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

Contents

Aim

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.

Risk

Suboptimal management of exchange transfusion may lead to adverse complications.

Key Points

- An exchange transfusion for severe hyperbilirubinaemia is a medical emergency and a 3-person procedure. Continuous intensive phototherapy (multiple lights) should be commenced immediately.
- **The Consultant Neonatologist on service should be contacted without delay. Communicate with the Blood Bank early.**
- Talk to the parents. Obtain and document consent and provide parent information 'Blood Transfusion for your Baby' leaflet. 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.
- Securing appropriate vascular access (arterial and venous) is imperative. if vascular access is problematic engage senior help early. **Note: 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.

Indications

- 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.

Potential Complications

The adverse events due to exchange transfusion may include:

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

Patient preparation

- Place infant on radiant warmer/incubator with servo-control.
- Continuous cardio-respiratory monitoring and pulse oximetry with 15 mins observations.
- Continue intensive phototherapy throughout the procedure.
- Insert umbilical venous and arterial catheters. 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 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.
- A checked resuscitation trolley must be nearby as the infant's condition may deteriorate acutely.
- Document on the Exchange Transfusion Record (MR460) time of commencement, aliquot volumes and total volume exchanged, blood specimens, observations and time of completion.

Calculation of Volume for Exchange

The volume of blood for exchange (single vs double volume 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 estimated circulating blood volume
- Preterm infants: 100 mL/kg estimated circulating blood volume

Double volume exchange	2 x estimated circulating blood volume (mLs) x weight (kg) = Total volume over 120mins
	e.g. Term baby weighing 3kg (2 x 80 mL) x 3 kg = Total 480 mL over 120 mins = rate 240 mL/Hr Withdrawal rate of blood from patient 4 mL/min

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).

See Indication for Irradiated Red Cells under Special Transfusion Requirements and Circumstances in the Neonatology Blood components and Blood Products (health.wa.gov.au)

Ordering blood products

Packed Red cells (PRC) **Order 2 units** **(250mL per unit)**	Usually enough to replace 85% of the blood volume of a term baby. Always add an additional 50mL volume required to prime the circuit.
	The haematocrit of packed red blood cells is 0.5 to 0.6, therefore removal of whole blood from the baby and replacing it with PRC may result in hyperviscosity and coagulopathy. Therefore, fresh frozen plasma (FFP) should also be ordered with the PRC
Fresh Frozen Plasma (FFP) **Order 1 unit** **(70mL per unit)**	For every 100mL of baby's blood withdrawn, 90mL replaced with PRC and 10mL with FFP. This is to help prevent risk of hyperviscosity and coagulopathy. FFP should never be added to the bag of PRC and instead administered in a separate syringe.

Calculation of Volume for Partial Exchange (haemodilution)

Polycythaemia and hyper viscosity can occur in situations of chronic foetal hypoxia, e.g. IUGR, twin-to-twin transfusion. Neonatal hyper viscosity has been implicated as a cause of long-term neurodevelopmental delay, however, 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 techniques

