ROUTINE CARE OF THE NEONATE POST CARDIAC SURGERY

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VENTILATION
All post-op cardiac neonates will require a period of ventilation at least overnight before considering weaning. In particular this facilitates pain relief.

**Arrival Back from Theatre:**

- Prior to arrival of the patient back from theatre, the ventilator should be set up and ventilator settings checked by the registrar/senior registrar.

- For neonatal cardiac patients on 6B usual neonatal ventilation strategies should be used apart from a higher PEEP as post-op patients are prone to atelectasis (especially those cardiac patients who have had a lung collapsed).

- For a term baby, the suggested initial settings for the Drager ventilator are below. The NICU consultant should be asked if these settings are suitable for this particular patient. Also, the anaesthetist will be able to give guidance as to what was required in theatre on arrival back to 6B.

<table>
<thead>
<tr>
<th>Mode</th>
<th>SIPPV + VG</th>
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<tbody>
<tr>
<td>PIP</td>
<td>20 cmH2O</td>
</tr>
<tr>
<td>PEEP</td>
<td>6-7cmH2O</td>
</tr>
<tr>
<td>Rate</td>
<td>40 bpm</td>
</tr>
<tr>
<td>Inspiratory time (Ti)</td>
<td>0.5s</td>
</tr>
<tr>
<td>Tidal Volume (TV)</td>
<td>5ml/kg</td>
</tr>
<tr>
<td>FiO2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

- Since lung atelectasis can be a significant problem in the immediate post-operative period, consideration need to be given for strategies such as long inspiratory time Ti (0.8-1.0s), low rate ventilation (20-25). Discuss with the treating consultant.

- On arrival back note the size of the endotracheal tube (ETT), it’s length, its point of entry (nose or mouth), cuffed or uncuffed, whether it is well secured and if it is kinked.

- Put the patient onto the ventilator and then check that chest wall movement is adequate and symmetrical and that SpO2 remains stable. If not, adjust ventilator accordingly.

- The strategy for ongoing ventilation will need to be individualised according to the cardiac lesion, lung mechanics and presence of associated complications after discussion with the NICU consultant.

**Blood Gases/ SaO2:**

- An arterial blood gas (ABG) should be done about 15 minutes after being transferred onto the ventilator and then settings should be adjusted further accordingly.

- For most patients, the higher side of normocarbia (pCO2 40-50 mmHg) should be the aim. There are exceptions which must be specified by the NICU consultant eg. hyperventilation (pCO2 35-40 mmHg) for pulmonary hypertension or hypercarbia (pCO2 >50mmHg) to control excessive pulmonary flow.

- For repairs where there is no residual shunt, pCO2/ SaO2 should be in the normal range.
• If there is a residual R→L shunt, persistent arterial desaturation is the norm and therefore there is a lower target SaO2 range which should be determined by the NICU consultant.

• If an adjustment of ventilation has taken place a blood gas should be done 1 hour later unless otherwise requested.

• If stable ventilation, gases should be done 2 hourly for first 4 hours and then 4 hourly following that unless otherwise stated.

• If ventilation becomes problematic or there is haemodynamic instability a blood gas should be done immediately.

**CXRrs:**

• A CXR should be done in all patients as soon as is reasonably possible to check for adequate expansion of the lungs, pneumothorax, ETT position and other line/ tube positions. These should all be recorded in the notes. The ETT position should be adjusted as required.

• Subsequent CXRs should only be ordered if clinically required eg. deteriorating gases, increased ventilation/ oxygen requirements or haemodynamic instability.

• A routine CXR is NOT required following the mediastinal chest drain removal.

**Muscle Relaxants/ Paralysis:**

• The patient may come back with a muscle relaxant on board and this should be allowed to wear off in it’s own time, but beware that ventilation and blood gases may change as it does.

**Weaning of Artificial Ventilation:**

• Patients should only be weaned and extubated at the request of the treating NICU consultant.

• Weaning should commence only when:
  - Patient is haemodynamically stable and will predictably remain so.
  - No excessive drain losses.
  - Stable ABGs and FiO2 <0.4
  - Adequate analgesia, but not overly sedated.
  - No other active process likely to interfere with weaning eg. abdo distension/ fluid overload.

