CLINICAL PRACTICE GUIDELINE
Guideline coverage includes NICU KEMH, NICU PMH and NETS WA

Exchange Transfusion

This document should be read in conjunction with the Disclaimer

Contents

Consult Transfusion Medicine Protocols for more detailed information as required.

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 (Rhesus/ABO incompatibility) to prevent kernicterus.
- Anaemia/Hydrops.
- Polycythemia i.e. Partial Exchange.
- Hyperkalaemia.
- Drug Toxicity/Overdose.
- Disseminated Intravascular Coagulation.
- Maternal Antibodies.

Key Points

- An exchange transfusion for hyperbilirubinaemia should be considered a medical emergency and continuous intensive phototherapy (multiple light) should be commenced immediately. **The Consultant Neonatologist on service should be contacted without delay.**
- Talk to the parents. Obtain and document consent (MR417). Be aware of issues relating to religious beliefs. A WNHS Leaflet 'Blood Transfusion for your Baby' is available for the parents to read. 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 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 isovolumetic 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 <1.0mmol/L administer 1-2 mLs 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.
- There is insufficent evidenced-based data to support the routine addition of albumin or fresh frozen plasma to packed red cells for exchange transfusion. Clinical practice is varied across neonatal intensive care units according to local policy with aim of achieving an haematocrit within the range of .50-.60. Formal analysis of haematocrit of PRC is not routinely undertaken for

exchange transfusions. If clinical concern regarding coagulopathy, consider FFP administration.

- 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) reamins in usage, IVIG may be approved as listed under exceptional circumstances, for infants cared for at KEMH following discussion with the Consultant Haemoatologist. With 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 WNHS hospital policy. **Consult Transfusion Medicine Protocols for more detailed information as required.**

Preparation of the Infant

- Nurse infant on an open warmer or isolette with servo-controlled thermoregulation. Continuous cardio-respiratory monitoring and, pulse oximetry to remain in situ and standard patient 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 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 insitu to open drainage. 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 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: 80ml/kg
- Preterm infants: 100ml/kg

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

Single blood volume exchange for non-haemolytic disease/ anaemia:

1 x estimated circulating blood volume as above for term and preterm infants

Replaces approximately 60% of the blood volume

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 (80mls) x weight (3kg) = total 480mls]
- 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).

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

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

Procedure 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 mls usually) from an artery (central or peripheral) and simultaneous continuous infusion of packed red cells into a vein (central or peripheral). This method minimises risk of wide fluctuations of blood volume and pressure.

The **'PUSH-PULL METHOD'** via a umbilical venous catheter, with the serial withdrawal and injection of small aliquots (5-20 mls), 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)

- Alaris blood giving set Ref 72980E with dual bag insertion spikes.
- Alaris exchange transfusion pump (allows for higher rates of infusions required).
- Biegler Blood warmer 585 with appropriate coil – set to 37 °C.
- Long blood warming extension tube for coiling.

- 2nd extension tube to connect to UVC/PIV reaching the patient.
- 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-lok syringe for blood withdrawal depending on aliquot size.
- Drainage bag and connection 74.5220.007.
- 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 (80mls) x weight (3kg) = total 480mls / 120mins = rate 240mls/Hr (therefore withdrawal rate of blood from patient 4mls/min)

Procedure

Blood Infused IN:

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.
2. Connect the blood administration set to the blood warming coil and clamp off the lines
3. Insert the administration set spike into PRC units (both if 2 required). Refer to image 2.
4. Release the clamp and prime the extension lines through to the end, clamp and connect to 3-way tap of UVC or PIV, maintaining asepsis.
5. Record baseline observations (infant temperature, heart rate, respiratory rate, blood pressure, oxygen requirement, oxygen saturations, neurological status) prior to commencement of procedure.
6. Commence infusion of PRC at the prescribed rate (recommended over 2 hours).

Blood Withdrawn OUT (Refer to image 3)

7. Size of aliquot depends on size of infant and cardiovascular stability; recommend aliquots of 5mls for infants <1500g; 10-15mls above 1500g, at pre-determined rate (4mls/min in example above).
8. 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.
9. 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 liver, GIT and renal beds, increasing the risk of complications

such as NEC. Rapid changes in blood volume may cause hypotension, cardiac arrhythmia's, hypoxia and metabolic instability.

10. Repeat sequentially, ensuring 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 100mls. Continue patient observations every 15mins, recorded on MR460.
11. 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, 30ml luer-lok 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-lok 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 (80mls) x weight (3kg) = total 480mls / 30 aliquots = 16 mls 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 first aliquot with a slow, steady pre-determined rate e.g. 16mls every 4mins. Announce "XX mLs 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 same rate. Announce “XX mLs 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 record of cumulative totals to be announced every 100mls by assisting nurse.
9. The pack containing the blood being infused should be gently agitated every 5 minutes during the transfusion. This will prevent settling of red blood cells.
10. 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.
- Coagulations 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 Cross match 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 procedure.

Routine observations every 15 mins during the procedure: infant temperature, heart rate, respiratory rate, blood pressure, oxygen requirement, oxygen saturations, blood warmer temperature, general condition of 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 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 necrotizing 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, necrotizing enterocolitis
- Septicaemia, blood born infection
- Hypo or hyperthermia

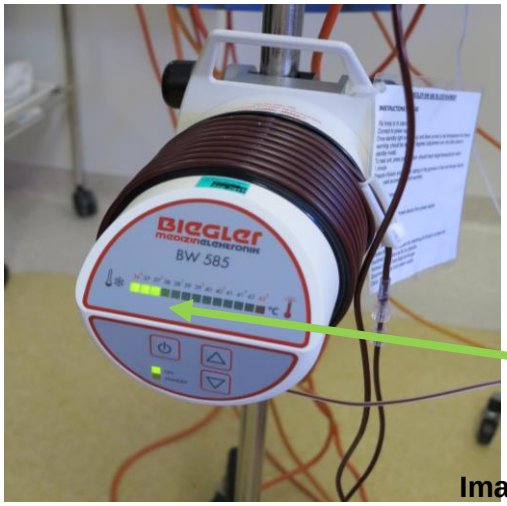


Image 1

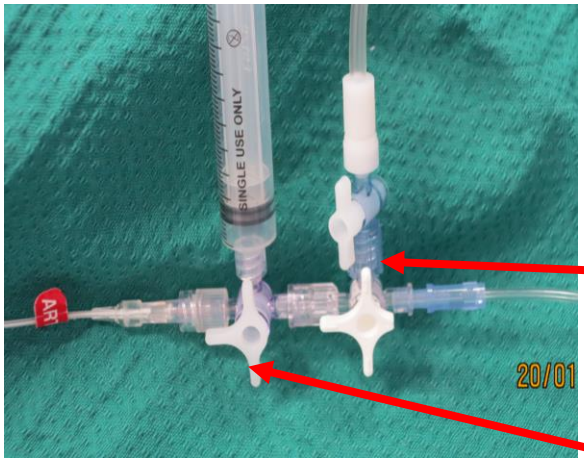
Blood warming extension set should be threaded onto the blood warming coil while it is **not primed**.

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.

Temperature set at 37°C.

Image 2

Isovolumetric set-up



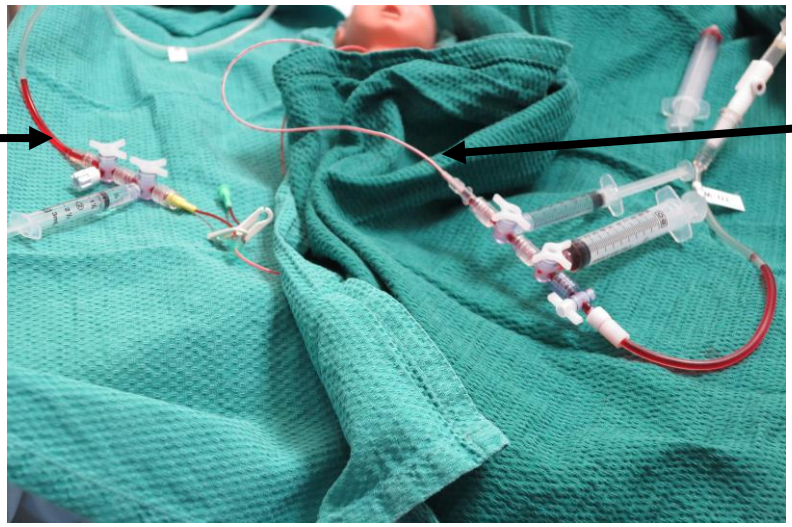
Isovolumetric set-up **Image 3**

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

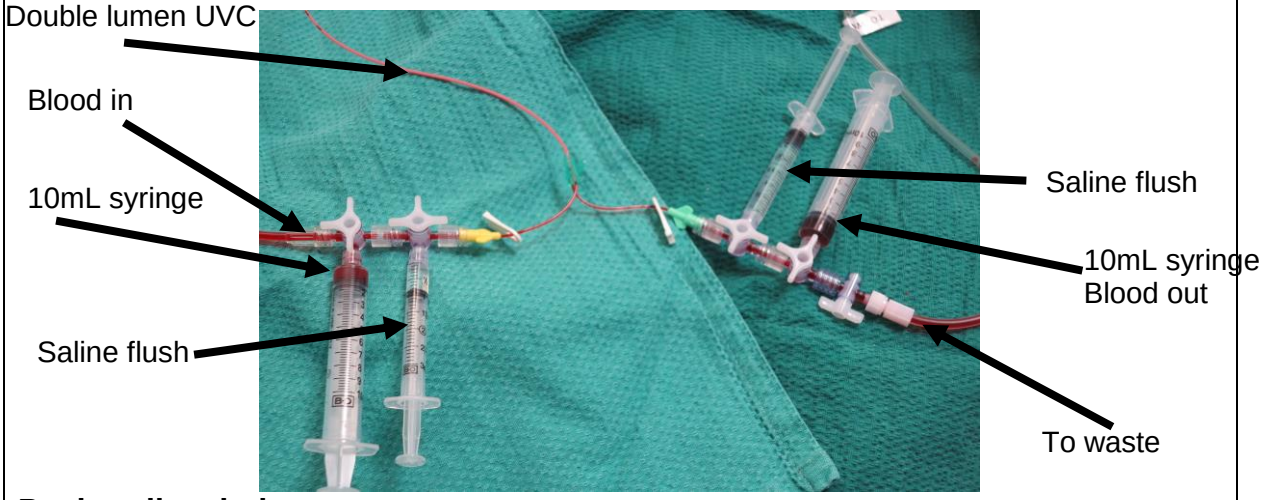
Note: the waste bag is attached to the distal 3-way tap.

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**

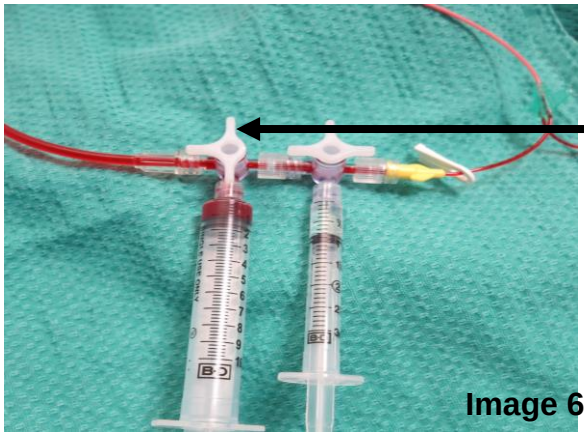
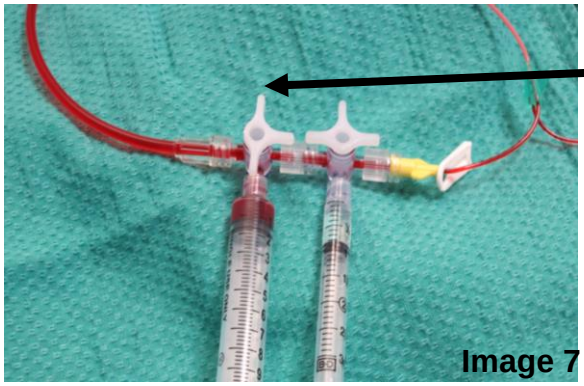
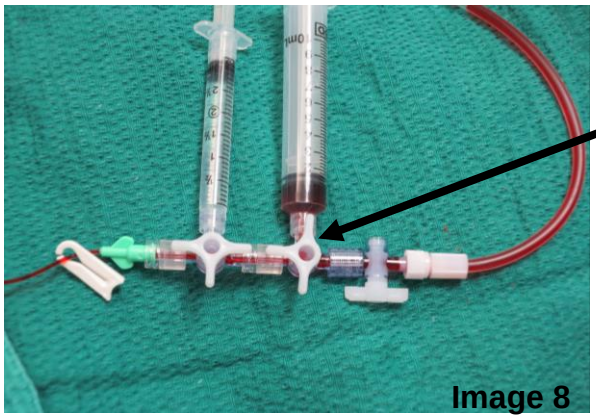
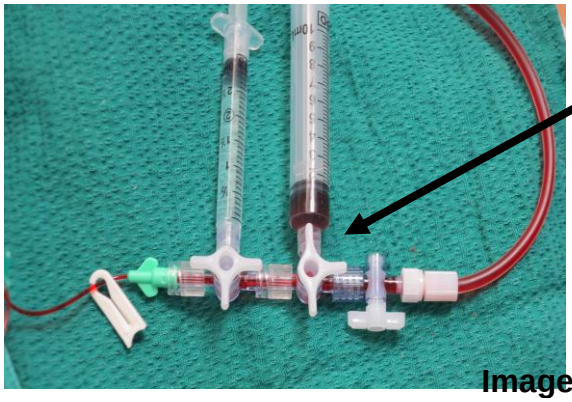


Image 6

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

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.

Related WNHS policies, procedures and guidelines

Transfusion Medicine Protocol
WNHS Parent Information: Blood Transfusion for your Baby

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