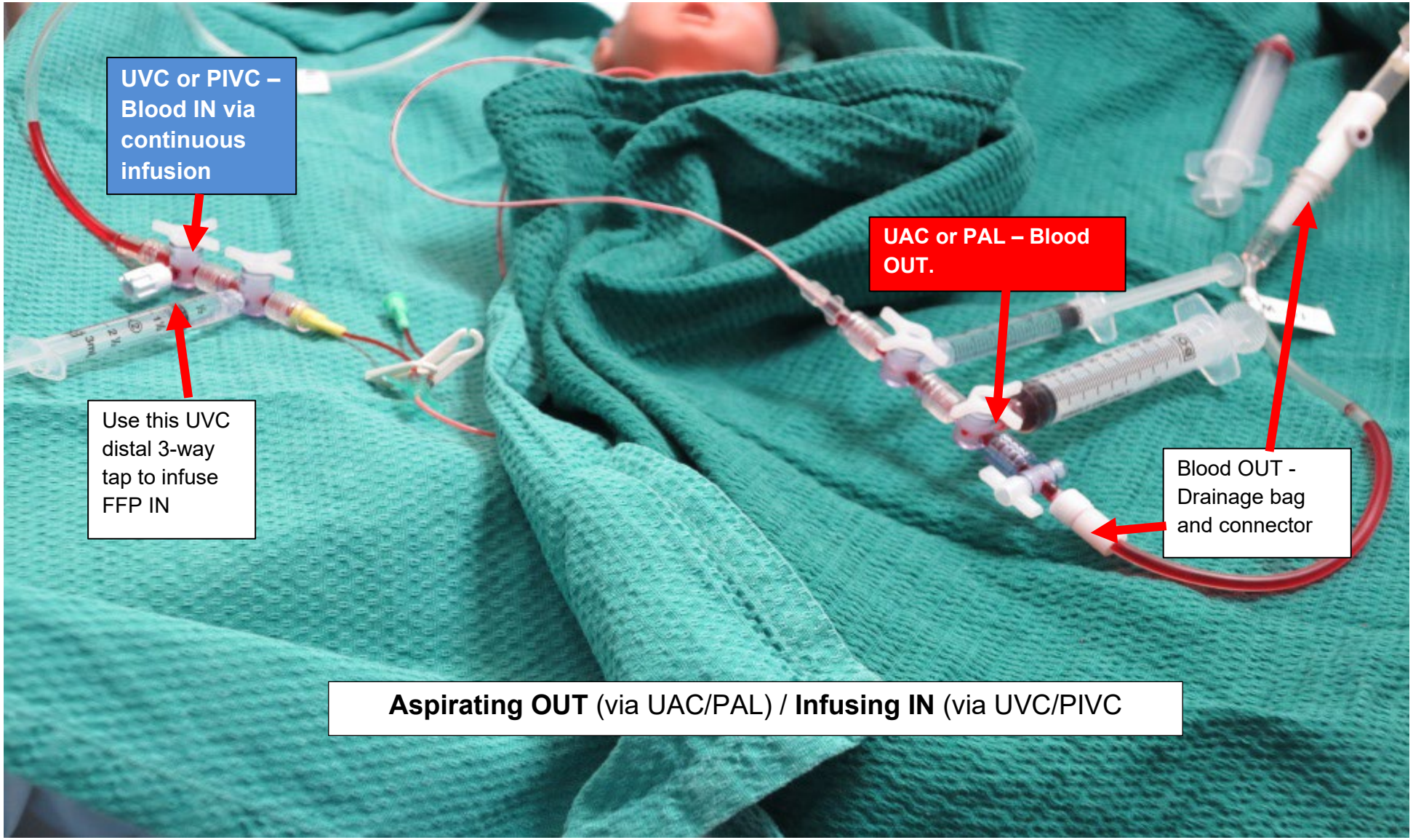
An exchange transfusion is a sterile aseptic procedure carried out using either of two techniques. Recommended duration using either method is a minimum of 2 hours, with the entire procedure including set-up should generally be completed within 3 hours.

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

Equipment

- Alaris VP Plus exchange pump which has been reset to allow higher rates of infusions. Kept in clean utility room SCN 3, and 3B Storeroom.
- Blood giving set with dual bag insertion spikes if blood required is > 1 unit.
- Blood warmer
    - Enflow Fluid Warmer (PCH 3B). See Appendix 1
    - Biegler 585 or 685S (KEMH). See Appendix 2 (585), Appendix 3 (685S)
- Blood giving set (single) for co-administering FFP. Use with Alaris Plus CC syringe pump, 50mL syringe and long extension for FFP
- 4 x 3-way taps (2 for OUT, 2 for IN)
- 2 x 2mL Luer-lock for saline flush
- 10 mL/20mL Luer-lock syringes for blood withdrawal
- Short extension tube only if PAL used.
- Drainage bag, connection and extension for blood OUT
- Exchange Transfusion Record MR460.
- Blood specimen tubes/sampling syringes
- Calcium Gluconate 10% ampoule