**CVS**

**Cardiac Output:**
Low cardiac output (CO) is one of the most frequently encountered problems post cardiac surgery. Maintaining an adequate cardiac output is essential for maintaining adequate oxygen delivery to all the major organs.

Cardiac output is very difficult to measure in children. Clinical indicators have to suffice.

$$\text{CO} = \text{HR} \times \text{Stroke Volume}$$

Neonates have very little ability to increase their stroke volume, and so increase their cardiac output by increasing HR. Therefore if a neonate becomes bradycardic, it’s CO drops.

**Blood Pressure**

Blood pressure alone is NOT a reliable indicator of cardiac output. In physiological terms, BP can be described as the product of flow (CO) and resistance of the systemic circulation (systemic vascular resistance (SVR)).

$$\text{BP} = \text{CO} \times \text{SVR}$$

Intense vasoconstriction can mask inadequate CO in the normotensive or hypertensive neonate and conversely, hypotension may occur in a vasodilated child in the presence of an adequate cardiac output.

**Aetiology of Low CO**

The aetiology of low cardiac output in any patient can be separated into 4 categories:

1. **Preload**

The preload equates to the end-diastolic volume. There is a well known relationship between this and indices of ventricular ejection such as stroke volume. According to Frank-Starling Law, the energy of the muscle contraction is proportional to the initial length of the muscle fibre. As ventricular end-diastolic volume increases, the force of contraction increases. That is, until distension proceeds beyond a certain volume (increased preload), when myocardial performance declines and signs of cardiac failure appear.

**Causes of decreased preload:**

- Hypovolaemia is by far the most common (secondary to haemorrhage and fluid redistribution eg. into gut in ileus, ascites, pleural collection, sepsis, capillary leak syndrome).
- Cardiac tamponade (also affects contractility).
- Tachyarrhythmias and arrhythmias where atrioventricular synchrony is lost.
- Pneumothorax

**Causes of increased preload:**

- Volume overload

2. **Rhythm**
A variety of rhythm disturbances commonly compromise CO in the perioperative period. They are more common following open cardiac surgery and bypass.

**Causes of rhythm disturbance causing decreased CO:**
- Bradycardia (especially if fixed stroke volume and neonates).
- Tachycardia (decreased filling time, poor subendocardial perfusion).
- Loss of atrial contraction/synchrony.

3. **Contractility**

This may be reduced by the myocardial oedema and decreased ventricular compliance that follow damage to the heart during open cardiac surgery and bypass. The myocardium may be further compromised by chronic volume or pressure overload, causing ventricular dilatation, hypertrophy and ischaemia. Coronary artery injury or compromise is ever present particularly in surgery involving coronary artery transfer. In addition a variety of metabolic derangements may contribute to poor contractility.

**Causes of decreased contractility:**
- Myocardial dysfunction following ischaemia (cross-clamping) or secondary to increased afterload such as that prior to CoA repair
- Acidosis and hypoxaemia.
- Hypoglycaemia.
- Electrolyte disturbances, particularly hypocalcaemia but also disturbances in potassium or magnesium homeostasis.

4. **Afterload**

Afterload is seen as impedance to ventricular ejection. High resistance to flow across either pulmonary or systemic beds or ventricular outflow obstruction raises afterload. This may reduce stroke volume, raise end-diastolic volume and detrimentally increase myocardial O2 requirement, secondary to increased myocardial wall tension.

**Causes of increased RV afterload:**
- Pulmonary hypertension/pulmonary hypertensive crisis.
- Pulmonary artery stenosis.
- Residual pulmonary valve stenosis.

**Causes of increased LV afterload:**
- Systemic hypertension.
- Increased systemic vascular resistance – systemic vasoconstriction secondary to increased sympathetic activity that occurs in cardiac failure or iatrogenic with the use of peripheral vasoconstrictors eg. noradrenaline in the already failing heart.
- Residual mechanical obstruction eg. CoA, hypoplastic arch.

5. **Other – shunts**

**L→R shunts** eg. residual VSD or BT shunt too small causes decreased right heart CO to pulmonary vascular bed.
**R→L shunts** eg. residual VSD in the presence of PHT or BT shunt too large causes decreased left heart CO to systemic vasculature.

