GUIDELINE

Exchange Transfusion

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

Also consult

- For NICU PCH – Red Blood Cells Prescribing, Ordering and Administration
- For NICU KEMH – Blood Products (Neonates)

Contents

Aim

The primary goal of the procedure is to remove circulating antibody-coated red blood cells and/or products of haemolysis, e.g. bilirubin, whilst maintaining a constant or nearly constant blood volume.

Advocated for infants with:

- Hyperbilirubinaemia (Haemolysis secondary to Rhesus/ABO or other blood group incompatibility, G6PD deficiency) to prevent kernicterus.
- Anaemia/Hydrops.
- Congenital leukaemia (as an alternative to plasmapheresis)
- Neonatal Hemochromatosis
- Polycythaemia (i.e. Partial Exchange)
- Hyperkalaemia.
- Drug Toxicity/Overdose.
- Disseminated Intravascular Coagulation.

Key Points

- An exchange transfusion for hyperbilirubinaemia should be considered a medical emergency, and continuous intensive phototherapy (multiple lights) should be commenced immediately. **The Consultant Neonatologist on service should be contacted without delay.**
- Talk to the parents. Obtain and document consent.
    - Provide consumer information 'Blood Transfusion for your Baby' to the parents.
    - Be aware of issues relating to religious beliefs.
    - Parents may stay with their infant during an exchange transfusion at the discretion of the medical staff involved.
- Communicate with Blood Bank early.
    - For further information regarding types of donor blood to use, consult

        For NICU PCH – PCH Transfusion Medicine Protocols

        For NICU KEMH – KEMH Transfusion Medicine Protocols
- Securing timely vascular access is imperative. Well placed umbilical arterial and venous catheters are the ideal standard, however, if vascular access is problematic engage senior help early and do not delay the procedure.
    - Note that arterial lines (umbilical or peripheral) should only be used for withdrawal of infant blood, not for injection of donor blood.

  - Evaluate the requirements for dedicated IV lines for other medications, e.g. non-interrupted infusions/ compatibilities for inotropic support or sedation.

- There are two techniques for this procedure the isovolumetric and push-pull techniques.
- Ensure blood warmer is set to 37 °C.
- Administration of intravenous calcium is not routinely recommended. Donor blood citrate may reduce circulating ionised calcium, with potential to induce tachycardia, peaked T waves, prolonged Q-Tc interval, and cause irritability, vomiting, and apnoea.
  - If symptomatic or ionised calcium <1.0 mmol/L administer 1-2 mL of Calcium Gluconate 10% solution (1 mL 10% Calcium Gluconate/Kg) via slow infusion and observe ECG. Clear line with NaCl 0.9% before continuing with transfusion.
- Although the haematocrit of packed red cells (PRC) from the blood bank is in the range of 0.5 to 0.6, removal of whole blood from the baby and replacing it with PRC may result in hyperviscosity and coagulopathy. For this reason, fresh frozen plasma (FFP) should also be ordered with the PRC. FFP should never be added to the bag of PRC, but rather administered in a separate syringe. See below.
- BloodSTAR (Blood System for Tracking Authorisations and Reviews) is a new ICT system developed by the National Blood Authority with standardisation in the *Criteria for the clinical use of intravenous immunoglobulin in Australia*, funded by all governments through the national blood arrangements. Whilst the second edition criteria (2012) remains in usage, IVIG may be approved as listed under exceptional circumstances, for infants cared for at KEMH following discussion with the Consultant Haematologist. With the release of the third edition criteria in 2017, the use of IVIG for treatment of haemolytic disease is not recommended.
- A checked resuscitation trolley must be nearby. If the infant's condition deteriorates acutely for any reason, the procedure must be suspended immediately pending involvement of the consultant on call.
- If the exchange has to be stopped for any reason, always leave anti-coagulated-donated blood in the line. Always leave the infant's blood volume in balance - i.e. volume removed = volume replaced.
- Perform bedside administration check and monitor and record observations as per policy.

Preparation of the Infant

- Nurse infant on radiant warmer or isolette with servo-controlled thermoregulation.