Isovolumetric Procedure Set-up



Isovolumetric and Push-Pull Method Step by Step

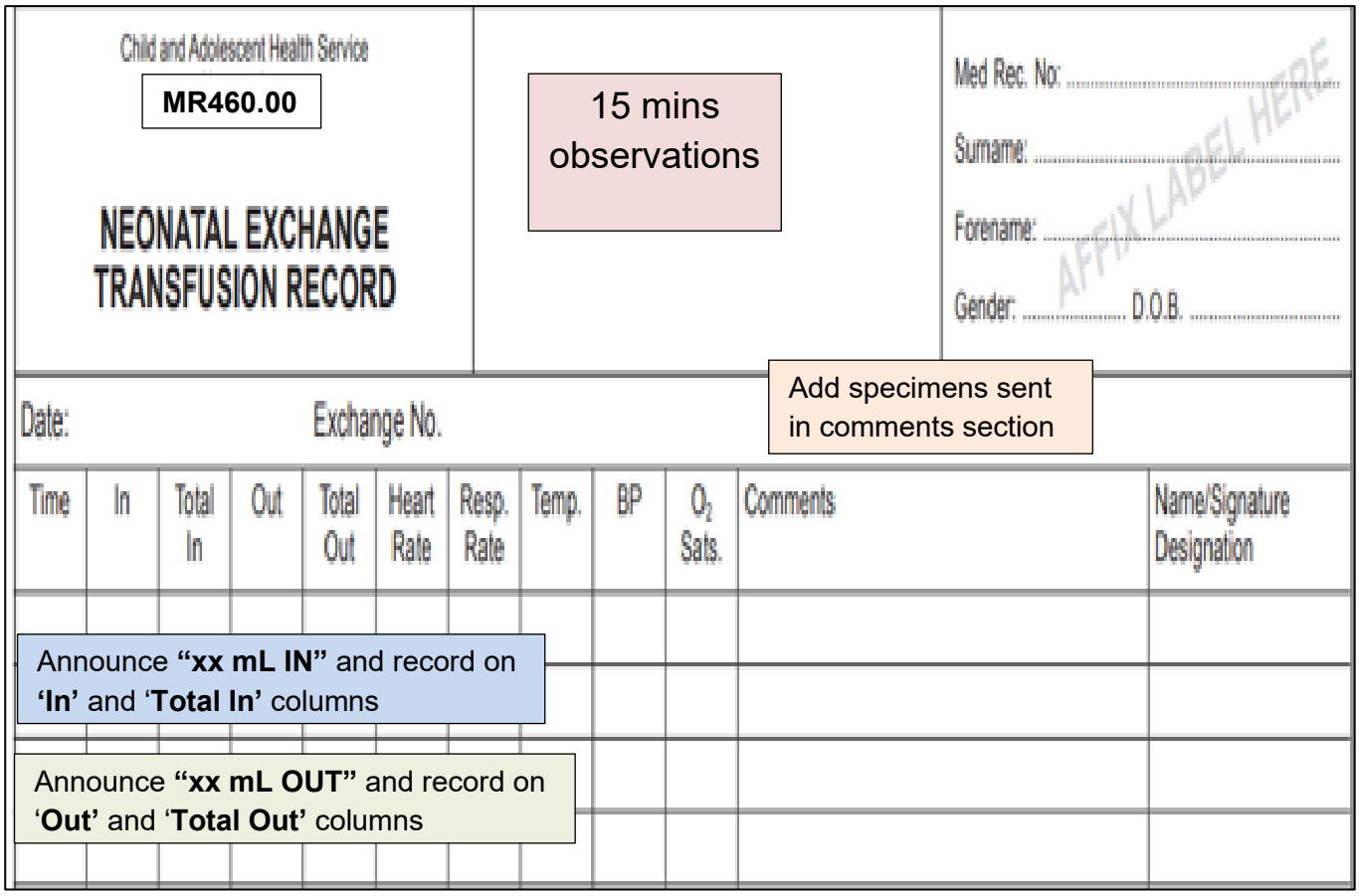
3 person procedure:

1. Dr – responsible for leading the procedure and withdrawal/infusion via 3-way taps
2. Nurse 1 – responsible for all documentation and announcing of each IN/OUT cycle
3. Nurse 2 – responsible to act as float during procedure and extra infusions/medication preparation.