### Diagnosis of Decreased CO

The following combination of clinical signs and blood tests help to determine whether the CO is adequate or not.

<table>
<thead>
<tr>
<th></th>
<th>Low CO</th>
<th>Adequate CO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peripheral perfusion</strong></td>
<td>Central capillary refill &gt;2 secs</td>
<td>Central capillary refill &lt;2 secs</td>
</tr>
<tr>
<td><strong>Core-peripheral</strong></td>
<td>&gt;3°C</td>
<td>&lt;3°C</td>
</tr>
<tr>
<td><strong>temperature gradient</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pulses</strong></td>
<td>Impalpable or weak peripheral pulses</td>
<td>Full peripheral pulses</td>
</tr>
<tr>
<td><strong>Urine output</strong></td>
<td>&lt;1ml/kg/hr</td>
<td>&gt;1ml/kg/hr</td>
</tr>
<tr>
<td><strong>Mental status</strong></td>
<td>Agitated/ lethargic/ little activity</td>
<td>Active/ alert</td>
</tr>
<tr>
<td><strong>Arterial pressure</strong></td>
<td>Small area under curve and dicrotic notch soon after peak</td>
<td>Large area under curve and dicrotic notch occurs later</td>
</tr>
<tr>
<td><strong>waveform</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Metabolic acidosis</strong></td>
<td>Base excess &gt; -5</td>
<td>Base excess &lt; -5</td>
</tr>
<tr>
<td><strong>Lactate</strong></td>
<td>Lactate &gt;4</td>
<td>Lactate &lt;4</td>
</tr>
<tr>
<td><strong>Blood pressure</strong></td>
<td>Maybe normal (early on) or low (later)</td>
<td>Normal</td>
</tr>
<tr>
<td><strong>(normal mean 40-55)</strong></td>
<td></td>
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If the diagnosis is in doubt, an urgent echocardiogram can define the structural integrity of the heart and repair, and any evidence of impaired systolic ventricular function or pericardial tamponade. It may also indicate underfilling, adequate filling, shunting and pulmonary hypertension.

### Treatment of Decreased CO

Adapted from ‘Paediatric Intensive Care’ – Alan Duncan: Peri-operative management of infants with congenital heart disease – Macrae, Sculplak
LOW CARDIAC OUTPUT

Correct: hypoxia, acidosis & electrolyte imbalance
Assess: circulating intravascular volume, consider echocardiogram to assess above & integrity of repair
Exclude: cardiac tamponade, pneumothorax, pulmonary hypertensive crisis or duct dependent circulation
Consider: sedation, intubation & ventilation

Usually reflects poor ventricular function

HIGH

PRELOAD (CVP / LAP)

LOW

OPTIMAL

VERY HIGH >200

HEART RATE

LOW < 100

NORMAL

BLOOD PRESSURE

HIGH

VASODILATOR

LOW - NORMAL

INOTROPE

INODILATOR
Milrinone 0.375-0.75mcg/kg/min

Discuss with cardiac surgeon
Consider sternal re-opening

Mechanical support:
- VAD
- ECMO
- Transplantation
- Aortic balloon pump

* Fluid challenge 5-10 ml/kg crystalloid / colloid or blood if haematoirnt < 0.35 (0.4 in cyanotic heart disease)
* Reassess & repeat
* Beware of bleeding
* Consider effect of ventilation on venous return

* 12 lead ECG
* Determine rhythm
* Anti arrhythmics
* Cool if JET
* Overpace
* DC Cardioversion

* 12 lead ECG & determine rhythm
* Anticholinergics
* Pace
* Isoprenaline (0.05 - 2mcg/kg/min)

GTN 1-10mcg/kg/min
SNP 1-10mcg/kg/min

DOPAMINE
5-15 mcg/kg/min

DOBUTAMINE
5-20mcg/kg/min

ADRENALINE
0.05-1.0mcg/kg/min & vaso / inodilator

NORADRENALINE
0.05-1.0mcg/kg/min if remains severely hypotensive
**Hypotension:**

A low BP should never be treated alone without consideration of the other indications of low cardiac output – *see above*.