- Continuous cardio-respiratory monitoring and, pulse oximetry to remain in situ and observations recorded every 15 minutes, including NIBP.
- Maintain continuous intensified phototherapy throughout the procedure and afterwards. Use of transparent sterile drapes facilitates this as well as the capacity to visualise the baby throughout.
- Insert umbilical venous and arterial catheters in accordance with policy, without delay.
    - An alternative is to secure peripheral venous and arterial access. Additional peripheral venous access may be required in an unstable patient requiring dedicated infusion lines.
- The infant should be NBM and a gastric tube inserted. Gastric contents should be aspirated, and the tube left in situ to open drainage. The infant may vomit (especially if ionised calcium low).
- The patient should not usually require pharmacological sedation; take steps to provide simple comfort measures, e.g. non-nutritive sucking, small quantities of oral sucrose.
- Place urine bag (infants > 30 weeks gestation) or cotton balls to collect and monitor urine output. This also assists with maintaining a clean, dry environment.

Calculation of Volume for Exchange

The volume of blood for exchange is dependent on the reason for the exchange and calculated using an estimate of the neonate's circulating blood volume:

- Term infants: 80 mL/kg
- Preterm infants: 100 mL/kg

Upon ordering PRC units, consider the need for an additional 50 mL volume required to prime the circuit.

Double volume exchange recommended for haemolytic disease of the newborn

- 2 x circulating blood volume [for example, for a term infant weighing 3 kg: 2 x estimated blood volume (80 mL) x weight (3 kg) = total 480 mL].
- The average volume per pack of PRC is 250 mL. Generally, 2 units of PRC are sufficient for a term baby.
- Replaces approximately 85% of the blood volume
- This will cause an approximate reduction of 50% of the pre-exchange bilirubin level (but can be expected to rebound 4 hours post-transfusion to approximately two-thirds of pre-exchange level).
- Order FFP as above. Each unit contains on average 70ml; generally, 1 unit of FFP will suffice for most exchange transfusions for a term baby.

Haemodilution for polycythaemia ('partial exchange transfusion' using normal saline):

Polycythaemia and hyperviscosity can occur in situations of chronic fetal hypoxia, e.g. IUGR, twin-to-twin transfusion. Although neonatal hyperviscosity has been implicated as a cause of long-term neurodevelopmental delay, the use of haemodilution for the treatment of polycythaemia is controversial. There is no evidence of long-term benefit, and the procedure has been associated with an increased risk of NEC.

There is minimal difference in efficacy using plasma, albumin or crystalloid products; therefore, normal saline is recommended to minimise the risk associated with blood product exposure (BCSH2016).

Volume exchanged (mL) =	Wt (kg) x (Blood volume/kg) x (Hct of patient- Desired Hct)
	Hct of patient

Exchange Transfusion Procedural Techniques

An exchange transfusion is a sterile aseptic procedure and can be carried out using either of two techniques. The likelihood of an uncomplicated exchange is increased if care is taken to have good arterial and venous access, and to have all equipment checked and ready **prior to commencing**.

Recommended duration of the transfusion using either method is a minimum of 2 hours, with the entire procedure including set-up should generally be completed within 3 hours.

The **'ISOVOLUMETRIC METHOD'** is the slow removal of aliquots (5-10 mL usually) from an artery (central or peripheral) and simultaneous continuous infusion of packed red cells into a vein (central or peripheral). This method minimises the risk of wide fluctuations of blood volume and pressure.

The **'PUSH-PULL METHOD'** via an umbilical venous catheter, with the serial withdrawal and injection of small aliquots (5-20 mL), via separate lumens. This is the traditional method, not often used now except when arterial access is a problem. A suggested rate is 30 aliquots over 2 hours, allowing 4 minutes each cycle.

Set-Up for Isovolumetric Method

Infusion IN (via UVC/PIVC)

	KEMH	PCH
1.	Alaris blood giving set Ref 72980E with dual bag insertion spikes	Alaris VP giving set REF 70895
2.	Alaris exchange transfusion pump (allows for higher rates of infusions required)	Alaris VP plus exchange transfusion pump (allows for higher rates of infusions required)
3.	Biegler Blood warmer 585 with appropriate coil – set to 37 °C.	Hotline fluid warmer

	KEMH	PCH
4.	Long blood warming extension tube for coiling	Hot line fluid warming set Ref-L70NI
5.	2nd extension tube to connect to UVC/PIV reaching the patient.	Ascena syringe pump ,blood giving set with extension if co-administering FFP
6.	Ascena syringe pump, syringe and extension tubing if co-administering FFP.	

