoglobin

- Should be kept around 120 g/L. Avoid too high levels as this may predispose to shunt thrombosis. Avoid a low Hb as patients with cyanotic heart disease require slightly higher Hb levels than normal.

## Post-Op BT Shunt Complications

- **Haemorrhage** from anastomosis may lead to haemothorax (Refer to [Cardiac: General Complications Management Following Surgery](#)).
- **Poor shunt flow/blockage** with thrombus or shunt too small (unusual – refer to [Low O<sub>2</sub> Saturations < 70%](#) Section).
- **'Over-shunting'** - additional blood supply from PDA (which is yet to close) or MAPCAs, or shunt too large.
- **Shunt infection** (rare) results in features of sepsis with elevated CRP and WCC (Refer to [Cardiac: General Complications Management Following Surgery](#)).
- Discuss with cardiac surgeon **before** commencing antibiotics if this is felt to be a possibility.
- **Seroma** - Gore-Tex can 'sweat'. Seen on CXR or echo.
- **Chylothorax** due to thoracic duct damage (Refer to [Cardiac: General Complications Management Following Surgery](#)).
- **Vocal cord palsy** due to recurrent laryngeal nerve (Refer to [Cardiac: General Complications Management Following Surgery](#)).
- **Diaphragmatic palsy** due to phrenic nerve damage (Refer to [Cardiac: General Complications Management Following Surgery](#)).
- **Shunt narrowing** may occur at the site of anastomosis and may sometimes need to be treated with balloon angioplasty.

## Low O<sub>2</sub> Saturations (< 70%)

Usually due to inadequate pulmonary blood flow.

### Causes

- Shunt blockage with thrombus.
- Inadequate shunt flow due to systemic hypotension.
- Small feeding artery/ pulmonary arteries (PAs)/branch PAs.
- Shunt too small (unusual as the shunt is usually larger than the feeding artery to allow for growth of the baby and so the feeding artery is usually the limiting factor).
- Inadequate ventilation e.g. Pneumothorax, atelectasis, pneumonia, haemothorax, chylothorax, dislodged ETT.

## Signs

A shunt blockage may present acutely or sub-acutely and can be complete or partial. If there is an acute complete blockage it is an emergency and will present with:

- Sudden severe desaturation.
- Normal (or low) blood pressure.
- Normal ventilator parameters, normal air entry and normal CXR.
- No shunt murmur heard on auscultation.

## Management

- If  $\text{SaO}_2 < 65\%$  and shunt malfunction suspected (i.e. no respiratory cause) call NICU consultant. Inform cardiac surgeon and cardiologist immediately.
- Review of ventilation status, blood gas and CXR should have been performed.
- Ensure haemodynamic status is adequate. May require volume expansion with normal saline. Give 5 mL/kg aliquots and titrate with response. It is essential to give smaller aliquots of fluid so as not to give too much fluid which could tip the delicate balance of a cardiac patient. **If requiring > 20-30 mL/kg of fluid, reconsider your diagnosis.**
- May require vasopressors to augment systemic pressure. Noradrenaline works well by intense peripheral vasoconstriction to increase the systemic driving pressure. However dopamine and/or adrenaline may be required to support the cardiac function.
- Ensure coagulation profiles are normal and blood available if trip back to theatre seems likely.

## High $\text{O}_2$ Saturations (> 85% in Air)

Usually due to high shunt flow, causing excessive blood flow to the lungs and an unbalanced circulation.

### Causes

- Unnecessarily high  $\text{FiO}_2$ .
- PDA still open and so additional shunting of blood to the lungs\*.
- MAPCAs as a source of additional blood flow to the lungs.
- Shunt too large.

\*The ductus arteriosus (DA) is not routinely ligated at PMH as most procedures are right sided and access to the DA is not possible. Therefore the DA is patent post-op and causes additional blood flow to the lungs. PGE1 will have been ceased in theatre, and the PDA usually closes over hours/days. If the high  $\text{O}_2$  saturations are due to this reason, then they should improve as the ductus closes.

### Other Signs

- Pulmonary plethora/oedema (may be unilateral).
- Cardiac failure.
- Systemic diastolic pressure low due to 'run off' to the lungs.
- Persistent metabolic acidosis in a 'pink' patient (reduced systemic flow).
- May cause pulmonary haemorrhage.

### Treatment

- Ensure ventilating in  $\text{FiO}_2$  0.21.
- Inform NICU consultant.

- If SaO<sub>2</sub> > 90% inform cardiologist (will require echo and sometimes cardiac catheter to assess shunt flow and possible sources of additional blood flow such as PDA or MAPCAs) and cardiac surgeon.
- Often fluid restriction and diuretics are beneficial.
- Sometimes volume loaded ventricle needs supporting with inotropes e.g. Dopamine.
- Consider increasing PEEP.
- In more refractory cases manipulation of pH (permissive hypercapnia) and FiO<sub>2</sub> lowering may assist in increasing the pulmonary vascular resistance (Refer to [Cardiac: Neonatal Circulation Changes/Unbalanced Circulation](#)).
- If poor systemic output, withhold feeds as at high risk of NEC.
- Occasionally urgent surgical revision of a large shunt is required (smaller diameter shunt inserted).

### **Prior to Discharge**

Whenever a child with a BT shunt develops an illness where they may become dehydrated e.g. Gastroenteritis/vomiting or has a decreased oral intake or is sweating excessively, they are at risk of shunt thrombosis. They will need increased oral fluids e.g. Oral rehydration solution (ORS) if tolerated or early IV fluids. Parents should be warned of this prior to discharge and told to seek medical help early.

Also, if their child ever becomes blue then they need to take them to hospital immediately as it may indicate shunt blockage.

## References

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## Related WNHS policies, procedures and guidelines




Neonatology Clinical Guideline - [Cardiac: Routine Post-Operative Care](#)

Neonatology Clinical Guideline - [Cardiac: General Complications Management Following Surgery](#)

Neonatology Clinical Guideline - [Cardiac: Neonatal Circulation Changes/Unbalanced Circulation](#)

Neonatology Clinical Guideline - [Monitoring: Blood Pressure Normal Limits](#)

Neonatology Clinical Guideline - [Post-Operative: Analgesia](#)

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