**Hypertension:**

*See guidelines on ‘general complications following cardiac surgery in the neonate and their management’.*
FLUIDS, ELECTROLYTES AND NUTRITION

Post-operative fluid therapy

Post-operative salt and water overload are invariable following cardiac surgery. It is particularly seen in those patients having had bypass surgery but also relates to pre-operative status, duration of surgery, the presence of ‘capillary leak syndrome’, post-operative myocardial function and renal function.

- On day 1 post surgery, all non-bypass neonates require fluid restriction of 60-80ml/kg/d of 10% glucose + 0.18% saline (+ potassium as required).
  (Those who have had bypass surgery should be restricted to 50ml/kg/d on day 1).
- The fluid restriction includes all drugs and infusions, but not boluses of volume expanders/blood products.
- Fluids can be liberalised daily by 10-20ml/kg/d depending upon the clinical status of the patient.

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).
- The choice of replacement fluid should be guided by the haematocrit and the lesion. Patients with a persisting cyanotic lesion will require a higher Hb than those with a non-cyanotic lesion.
- Automatic filling to a pre-determined RA pressure (CVP) is dangerous practice. The optimal filling pressure is usually the lowest possible pressure consistent with adequate CO and should be titrated to each patient’s individual requirements. The normal range is 5-10 mmHg but the target range for each patient should be determined by the consultant according to the individual and the lesion they have/repair.
- In neonates, CO is stroke volume limited and rate dependent. Therefore, regular assessment is vital and judicious fluid replacement should be used to anticipate intravascular depletion and prevent circulatory collapse.
- Excessive volume replacement in response to hypotension or low atrial pressures may be associated with significant increase in total body water particularly in the presence of capillary leak syndrome. Fluid overload may lead to excess lung water and exacerbate PHT, hypoxaemia, V/Q mismatch and cardiac failure.
- Neuromuscular blockade may exacerbate fluid retention by impairing lymphatic drainage.
**Is filling necessary?**

**NO**

Always consider:
- Poor contractility
- High afterload
- Tamponade (filling may still be useful)
- Pulmonary hypertension (PHT)

**YES**

Replace drain losses routinely.
Give preload as required:
- Titrate amount in aliquots of 5ml/kg to clinically relevant endpoint.
- Give more rapidly in active bleeding.

**Which type of fluid?**

Is Haematocrit adequate?
(As a guide, Hb 130-150 in cyanotic lesions and 90-120 in non-cyanotic lesions, but this should be individualised and decided with consultant.)

**YES** Use crystalloid (normal saline) / colloid (4% HAS)

**NO** Consider packed red cells if patient compromised/ acidic/ low cardiac output. Otherwise crystalloid/ colloid may be adequate.

Use small aliquots of 5mL/kg, review and repeat.
If requiring >20-30mL/kg question your diagnosis.

**Fluid Balance**

- All patients should have an hourly urine output measured, preferably by urinary catheter initially. A urine output of at least 1ml/kg/hr should be maintained.

- The overall balance to aim for should be determined by their clinical status.

- NGT losses of >10ml/kg over 12hrs should be replaced with 0.9% saline.

- Drain losses should be replaced ml for ml every 6 hours with the appropriate fluid according to the patient’s clinical status. The type of fluid used (eg. saline/ blood) depends upon the draining fluid.
**Electrolyte Homeostasis**

- Potassium, calcium and magnesium levels are commonly deranged following cardiac surgery (usually post bypass) and it is important they are corrected promptly. In particular hyper/hypokalaemia and hypocalcaemia are potentially serious.

- Electrolyte levels (Na/K/Ca) should be reviewed with each blood gas analysis and formal levels done immediately post-op, daily and where there is question over the blood gas values.

**Potassium disturbance**

- 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.

- NB Arterial K may be 0.5 mmol/L lower than venous and even lower than heelprick capillary sample.

*For treatment of hyper/hypokalaemia see section in ‘general complications following cardiac surgery in the neonate and their management’.*

**Calcium disturbance**

- Maintenance of normal ionised serum Ca levels 1.0-1.3 mmol/L improves cardiac contractility.