Aspirating OUT (via UAC/PAL)

- 2 x 3-way taps in sequence as per diagram.
- Short extension tube if PAL used.
- 10 mL or 30 mL Luer-lock syringe for blood withdrawal depending on aliquot size
- Drainage bag and connection 74.5220.007 (KEMH) / DUB2000 (PCH)
- Heparinised arterial line set or heparinised saline syringe

Additional Equipment

- Exchange Transfusion Record MR460.
- Resuscitation trolley nearby.
- Calcium Gluconate 10% ampoules.
- Blood specimen tubes/sampling syringes.
- Ensure packed red cells prescribed and rates of infusion checked. (e.g. double volume exchange in a term infant weighing 3 kg: 2 x estimated blood volume (80 mL) x weight (3 kg) = total 480 mL / 120 mins = rate 240 mL/Hr (therefore withdrawal rate of blood from patient 4 mL/min).

Procedure

Blood Infused IN:

	KEMH	PCH
1.	Blood warming extension set should be threaded onto the blood warming coil while it is **not primed**. Start at the back of the device and wind anti-clockwise towards the front 8 times (that is 80cm between blood warmer and patient). Line must be completely inserted between the grooves of the blood warming coil. Refer to image 1.	Pour sterile water into the reservoir of hotline warmer.
2.	Connect the blood administration set to the blood warming coil and clamp off the lines.	Plug the Twin-Tube Connector on the hotline infusion set into the socket of hotline warmer and turn the power on. Refer image 1b.
3.	Insert the administration set spike into PRC units (both if 2 required). Refer to image 2.	Remove the end cap and inspect the patient end of the warming set for leaks to confirm the integrity of the intravenous pathway.
4.	Release the clamp and prime the extension lines through to the end, clamp and connect to the 3-way tap of UVC or PIV, maintaining asepsis.	Prime the Alaris VP giving set with blood and connect it to HOTLINE Fluid warming set.
5.		Prime the entire circuit with blood and connect the distal end of the HOTLINE Fluid warming set to the patient's intravenous access site. Refer image 2b
6.	Record baseline observations (infant temperature, heart rate, respiratory rate, blood pressure, oxygen requirement, oxygen saturations, neurological status) prior to commencement of the procedure.	
7.	Commence infusion of PRC at the prescribed rate (recommended over 2 hours).	
8.	The pack containing the blood being infused should be gently agitated every 5 minutes during the transfusion. This will prevent the settling of red blood cells.	
9.	Once 90 mL of PRC has been infused, stop the PRC infusion, and administer 10ml of FFP instead. Then continue the PRC and repeat this process every 90 mL until the exchange transfusion is complete. I.e., replace 100 mL of baby's blood with 90 mL of PRC and 10 mL of FFP.	

Blood Withdrawn OUT (Refer to image 3)

1. Size of aliquot depends on the size of the infant and cardiovascular stability; recommend aliquots of 5mls for infants <1500 g; 10-15 mL above 1500 g, at a pre-determined rate (4 mL/min in the example above).
2. Slowly aspirate aliquot, maintaining steady gentle flow. Turn 3-way tap **OFF** to infant and send **"First out"** specimens to the laboratory. In all other sequences turn 3-way tap **ON** to waste bag to discard blood.
3. Do not use excessive suction or too rapid withdrawal as potential to induce Negative pressure within the vessel causing injury and altered tissue perfusion to the liver, GIT and renal beds, increasing the risk of complications such as NEC. Rapid changes in blood volume may cause hypotension, cardiac arrhythmias, hypoxia and metabolic instability.
4. Repeat sequentially, ensuring the balance of infusion and withdrawn blood. Nurse assisting with the procedure to maintain documentation on Exchange Transfusion Record MR460 of aliquots and cumulative totals exchanged, to be announced every 100 mL. Continue patient observations every 15 min, recorded on MR460.
5. Complete the exchange transfusion and collect 'last out' specimens for testing as indicated.