- Record baseline observations prior and every 15 min during on **MR460 Neonatal Exchange Transfusion Record.**
- Connect the blood administration set to the blood warmer (see appendix) and clamp off the lines.
- Spike the dual blood administration set into both PRC units (if 2 units required).
- Release the clamp and prime the extension lines, clamp and connect to the 3-way tap of UVC or PIV, maintaining asepsis.
- Size of aliquot depends on the size of the infant and cardiovascular stability; recommend aliquots of:
    - 5mLs for infants <1500g
    - 10-15 mL above 1500g
- Aliquots need to be aspirated by a steady, gentle flow from UAC/PAL/UVC. Do not use excessive suction or too rapid withdrawal as may induce negative pressure within the vessel causing injury and altered tissue perfusion to the liver, GIT and renal beds; increasing the risk of complications and rapid changes in blood volume.
- **Isovolumetric -** Commence infusion of PRC at the prescribed rate (recommended over 2 hours).
- **Push-pull** - as infusion is by aliquots the blood transfusion pack should be gently agitated every 15mins to prevent settling of red blood cells and the infant receiving mostly plasma at end of each unit.

Method

- For each cycle of IN and OUT the person responsible for documentation to announce each cycle. E.g. “XX mL OUT”, “XX mL IN”.
- **“First aliquot out”** sample is to be sent to the laboratory. In all other sequences turn 3-way tap **ON** to waste bag to discard blood.
- Repeat cycle of IN/OUT, ensuring the balance of infused and withdrawn blood is exact. Maintain strict documentation on MR460 of aliquots and cumulative totals exchanged, to be announced every 100 mL

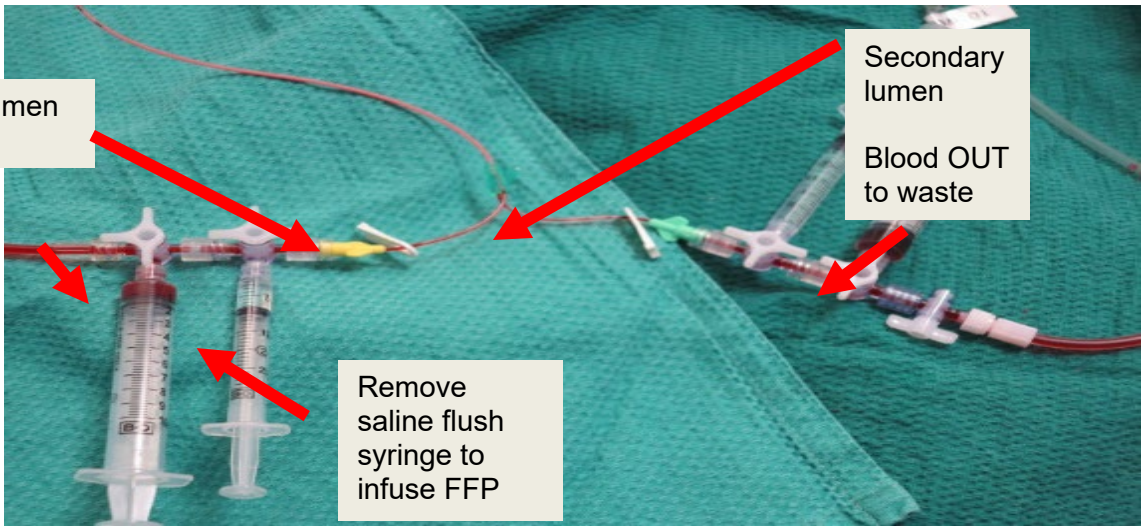


- Once 90 mL of PRC has been infused, stop the PRC infusion, and administer 10mL of FFP instead of PRC. Then continue the PRC and repeat this process every 90 mL until the exchange transfusion is complete. **i.e., replace every 100 mL of baby's blood with 90 mL of PRC AND 10 mL of FFP.**
- Suspend the procedure immediately if any deterioration and call the consultant. If the exchange is suspended, always leave anti-coagulated donated blood in the line and leave the infant's blood volume in balance - i.e. volume removed = volume replaced.
- 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.

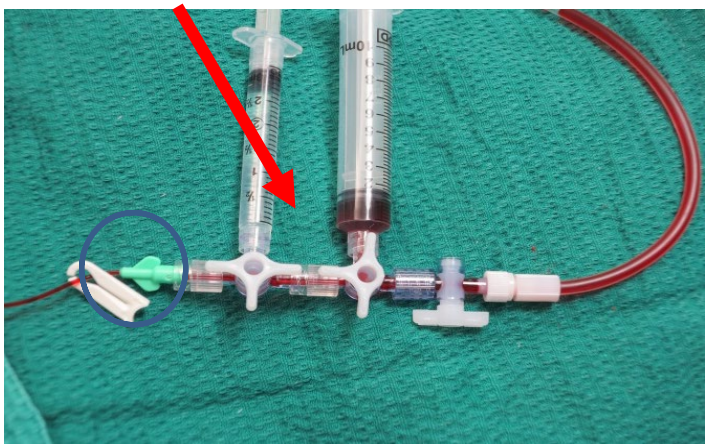
Push-Pull Method Set-up (Double Lumen UVC)

Infusion IN (via primary lumen UVC) **Aspirating OUT** (via secondary lumen UVC)

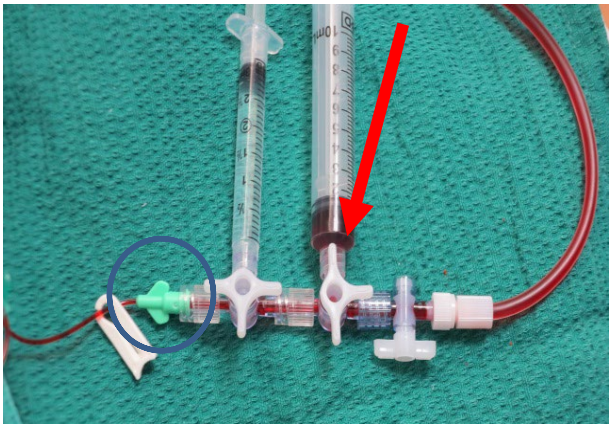
Push-Pull Set up



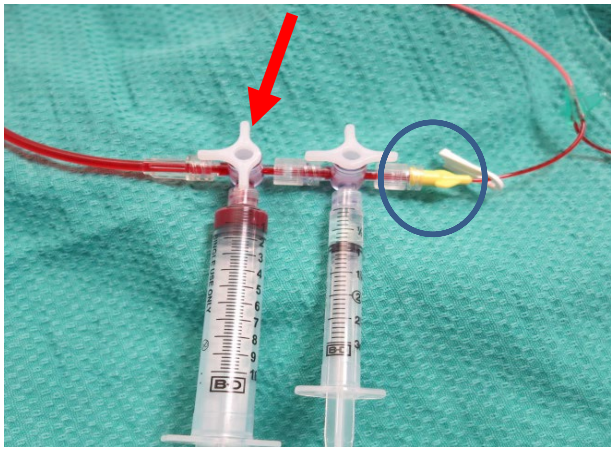
Step 1: BLOOD OUT. 3-way tap turned **OFF** to waste, **ON** to baby (secondary lumen)



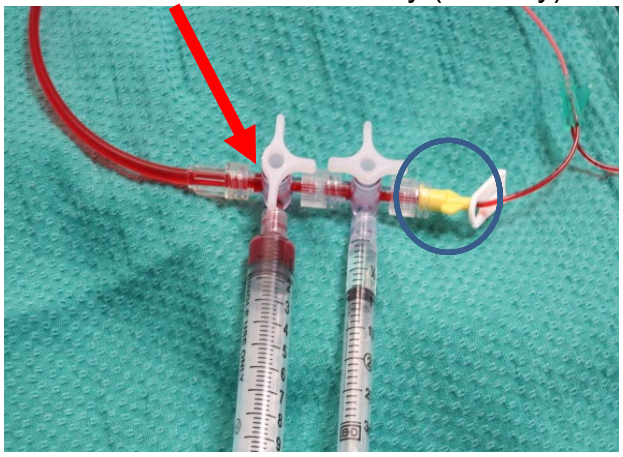
Step 2: TO WASTE. 3-way tap turned **OFF** to baby, **ON** to waste (secondary lumen)



Step 3: BLOOD IN. 3-way tap turned **OFF** to baby. **ON** to blood transfusion (Primary)



Step 4: BLOOD IN. 3-way tap turned **OFF** to blood transfusion. **ON** to baby (Primary)



Blood Specimens to be taken during the procedure

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 Care

- Monitor vital signs and record 30 minutely for the first 4 hours.
- Continue phototherapy and take a SBR 2 hours post-procedure. Further SBR levels as indicated.
- Observe the infant's behaviour and catheter sites for bleeding or signs of infection.
- PGL as indicated.
- Keep infant NBM for at least 4 hours post exchange transfusion, or longer if needed. Exchange transfusion carries a potential risk of necrotising enterocolitis (especially in the preterm infant) therefore monitor the abdomen and bowel sounds. Observe for signs of feed intolerance when feeding is recommenced.

Follow-up after Discharge

Arrange referral to the Group C Follow Up Program (health.wa.gov.au)

Related CAHS internal policies, procedures and guidelines

Blood components and Blood Products (health.wa.gov.au)

For 3B PCH also see: PCH Transfusion Medicine Protocols

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.

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Endorsed by:	Neonatal Coordinating Group		
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Healthy kids, healthy communities

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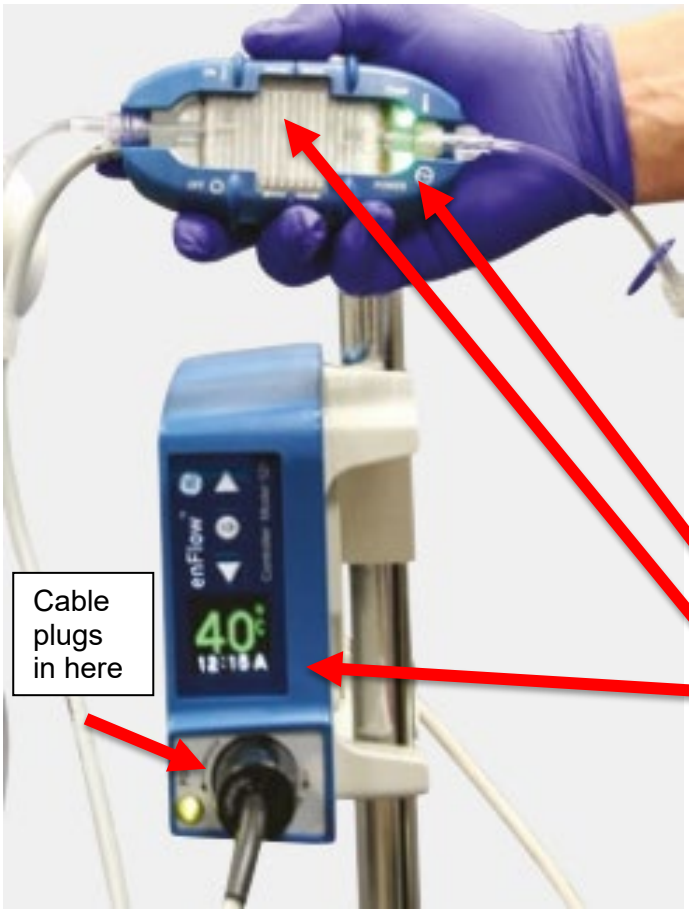
Neonatology | Community Health | Mental Health | Perth Children's Hospital

Appendix 1 - ENFLOW BLOOD WARMER INSTRUCTIONS

The enFlow IV fluid/blood warming system consists of the enFlow Warmer (Model 100 series), the enFlow Controller (Model 121 series), the enFlow Disposable Cartridge with IV extension set (Model 202) or without IV extension set (Model 200).

Designed to deliver blood and intravenous fluid at a consistent normothermic temperature. The disposable cartridge allows the IV fluid to reach temperature in seconds, thus minimising prep and waiting time, fluids will be warmed in seconds from being turned on. Flow rates from 'Keep Vein Open' (KVO defined as 2 mL/min) to 200 mL/min with input fluid temperature of 20 °C.



- The blood warming device and all exchange equipment and circuits are kept in the 3B storeroom.
- Spare devices are kept in the Equipment Library and need an Agility request completing to obtain the device
- Theatre, PICU and ED use the same device if you need advice or an urgent circuit.

You will need the following:

- EnFlow Warmer Unit/Cable
- EnFlow Warmer Cartridge
- EnFlow Controller Unit
- IV Giving Set
- Extension Set, if the infusion rate is less than 50ml/h

Note: In order to maintain the fluid temperature, it is recommended that the warmer be positioned as close to the site of infusion as possible. The warmer unit has a clip on the cable that is designed to secure the IV line, in order to prevent it kinking. There is also a clip on the cable so that the warmer can be secured to the bedding etc.

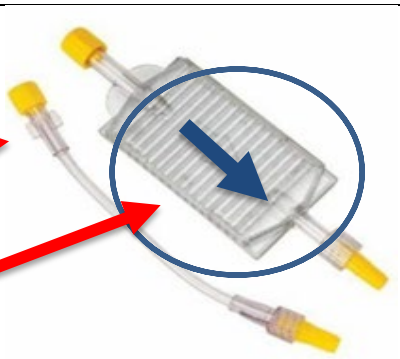
EnFlow Control Unit Set Up.

STEP 1

- Plug the warmer unit/cable into the controller unit, making sure that the connector is pushed in firmly and twist to lock.
- Connect the unit to a suitable power outlet.
- Turn ON - the switch is located at the back of the unit.

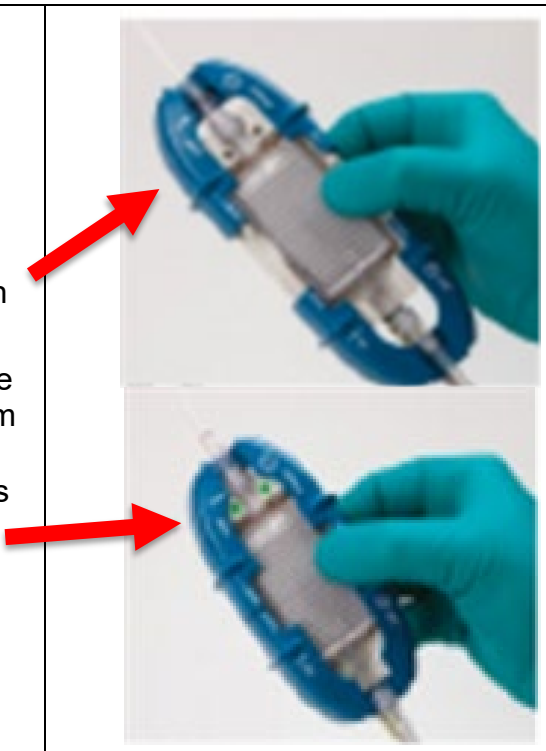
STEP 2

- Connect the warmer cartridge to the giving set and attach the small extension.
- The cartridge has an arrow on the front which shows the travel direction of fluid to the patient.



STEP 3

Holding the cartridge with the arrow pointing upwards prime slowly making sure that all air is removed from the cartridge and the line.

STEP 4 • Place the cartridge within the warmer unit, aligning the bevelled edge of the cartridge with that of the warmer. • Slide the door inwards to close. As soon as the doors are closed the warmer will begin to warm the fluid/Blood. • To remove the cartridge simply open the doors and remove. (opening the warmer cover and removing the cartridge will stop the heating function, but not the flow.)	

Electromagnetic interference

- ECG, EEG or EMG (cardiac or neuro monitoring) artifact or other interference caused by the enFlow is an uncommon event.
- Cardiac or neuro monitoring interference is common and well-documented in medical literature.

"Interference of the monitored or recorded electrocardiogram is common within operating room and intensive care unit environments." 1 The enFlow IV fluid/blood warming system, as with all electrical devices, can be associated with some electromagnetic interference (EMI); however, it has been uncommon and inconsistently experienced.

After Use

- Turn OFF the power switch.
- Remove the EnFlow cartridge and dispose of set in medical waste *(Yellow bin).*
- Wipe down the external surfaces of the EnFlow Warmer cable and Control unit, as per cleaning guidelines.

Appendix 2 - BIEGLER BW 585 BLOOD WARMER INSTRUCTIONS

- Fix to IV stand and connect to power supply
- Once standby light is lit - use ▲ and ▼ arrows to set temperature for blood warming. Set at 37°C (adjustment can only take place in standby mode)
- To heat unit, press power button - should reach target temperature within 1 minute
- Prepare infusion and position tubing in the grooves of heat exchanger.
- Measure 80cm of extension set from patient end of line. At this point start from the rear of the warmer, gently pull the extension tube and coil it forward in a counter clockwise direction. The tube must be completely inserted into the groove.
- Do not increase the distance between the blood warmer and patient beyond 80cm.

Alarms

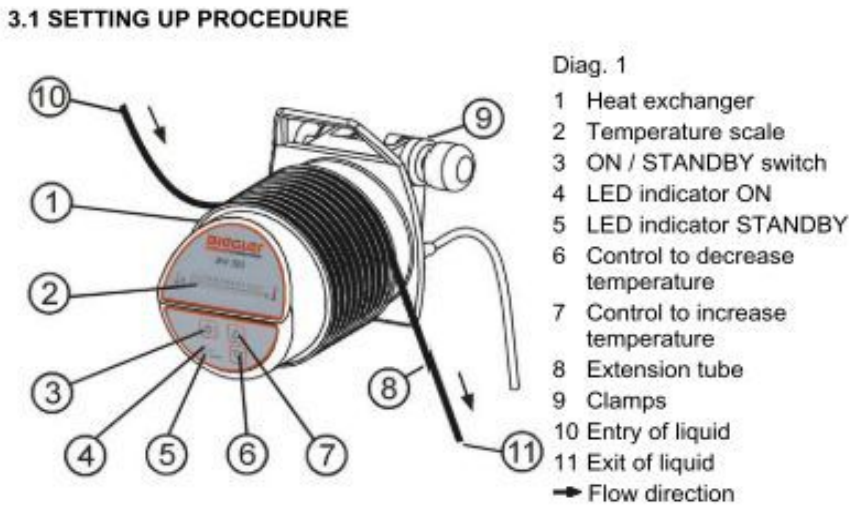
Are preset:

- Low at 36.5°C
- High at 42°C

To reset alarms disconnect device from power supply.

At cessation of treatment

- Switch to standby mode
- Release pressure from system by switching off infusion pumps and disconnecting system as far as possible
- Remove material from heat exchanger
- Disconnect device from power supply and wipe clean



Appendix 3 - BIEGLER BW 685S BLOOD WARMER INSTRUCTIONS

- Fix firmly to IV stand and connect to power supply
- Once standby light is lit - use ▲ and ▼ arrows to set temperature for blood warming - should be set at 37°C (adjustment can only take place in standby mode)
- To heat unit, press power button - should reach target temperature within 1 minute

- Prepare infusion and position tubing in the grooves of heat exchanger. Measure 80cm of extension set from patient end of line. At this point start from the rear of the warmer, gently pull the extension tube and coil it forward in a counter clockwise direction. The tube must be completely inserted into the groove.
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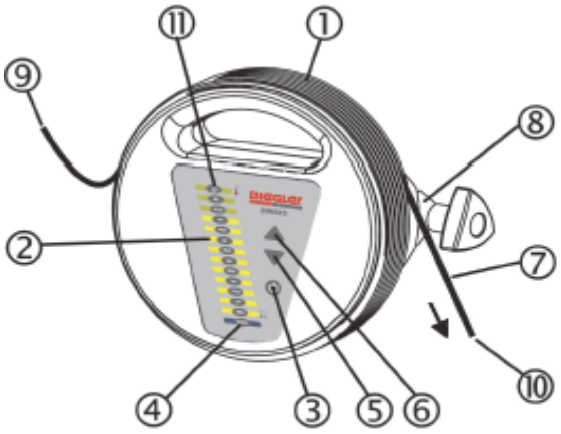

Fig. 1
1 Heat exchanger
2 Temperature scale
3 ON / STANDBY button
4 LED STANDBY
5 Button to reduce the temperature
6 Button to increase the temperature
7 Extension tube
8 Fastening clamp
9 Fluid entry point
10 Fluid exit point
11 Alarm LED
→ Flow direction