- A very high ionised Ca level does not add benefit and may increase systemic vascular resistance.

- Ionised Ca level may be low due to blood product administration (citrate) and bypass.

- Beware of hypocalcaemia in those with known 22q11 del or those with arch abnormalities who may have it.

- Remember to also check and correct magnesium level.

  **NB Ca is lowered by excess heparin in the sample.**

*For treatment of hypocalcaemia see section in ‘general complications following cardiac surgery in the neonate and their management’.*

**Glucose Homeostasis**

- A blood glucose level will be measured with each blood gas ie. at least 4 hourly.

- As fluids are restricted, higher concentrations of dextrose may be required to keep PGL stable.

- Drug infusions should be made up with 10% glucose where possible.

- A glucose delivery rate of 4-8mg/kg/min is desired and sufficient for most patients.

**Nutrition**
- Enteral feeding should not occur on the first night post cardiac surgery.

- If there was risk of poor gut perfusion prior to theatre (most CoAs), then feeding should be delayed a few days and then graded up slowly.

- Feeding should be started as early as is safe for the individual patient with milk via NGT and graded up according to the patients’ individual clinical status.

- If it is thought that full feeds will not be reached within 48 hours in a term baby, TPN should be commenced the day following surgery. Especially consider in a baby who has been NBM for a period prior to surgery eg. sick CoA patients.
**ANTIBIOTICS**

**At induction of anaesthesia:**

- First choice: Cefazolin 50mg/kg iv (max 1.5g)
- Second choice: Flucloxacillin 50mg/kg iv (max 2g) and Gentamicin 5mg/kg iv

If period of >72hr hospitalisation prior to surgery: Vancomycin 15mg/kg iv and Gentamicin 5mg/kg iv

Repeat full dose of Cefazolin or Flucloxacillin at 3 hours in bypass cases, or if asepsis breached in any case, provided it is >3 hours post induction dose.

**Postoperatively:**

All patients should receive a total of 24hrs of antibiotic cover.

If **cefazolin** was used intra-operatively: Give further 2 doses* cefazolin 25mg/kg 8hrly iv (ie. at 8 and 16hrs after the last intra-operative dose, and stop)

**NB** Neonatal drug guidelines suggest 20mg/kg per dose of cefazolin. The higher dose of cefazolin 25mg/kg shouldn't present any issues but if baby is premature and/ or decreased renal function there may be a need to reduce dose to 20mg/kg/dose and/ or increase dose interval. In this case, contact ward pharmacist or the on call clinical microbiologist for dose adjustment.

If **flucloxacillin and gentamicin** were used intra-operatively:
- Give further 3 doses* flucloxacillin 25mg/kg 6hrly iv (ie. at 6, 12 and 18hrs after the last intra-operative dose).
- There is no need for further doses of gentamicin.

If **vancomycin and gentamicin** were used intra-operatively:
- Give further 3 doses* vancomycin 15mg/kg 6hrly iv over 1hr (ie. at 6, 12 and 18hrs after the last intra-operative dose).
- There is no need for further doses of gentamicin.

**NB** If there is renal compromise, do **vancomycin** levels prior to giving 2nd dose. If vancomycin is to be continued for >24hrs, levels should be done prior to the 5th dose.

*Whether had 1 or 2 doses intra-operatively.
**ANALGESIA, SEDATION AND NEUROMUSCULAR BLOCKADE (MUSCLE RELAXANTS)**

**Analgesia/ Sedation:**

- All patients should be commenced on a morphine infusion at 10-20 mcg/kg/hr. This is usually sufficient in neonates.
- Some patients will also require sedation with midazolam 1-2 mcg/kg/min.

Midazolam and morphine may be cumulative in neonates and patients with liver dysfunction.

Beware that midazolam has negative inotropic effects especially when given as bolus. This may result in hypotension.

Morphine and midazolam need to be weaned to low levels before weaning/ extubation can safely take place.

As the infusions are being weaned, chloral hydrate 8 mg/kg 6-8 hourly PO/PR is useful if ongoing sedation is required and regular paracetamol is helpful for pain.

