

NCCU CLINICAL GUIDELINES
SECTION: 14

NEONATAL CARDIAC CONDITIONS:

MEDICAL AND SURGICAL MANAGEMENT

Section 14: Neonatal Cardiac Conditions
Cardiac procedures: post-operative management BT Shunt
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Neonatology Clinical Guidelines
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**POST-OPERATIVE MANAGEMENT FOLLOWING INSERTION OF A
BLALOCK-TAUSSIG SHUNT (BT SHUNT)**

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.

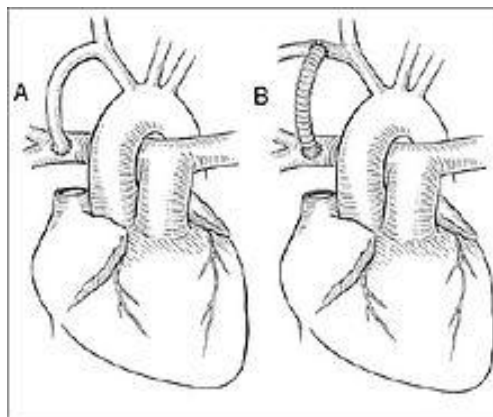
The BT shunt is a systemic to pulmonary shunt which is a palliative procedure usually performed in neonates to establish a reliable pulmonary blood flow in patients with obstructed pulmonary blood flow eg. tricuspid atresia, pulmonary atresia and severe Tetralogy of Fallot. The pulmonary blood flow will 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.

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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 (3.5-5.0mm 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.



A – Right Classical Blalock Taussig Shunt
B – Right Modified Blalock-Taussig Shunt

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 (SaO₂). Ideally the post-op SaO₂ is 75-80%, and this gives a Q_p:Q_s ratio 1:1-1.8 (see guideline on 'The circulation').

ROUTINE POST-OP MANAGEMENT FOLLOWING NEONATAL BT SHUNT INSERTION

(For more general post-op cardiac management, see 'Routine Care of The Neonate Post Cardiac Surgery').

Respiratory

- Will require ventilation at least overnight.
- Routine neonatal ventilation strategy.
- Keep SaO₂ 70-85% (ideal 75-80%).
- Gradually wean oxygen therapy down to air if SaO₂ >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).

Pre-requisites for extubation:

- Stable SaO₂ 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 SaO₂.
- Aim for BP in normal range (*refer to the graph in appendices to find out the normal blood pressure range*) unless otherwise ordered.
- If inotropic support required, 1st line dopamine, 2nd 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 60-80ml/kg/day on day 1. Then can than be increased by 10-20ml/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

As per normal post-op protocol (see '*Routine Care of The Neonate Post Cardiac Surgery*').

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. See *NCCU guidelines for postoperative pain management*. 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 3-5mg/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.
 - (See “*General Complications Following Cardiac Surgery in the Neonate*’ guidelines.)
- **Poor shunt flow/ blockage** with thrombus or shunt too small (unusual – see below).
- **‘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. (See “*General Complications Following Cardiac Surgery in the Neonate*’ guidelines.)
- 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.
 - (See “*General Complications Following Cardiac Surgery in the Neonate*’ guidelines.)
- **Vocal cord palsy** due to recurrent laryngeal nerve.
 - (See “*General Complications Following Cardiac Surgery in the Neonate*’ guidelines.)
- **Diaphragmatic palsy** due to phrenic nerve damage.
 - (See “*General Complications Following Cardiac Surgery in the Neonate*’ guidelines.)
- **Shunt narrowing** may occur at the site of anastomosis and may sometimes need to be treated with balloon angioplasty.

LOW O₂ 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 eg. pneumothorax, atelectasis, pneumonia, haemothorax, chylothorax, dislodged ETT.

Signs:

A shunt blockage may present acutely or subacutely 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 ventilatory parameters, normal air entry and normal CXR.
- No shunt murmur heard on auscultation.

Management:

- If SaO₂ <65% and shunt malfunction suspected (ie. 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 5ml/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 O₂ SATURATIONS (>85% IN AIR)

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

Causes:

- Unnecessarily high FiO₂
- 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 O₂ sats 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 FiO₂ 0.21.
- Inform NICU consultant.
- If SaO₂ >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 eg. dopamine.
- Consider increasing PEEP.
- In more refractory cases manipulation of pH (permissive hypercapnia) and FiO₂ lowering may assist in increasing the pulmonary vascular resistance (*see guideline on 'The 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 eg. 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 eg. 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.

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