Set-Up for Push-Pull Method (Double Lumen UVC)

Infusion IN (via primary lumen UVC)

Refer to images 5, 6 and 7

- Alaris blood giving set Ref 72980E with dual bag insertion spikes
- Biegler Blood warmer 585 with appropriate coil – set to 37 °C.
- Long blood warming extension set for coiling
- 2nd extension set to connect to UVC/PIV reaching the patient
- 2 x 3-way taps, 30 mL Luer-lock syringe for measuring and administering aliquots
- Saline-filled syringe or flush
- Ascena syringe pump, syringe and extension tubing if co-administering FFP.

Aspirating OUT (via secondary lumen UVC)

Refer to image images 5, 8 and 9

- 2 x 3-way taps.
- 10 mL or 30 mL Luer-lock syringe for blood withdrawal depending on aliquot size
- Drainage bag and connection 74.5220.007

- Saline-filled syringe or flush.

Additional Equipment

- Exchange Transfusion Record MR460.
- Resuscitation trolley nearby.
- Calcium Gluconate 10% ampoules.
- Blood specimen tubes/sampling syringes.
- Ensure packed red cells prescribed and rates of infusion checked. (e.g. double volume exchange in a term infant weighing 3 kg: 2 x estimated blood volume (80 mL) x weight (3 kg) = total 480 mL / 30 aliquots = 16 mL every 4 mins.)

Procedure

1. Steps 1-5 as per isovolumetric set up for PRC infusion.
2. Connect to the two 3-way taps in sequence to each lumen (the second tap allows for saline flush as required).
3. Connect the PRC infusion and 'giving' syringe to the proximal lumen tap, and the aspirating syringe and drainage tube/bag to the distal lumen tap – refer to image 5.
4. Withdraw the first aliquot with a slow, steady pre-determined rate, e.g. 16 mL every 4 mins. Announce "XX mL OUT"; nurse records, send "First out" specimens to the laboratory. Refer to image 8.
5. Fill giving syringe accurately from blood pack via proximal tap – image 6.
6. Turn 3-way tap ON to infant and infuse at the same rate. Announce "XX mL IN"; nurse records. If infant hypovolaemic may start with small aliquot 'In' first. Refer to image 7.
7. For all subsequent withdrawals turn 3-way tap ON to waste bag for collection – image 9.
8. 'Ins' and 'Outs' are repeated sequentially, with a record of cumulative totals to be announced every 100 mL by assisting nurse.
9. After 90 mL of PRC have been infused, administer 10 mL FFP next instead of PRC. Then continue administering PRC until the next 90ml has been administered, after which 10 mL FFP is administered again. Continue this process until the exchange transfusion is completed. I.e., replace 100ml of baby's blood with 90 mL of PRC and 10 mL of FFP.
10. The pack containing the blood being infused should be gently agitated every 5 minutes during the transfusion. This will prevent the settling of red blood cells.
11. Finish in exact balance (or in positive balance if advisable). Collect 'last out' specimens for testing as indicated.

Blood Specimens

Initial or “First Out”.

- FBC & film
- Blood Group, Direct Coomb's test
- Urea and electrolytes, calcium, SBR, total and conjugated
- Blood gas with PGL
- Coagulation profile
- Newborn screening test
- Hold samples for other tests as indicated, e.g. G6PD deficiency, viral infection, hereditary spherocytosis, metabolic studies.

Halfway Specimens

- SBR
- Blood gas with PGL
- FBC/Coagulation screen if warranted

End or “Last Out” specimens

- SBR, Urea & Electrolytes, calcium, magnesium, phosphate
- FBC and Crossmatch for possible subsequent exchange
- Coagulation studies
- Blood gas with PGL

Post Exchange

Measure serum bilirubin within 2 hours of performing the exchange transfusion, and frequency thereafter is dependent on the indication for the exchange, the anticipated rate of rise of bilirubin and the most recent results.

Documentation

Document the procedure in the medical record and using the Exchange Transfusion Record (MR460) recording time of commencement, aliquot volumes and the total volume exchanged, blood specimens’ analysed, infant observations and completion of the procedure.

Routine observations every 15 min during the procedure: infant temperature, heart rate, respiratory rate, blood pressure, oxygen requirement, oxygen saturations, blood warmer temperature, the general condition of the infant

Document any patient instability, complications of the exchange transfusion and any further management required, e.g. medications.

Post Exchange Care

Continuously monitor vital signs and record 30 minutely for the first 4 hours post-procedure. Routine observations as per NICU observation chart should be continued for 24 hours.

Phototherapy needs to be continued post exchange and reviewed with the results of the SBR 2 hours post-procedure. Further SBR levels at approximately 6 hourly intervals.

Observe the infant's behaviour and catheter sites for bleeding or signs of infection.

PGL, as indicated by initial and post exchange results.

Keep infant NBM for at least 4 hours post exchange transfusion, or longer at the direction of the medical officer. As exchange transfusion carries a potential risk of necrotising enterocolitis (especially in the preterm infant) monitor the appearance of the abdomen and the presence of bowel sounds. Observe for signs of feed intolerance when feeding is recommenced

Document how the infant tolerated the procedure and ensure the parents are informed.

Potential Complications

The most commonly reported adverse events during or soon after exchange transfusion:

- Catheter-related complications; air emboli; thrombosis; haemorrhage
- Haemodynamic (related to excess removal of injection of blood): hypo or hypertension, intraventricular haemorrhage (preterm)
- Hypo or hyperglycaemia (often transient)
- Hypocalcaemia, hyperkalaemia, mild metabolic acidosis
- Thrombocytopenia

Potential complications related to exchange transfusion:

- Arrhythmias
- Bradycardia
- Neutropenia, dilutional coagulopathy
- Feed intolerance, necrotising enterocolitis
- Septicaemia, blood-born infection
- Hypo or hyperthermia

Images

Fluid / Blood warmers

Used at **KEMH**

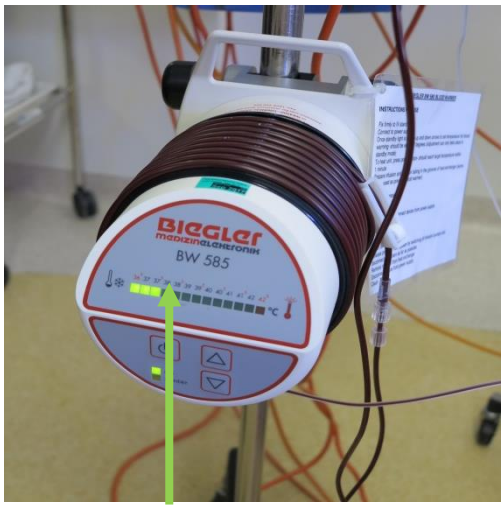


Image 1a

Temperature set at 37 °C.

Blood warming extension set should be threaded onto the blood warming coil while it is **not primed**.

Start at the back of the device and wind anti-clockwise towards the front 8 times (that is 80 cm between blood warmer and patient). Line must be completely inserted between the grooves of the blood warming coil.

Used at **PCH**

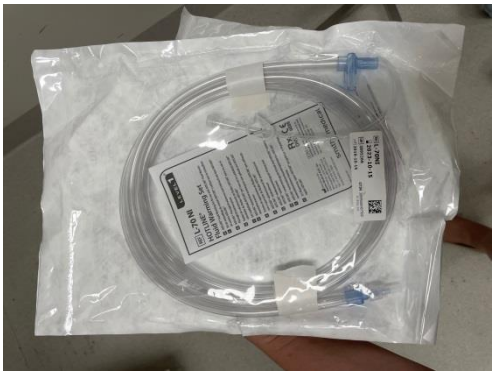
Image 1b

HotLine blood warmer

Follow instructions with blood warmer.

NOTE: Requires flow rates of 50-2,000 mL/hours.

Remember to add an extension set if the flow rate is less than 50ml/h to prevent overheating the infusion given.



Isovolumetric Technique

Isovolumetric set-up KEMH

Image 2a

Isovolumetric set-up PCH

Image 2b

Isovolumetric set-up

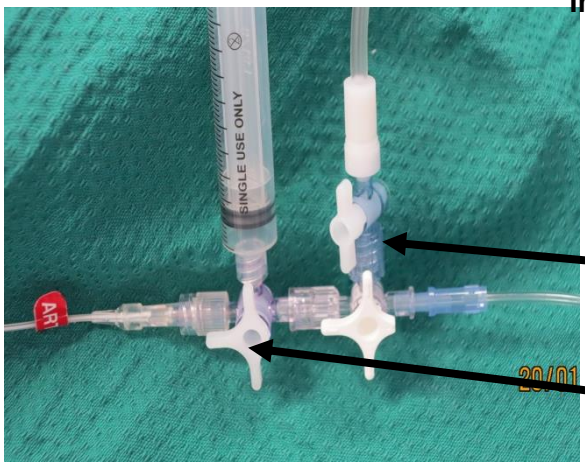


Image 3

Isovolumetric – two 3-way taps attached to arterial line.

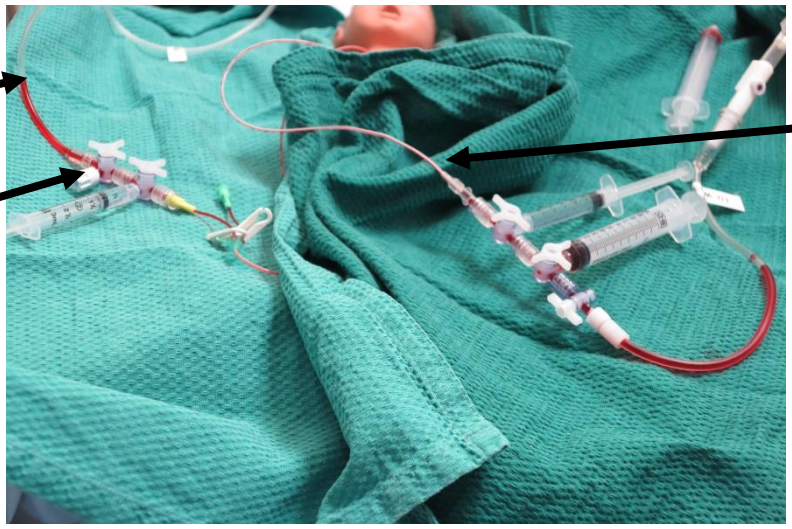
Note: the waste bag is attached to the distal 3-way tap.

Waste extension attached to distal 3-way tap

3-way tap on to baby off to waste

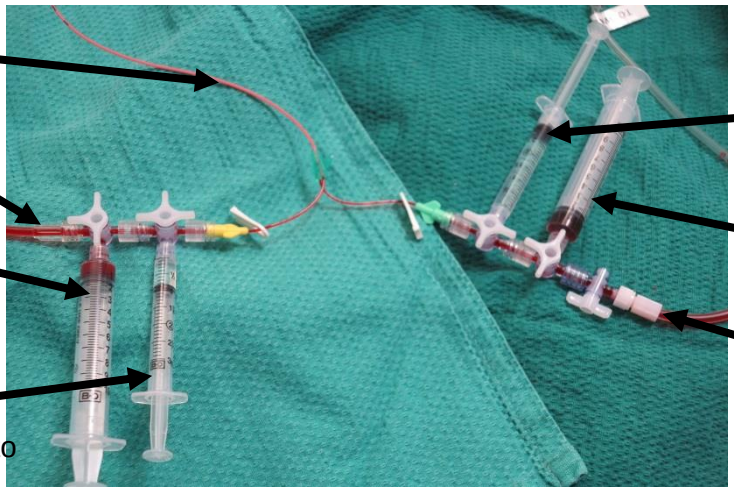
Isovolumetric set-up

Image 4



Push-pull Technique

Image 5



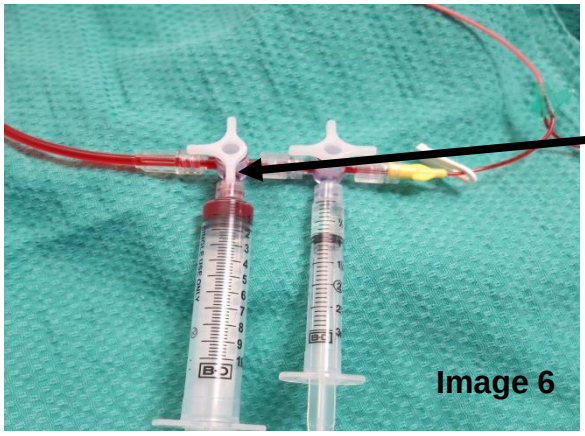
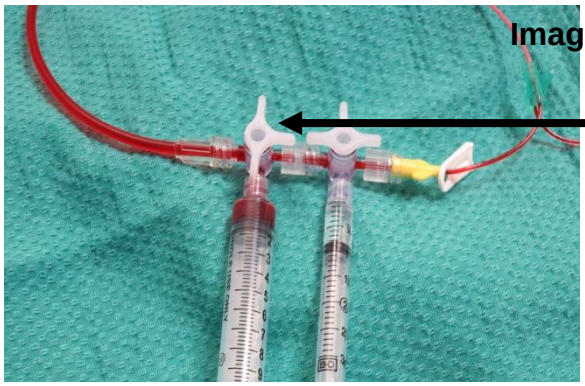
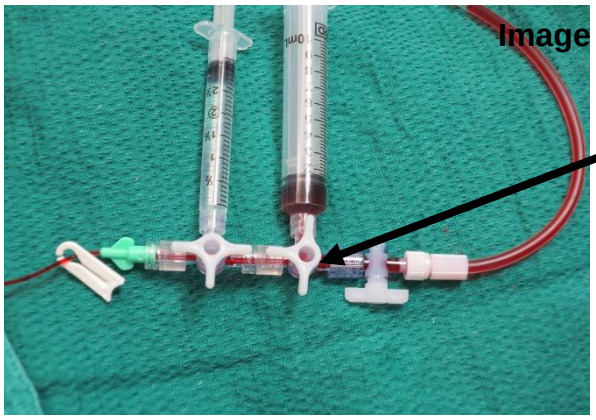
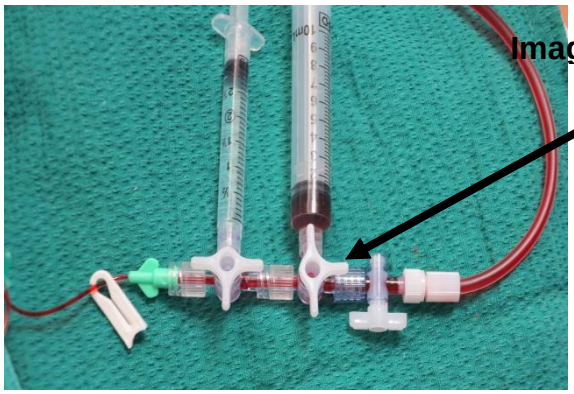


Image 6

Push-pull technique – Blood in

Double lumen UVC (primary lumen)

3-way tap turned off to baby, on to unit of packed red blood cells.

 **Image 7**	**Push-pull technique – Blood in** 3-way tap turned off to unit of packed red blood cells and open to baby.
 **Image 8**	**Push-pull technique – Blood out** Double lumen UVC (secondary lumen) 3-way tap turned on to baby, off to waste
 **Image 9**	**Push-pull technique – Blood out** 3-way tap turned off to baby, open to waste

Related CAHS internal policies, procedures and guidelines

WNHS

- Blood Products (Neonates)

PCH

- Red Blood Cells (RBC) Prescribing, Ordering and Administration

References

1. American Academy of Pediatrics Subcommittee on Hyperbilirubinemia. Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. Pediatrics. 2004;114(1):297–316
2. British Committee for Standards in Haematology (BCSH) (2016). Guidelines on transfusion for fetuses, neonates and older children.
3. National Blood Authority Australia. Patient Blood Management Guidelines; Neonatal and Paediatrics p113-114. https://www.blood.gov.au/bloodstar accessed 20/12/2016

Useful resources (including related forms)

Parent Information: Blood Transfusion for your baby

This document can be made available in alternative formats on request.

Document Owner:	Neonatology		
Reviewer / Team:	Neonatal Coordinating Group		
Date First Issued:	July 2006	Last Reviewed:	15th February 2021
Amendment Dates:	7th September 2021	Next Review Date:	15th February 2024
Approved by:	Neonatal Coordinating Group	Date:	24th March 2021
Endorsed by:	Neonatal Coordinating Group	Date:	
Standards Applicable:	NSQHS Standards:  Child Safe Standards: 1,10		

Printed or personally saved electronic copies of this document are considered uncontrolled

Healthy kids, healthy communities

Compassion | Excellence | Collaboration | Accountability | Equity | Respect

Neonatology | Community Health | Mental Health | Perth Children's Hospital