**Neuromuscular blockade (Muscle Relaxation/Paralysis):**

Most patients will come back from theatre with a muscle relaxant on board. This should not be reversed, but allowed wear off in its own time. Note that ventilator requirements may change as the drug is wearing off.

Routine ongoing use of muscle relaxants is not necessary. It may occasionally be required eg. to facilitate hyperventilation or in unstable PHT, but this decision should be made on a case by case basis by the NICU consultant.

Note that vecuronium avoids tachycardia, but may sometimes drop the BP and pancuronium causes tachycardia whilst maintaining or increasing the BP.
**BLOOD PRODUCTS**

**Packed Red Blood Cells (PRBC)**

It is appropriate to use packed cells for the patient who is actively bleeding or in those with a low haematocrit. 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 around 20 mmol/ unit.
- The K content is 0.5-5.0 mmol/unit (up to 15 mmol/unit). Old stored blood has a higher K content. Neonates should be transfused with blood as fresh as possible.

1 unit = 1 donation = >240ml

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

It is standard practice that all neonates receive irradiated and leuco-depleted blood at PMH.

The blood must be stored in designated fridge, set up within 30 mins of removal from fridge and completed within 4 hours of removal from fridge.

**4% Human Albumin Solution (HAS)**

4% HAS is commonly used in PICU but not so much in NICU. It is mainly used as a volume expander as an alternative to normal saline.

- Contains 140 mmol/L Na.
- Contains 40 g/L protein (96% as albumin).

**Platelets**

Used to replace platelets when count is low. Not to be used as a volume expander.

Dose is 10mL/kg over 30 mins, then repeat platelet count to determine if further required.

Should be ABO compatible to prevent haemolysis caused by anti-A and anti-B. All females should receive RhD negative platelets.

Platelets are stored at room temperature in the lab under gentle agitation. Transfusion can be as fast as tolerated and should be completed within 4 hours.

Transfused platelets have a storage (functional) defect lasting 2-4 hrs.

**Fresh Frozen Plasma (FFP)**

- Contains almost normal levels of stable clotting factors, albumin and immunoglobulin (Ig). Factor VII levels are at least 70% of normal levels.
Used to treat ongoing bleeding post surgery or in coagulopathy (INR >2.0, also give vitamin K 1mg iv and in case where INR 1.5-2.0). Also consider use in case of massive transfusion. Should not be used as routine volume expander.

**Dose** - 10-20ml/kg as fast as tolerated (eg. 30 mins) and within 4 hours.

Should be ABO compatible to prevent haemolysis caused by donor anti-A or anti-B.

NB Loss of clotting factors may occur as a result of excessive loss of peritoneal and pleural fluid and if this is replaced by saline alone may lead to a dilutional coagulopathy.

**Cryoprecipitate**

Separated from FFP after thawing at 1-6 C and recovering the precipitate which is then refrozen.

- Contains most of factor VIII, fibrinogen, vWF and fibronectin from the FFP. 1 unit cryoprecipitate contains about as much fibrinogen as 1 unit FFP but at recommended dose given the amount is higher. Fibrinogen >140 mg/ unit.

Indicated where fibrinogen <1.0 g/L and where there is active bleeding. May be required in the event of massive transfusion.

**Dose** - 5 mL/kg immediately after thawing. Can be given over 30 mins or slower if required (max 4 hours. Should be ABO compatible.
LINES

The lines in which a neonatal cardiac patient in NICU are likely to have are an intra-arterial catheter and a central venous line (right atrial) (patients with more complex congenital heart disease/post bypass surgery in PICU often have a left atrial pressure monitoring line also).

a) Intra-arterial catheter

Used for invasive monitoring of BP and as a sampling line.

- The line is most commonly placed in the right radial (pre-ductal) or left radial arteries.
- Other sites that can be used are brachial and posterior tibial arteries.
- The femoral artery may be used by an anaesthetist only.
- Use of the ulnar and axillary arteries should be avoided.

Care must be taken with brachial, axillary and femoral arterial lines as these are ‘end-arteries’ and if become blocked (by thrombus) can have devastating consequences (distal limb ischaemia and loss of digits/limb).

- The lines should generally be of 24G calibre (yellow cannula). The line should have red tape with ‘ARTERIAL’ written on it to differentiate from venous cannula.
- Any intra-arterial sheath should always have 0.5-1.0 mL/hr 0.45% saline + 0.5 unit heparin/ml of fluid running.
- If the line is not sampling/flushing it should be removed. The line should be removed at the earliest and safest time.

Nursing care should include regular neurovascular observations of that limb. If there is a concern that there colour change of the limb or loss of distal pulses consideration should be given to immediate removal of the line, request an ultrasound by radiology and contact vascular surgeon/cardiac surgeon.

When used for sampling in neonates it is important to take sufficient discard blood of at least 2mL otherwise the values may be diluted. The discard blood must then be replaced slowly (not thrown away) once the sample is taken and then the line flushed slowly.

b) Central Venous Line

Used for access:
- Stable, lasts up to a couple of weeks.
- Multiple lumens coming out at different points so a number of different drugs/fluids can be administered.
- Large vessel, hence good for administering inotropes.
- Used for central venous pressure (CVP) monitoring (sometimes RA). The line should be connected to a continuously monitored pressure transducer.

Indicator of RV preload (can help guide filling – see above) and RV performance.
Commonly jugular CVL in post cardiac surgery babies as gives most accurate indicator of CVP. Sometimes femoral CVL, but CVP reading maybe inaccurate particularly where there is abdominal distension/ increased intra-abdominal pressure.

The line should have blue tape attached with ‘VENOUS’ or ‘CVP’ written on it.
CHEST DRAINS

The underwater sealed chest drain(s) should be connected to continuous low suction of 15-20 cm H2O on arrival back from theatre before handover takes place.

The amount of chest drainage should be measured and recorded:

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

Excessive drainage should be reported to the registrar.

Very severe or relentless bloody drainage may be a surgical emergency and must be reported to the NICU consultant and cardiac surgeon immediately. Losses of > 3ml/kg/hr should be consider as severe and require immediate review by registrar.

The chest drain should be ‘milked’ regularly to ensure patency.

Patent thoracic drainage is essential to avoid intrathoracic collections – pericardial/ mediastinal/ pleural. Pericardial effusion/ cardiac tamponade is unlikely in non-open cardiac cases.

Drains should remain in situ until losses are minimal. The removal should only be ordered by the cardiac surgeon.

Removal of Chest Drains

Chest drain removal is painful and appropriate analgesia should be provided.

Equipment:

Basic dressing pack
Sterile towel
Gauze swabs
Stitch cutter
Saline to clean skin
Chlorhexidine solution
Sterile gloves
Steristrips and tegaderm

Procedure:

1. An assistant is required and a medical officer should be on the unit when the removal is performed.
2. Universal precautions against contamination by body fluids must be observed.
3. If parents around explain procedure.
4. Ensure adequate analgesia is administered.
5. Prepare trolley with necessary equipment.
6. Wash hands and don gloves.
7. Place sterile towel under drain/s to be removed.
8. Swab wounds and chest drains with chlorhexidine solution.
9. Untie and unravel purse string suture around the drain (not all chest drains will have purse string sutures – where held in with a conventional skin suture this should be cut and removed just before the drain is taken out.)
10. If 2 drains are attached to the same drainage system via a ‘Y’ adaptor an assistant should clamp the drain that is being removed to reduce the risk of a pneumothorax.
11. Use a gauze square to hold the chest drain.
12. An assistant should clamp chest drain and turn off the suction.
13. Pull out chest drain as quickly as possible at the appropriate point in the ventilation cycle (on expiration).
14. The assistant should pull the skin together with the purse string tie immediately following the removal of the drain. If there is no purse string suture then pull the skin together with some gauze and apply steristrips and a Tegaderm dressing.
15. The purse string suture may be removed after 5 days. Discuss with the cardiac nurse regarding the timing of removal. Steristrips may be removed after 24hrs if there is no ooze.
16. Observe patients respiratory status including auscultation of the chest for equal air entry.
17. A CXR is not routinely required. It should only be ordered if clinically indicated. Observe for clinical features of pneumothorax as occasionally air may be sucked in during the process of drain removal.
References: