

Newborn Critical Care Center (NCCC) Clinical Guidelines

Exchange Transfusion Guidelines

Exchange transfusion is a potentially life-saving intervention that involves removing aliquots of the neonate's innate blood and replacing with donor blood in order to remove abnormal blood components and circulating toxins whilst maintaining adequate circulating blood volume. In the case of the neonate, this procedure is primarily performed to remove antibodies and excess bilirubin.

INDICATION

I. **Know** the Reason for Giving an Exchange Transfusion

- A. Hyperbilirubinemia
- B. Polycythemia
- C. Hemolytic disease
- D. Severe anemia with congestive heart failure
- E. Uncommon reasons:
 - 1. Congenital leukemia/hyperleukocytosis
 - 2. Extreme thrombocytosis
 - 3. Neonatal hemochromatosis
 - 4. Hyperammonemia
 - 5. Severe hypertriglyceridemia or hyperlipidemia
 - 6. Lead poisoning
 - 7. Renal failure
 - 8. Drug overdose or toxicity
 - 9. Removal of antibodies and abnormal proteins
 - 10. Neonatal sepsis or malaria

PREPARATION

II. **Identify** Critical Personnel

- A. Two medical providers
 - 1. Attending, Fellow, Nurse Practitioner, Resident
 - 2. Ideally two providers remain at the bedside during the procedure
 - 3. Responsibilities:
 - a. Ordering the blood
 - b. Calculating the appropriate volume for the exchange
 - c. Determining the most suitable exchange method
- B. One registered nurse
 - 1. Bedside nurse and/or charge nurse
 - a. Nursing may rotate; however, one must remain at the bedside at all times
 - b. Infant should be a one-to-one assignment

2. Responsibilities:

- a. Maintain sterile bubble throughout the entire exchange
- b. Document exchange volumes in EPIC during the procedure
- c. Record all pertinent times accurately
- d. Obtain labs prior to, during, and at the end of the exchange
- e. Maintain 2 PIVs throughout the procedure

III. **Before** the Procedure

Notify Transfusion Medicine Fellow via paging system AS SOON AS exchange transfusion is considered, given the labor-intensive setup and preparation of blood products.

- A. Obtain consent from parents for administration of blood products
- B. Order the blood
 1. Ensure the infant has a resulted Type & Screen AND ABO type check
 2. Preparing the blood will take a minimum of 4 hours, often longer (especially at night)
 3. Blood should be < 7 days old
 4. Blood should be irradiated just prior to exchange (< 24 hours)
 5. Hematocrit of donor (if known): Hct of 40-45% preferred when indication is hyperbilirubinemia
 6. Check potassium level of donor blood if the patient has hyperkalemia or renal compromise
- C. Infant should be NPO at least 4 hours before the procedure. Place orogastric tube prior to procedure. Remove gastric contents and leave on open drainage.
- D. Volume
 1. When possible, use no more than one whole unit of blood (~300 mL per UNC Blood Bank) to minimize donor exposure.
 2. Infant blood volume
 - a. **TERM** infant = 80 mL/kg
 - b. **PRETERM** infant = 100 - 120mL/kg
- E. Calculations

DOUBLE VOLUME = 2 x infant's blood volume
(exchanges ~ 85% of total blood volume)

SINGLE VOLUME = infant's blood volume
(exchanges ~ 60% of total blood volume)

PARTIAL EXCHANGE (SEVERE ANEMIA):

$$\text{Volume} = \frac{\text{infant's blood volume} \times (\text{Hgb desired} - \text{Hgb initial})}{\text{Hgb of pRBC} - \text{Hgb initial}}$$

PARTIAL EXCHANGE (POLYCYTHEMIA):

Optimal dilutional fluid is normal saline rather than plasma or albumin

$$\text{Volume} = \frac{\text{infant's blood volume} \times \text{desired change in Hct}}{\text{Initial Hct}}$$

Order “over-fill” of at least 30 mL to account for priming the tubing and blood warmer

F. Access

1. **TERM** infant

- a. Venous - 8 Fr single lumen catheter preferred; may place a 5 Fr if unable to obtain 8 Fr
- b. Arterial - 5 Fr single lumen catheter preferred; may place 3.5 Fr if unable to obtain 5 Fr

2. **PRETERM** infant (< 1500 grams)

- a. Venous - 5 Fr single lumen catheter preferred; may place a 3.5 Fr if unable to obtain 5 Fr
- b. Arterial - Must place at least a 3.5 Fr arterial line; DO NOT place a 2.5 Fr arterial line

3. Infant must have two additional peripheral access lines for:

- a. Maintenance IV fluids during the procedure
- b. Emergency / intermittent medications given during the procedure

4. Confirm correct placement of catheters via radiograph

G. Methodology

1. Single Catheter Exchange

[“Push – Pull” Method](#)

- a. Venous access only
- b. **Never** arterial access

2. Dual Catheter Exchange

[“Isovolumetric” Method](#)

- a. Venous (UVC / PIV) and Arterial (UAC / PAL) access
- b. **DO NOT USE A DOUBLE LUMEN UVC**

H. Laboratory Values (*see table on next page*)

- 1. Order entire laboratory panel prior to beginning the procedure
- 2. Nursing to obtain and be responsible for sending samples to core lab

LABORATORY EVALUATION SCHEDULE <i>Order ALL labs STAT prior to beginning procedure</i>			
PRE-PROCEDURE	HALFWAY POINT <i>(Determined by number of passes completed/volume of blood exchanged)</i>	POST-PROCEDURE	FOUR (4) HOURS POST PROCEDURE
Arterial blood gas (VBG if only venous access) iCal	Arterial blood gas (VBG if only venous access) iCal	Arterial blood gas (VBG if only venous access) iCal	Arterial blood gas (VBG if only venous access) iCal
Basic Metabolic Panel Glucose	Basic Metabolic Panel Glucose	Basic Metabolic Panel Glucose	Basic Metabolic Panel Glucose
CBC with differential	CBC with differential	CBC with differential	CBC with differential
Neobilirubin			Neobilirubin
Coagulation Studies: PT PTT INR Fibrinogen			

IV. **Gather Supplies** for Procedure

A. One Neonatal Exchange Transfusion Kit (Marian Medical Inc)

1. Shuttle
2. 20mL syringe (for donor blood obtainment and distribution)
3. 10mL syringe (for withdrawal and waste of patient's blood)
4. Waste bag
5. Blood tubing extension set
6. Blood tubing with spike and blood micro-filter

B. Use full barrier sterile precautions (sterile gloves and gown, hat, mask)

V. **Set-Up** the Equipment

A. Setup for [Push-Pull Method Using a Single Catheter](#)

B. Setup for [Isovolumetric Transfusion Using Two Catheters](#)

1. Two providers
 - a. One provider removes/wastes infant's blood from the arterial access
 - b. One provider administers fresh blood through the venous line
2. One provider and intravenous pump
 - a. The provider removes/wastes infant's blood from the arterial access
 - b. The pump is programmed to continuously deliver the blood aliquot over set amount of time

PROCEDURE

VI. **Responsibilities**

A. **NURSING** responsibilities

1. Spike the donor blood bag with the blood tubing micro filter extension

2. Prime the blood tubing all the way to the end of the extension tubing
3. Ensure continuous pulse oximetry and cardio-respiratory monitoring
 - a. Obtain and record baseline vital signs
 - Temperature
 - Heart rate
 - Respiratory rate
 - Cuff blood pressure (preferably right upper extremity)
 - SpO2
 - b. Obtain and record vital signs every 15 minutes during procedure
 - c. Check peripheral glucose levels every 60 minutes during procedure.
4. Verbalize, record, and document the following:
 - a. One cycle:
 - Time patient's blood is removed
 - Volume of patient's blood removed
 - Time the donor blood is given
 - Volume of the donor blood given
5. Record time with a stopwatch or using the Apgar timer
 - a. **Push / Pull Method**
 - One cycle should equal ~ 5 minutes
 - Volumes will be equivalent though not synchronously withdrawn and given
 - b. **Isovolumetric Method**
 - One cycle should equal ~ 5 minutes
 - Cycles should remain synchronous
 1. If using a pump rather than the 2nd provider, the provider removing the blood must match the rate/volume of the blood being administered.
 2. If using a second provider, removal and administration should remain synchronized throughout.
6. Agitate the blood bag every 10 to 15 minutes to avoid red cell sedimentation
7. Obtain all laboratory values as required (See [Laboratory Schedule](#))
 - a. Additionally, obtain POC blood glucose values every 30-60 minutes
8. Participate in "call back" during the exchange to verify direction and flow of blood

REMEMBER:

Each cycle should take ~ 5 minutes. Do not replace more than 5 mL/kg per cycle.

B. PROVIDER responsibilities

1. Determine the number of passes needed to exchange the desired volume of blood
 - a. **Isovolumetric Method**
 - **TWO** provider method
 1. The number of passes should be calculated and the bedside nurse will update the providers throughout the procedure

- **ONE** provider and syringe pump
 1. Place a stopcock with 7-inch extension set in between the blood tubing (past the filter) and venous access point
 2. Attach a 60 mL syringe to the 7-inch extension set
 3. Calculate the blood infusion rate:

$$\text{Volume per pass (5 mL/kg) x 12 (5 min passes) = mL/hr}$$

4. The system will remain closed. The nurse will monitor the volume of blood remaining in the syringe. When necessary, pause the pump between passes to allow the nurse to draw up additional fresh blood in the syringe, restarting the pump with the next pass. The provider will pause during this time as well.
- b. **Push / Pull Method**
 - One provider will withdraw and administer blood in designated aliquots for the calculated number of passes
 - Providers may need to trade out during the procedure
2. Connect the pieces of the exchange transfusion set
 - a. Single lumen = single shuttle device
 - b. Double lumen = divide shuttle device into two sections
 3. Connect blood extension tubing (fully primed by nursing) to the shuttle
 4. Connect syringes, secondary extension, waste bag
 5. If infant is **hypovolemic** or has low CVP, start the exchange by transfusing the aliquot into catheter. If infant is **hypervolemic**, start by withdrawing precalculated aliquot.
 6. Collaborate with the team (second medical provider and nurse) to ensure clear communication with regard to the following:
 - a. Time patient's blood withdrawn
 - b. Volume of patient's blood withdrawn
 - c. Time of donor blood withdrawal
 - d. Volume of donor blood given
 7. Maintaining access:
 - a. If the exchange transfusion will be stopped for > 3 minutes, the umbilical lines need to be flushed and heparinized to prevent clot formation
 - b. Intermittently flush arterial line with heparinized saline to clear (heparin solution remaining in tubing will be removed with next withdrawal, reducing the total heparin dose received by the patient)

VI. **Post Exchange Transfusion**

1. Flush the catheters completely and heparinize per unit policy
2. Obtain [LABS](#) upon completion of procedure and four hours after the procedure is complete
3. Obtain and record vital signs every 30 min x 4; then every 1 hour until 4-6 hours after the exchange has been completed
4. Follow glucoses every 2 - 4 hours for the next 24 hours
5. Keep infant NPO for a minimum of 4 hours

- a. Restart enteral feeds when clinically stable
- b. Record/monitor abdominal girth and bowel sounds every 4 hours during the next 24 hours
- c. Monitor for signs of feeding intolerance

VII. **Complications**

A. Metabolic:

1. Hypocalcemia
2. Hypo or hyperglycemia
3. Hyperkalemia
4. Metabolic acidosis

Plan: Have electrolyte infusions readily available

B. Cardiorespiratory:

1. Apnea, bradycardia, desaturation events
2. Hypotension or hypertension

Plan: Have intubation/ventilation supplies and cardioversion/defibrillation equipment available

C. Hematologic:

1. Thrombocytopenia
2. Dilutional coagulopathy / DIC
3. Neutropenia

Plan: Anticipate potential need for additional blood products

D. Vascular (catheter-related)

1. Vasospasm
2. Thrombosis
3. Embolization

Plan: If unable to withdraw from the line during the procedure, pull the catheter back to 5 cm ("low lying" position) and finish the procedure

E. Gastrointestinal:

1. Feeding intolerance
2. Ischemic injury
3. NEC

Plan: Carefully restart trophic feeds four hours post-transfusion at the earliest

F. Infection:

1. Omphalitis
2. Septicemia

Plan: Sepsis evaluation with potential for antibiotic therapy

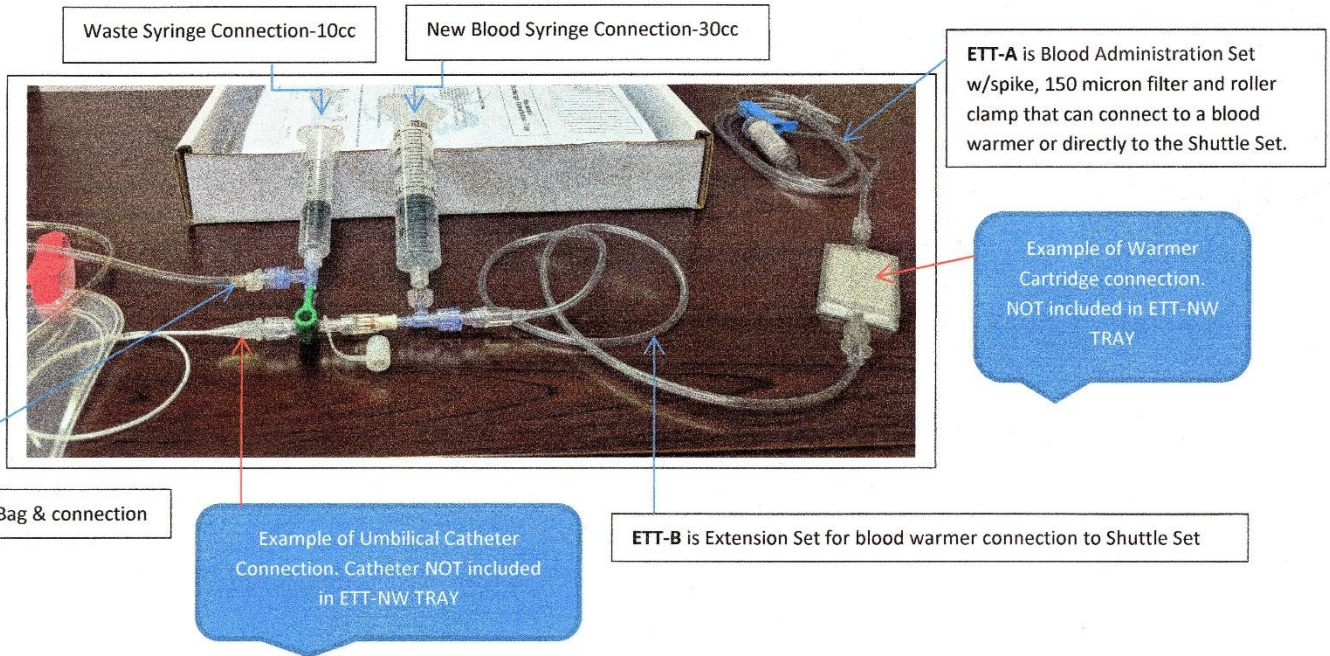
VIII. **Documentation**

- A. Document the exchange transfusion in a procedure note.
- B. Documentation should include the volume of blood exchanged over the period of time exchanged, and the types of catheters used.

Reference:

MacDonald's Atlas of Procedures in Neonatology, Sixth Edition. Ed. MacDonald, M.G., Ramasethu, J. & Seo, S. Lippincott Williams & Wilkins. Philadelphia, PA.2020.

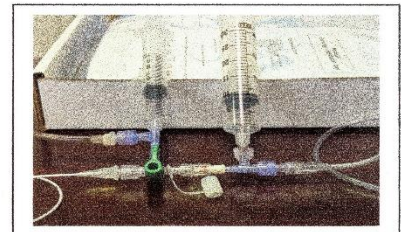
Exchange Transfusion Tray-Single Catheter Diagram



Part Number: ETT-NW

Neonatal Exchange Transfusion Tray

- 1 CSR Wrap
- 4 Documentation Sheets
- 1 Blood Tubing 67" w/bag spike and 150 micron filter
- 1 Blood waste bag w/Velcro loops
- 1 Extension set with MLL and FLL on opposite end
- 1 Shuttle Set
- 1 Syringe 10ml
- 1 Syringe 30ml
- 1 Label for Waste Blood Syringe
- 1 Label for New Blood Syringe



SS-1660.13 is the Shuttle Set diagram for single catheter exchange

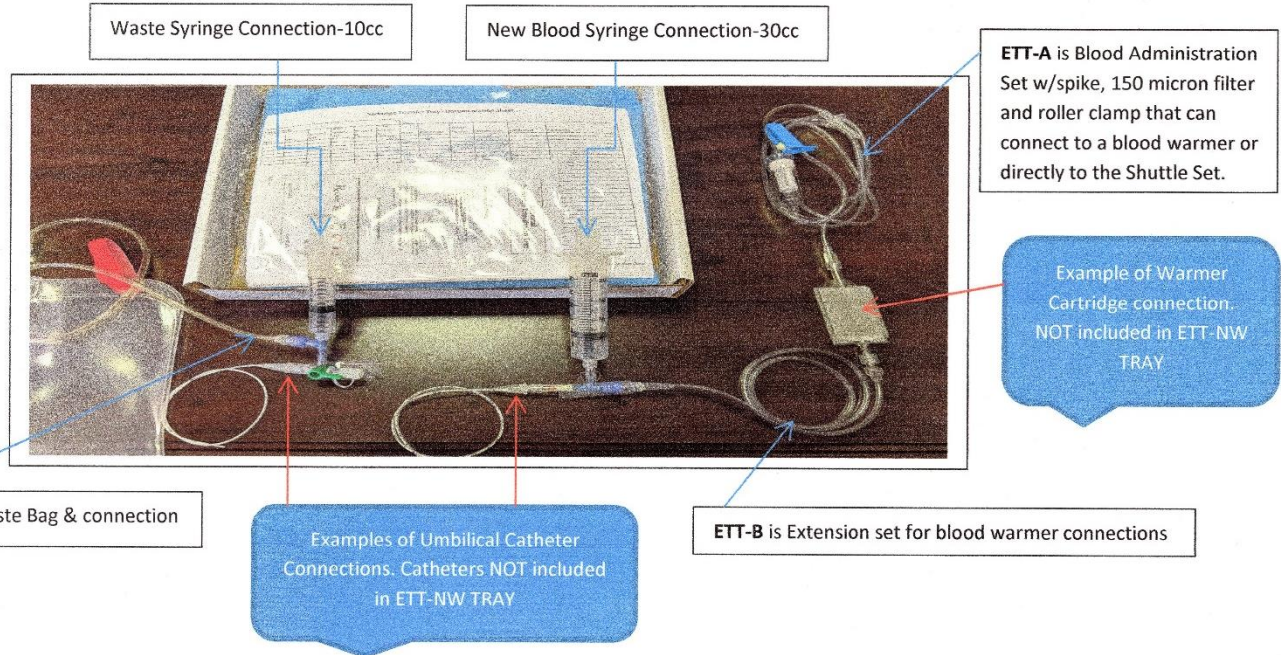
**Ensure ALL connections are tight before starting the exchange transfusion. Note: Over tightening the Shuttle Set can crack or break the Set.*

- Standard clinical or hospital protocol must be established and performed by persons trained in the procedure and knowledgeable of the inherent risks.
- Do not use if package has been opened or damaged.
- Follow physician's instructions in opening package and using contents.
- Sterile, Latex Free, Non-DEHP

Warning: Umbilical catheters should NOT be left in place between procedures. **Caution:** Blood administration set should not be used if protectors are not in place. Do not allow air to be trapped in the line/set. Do not puncture blood chamber or tubing because that could cause an air embolism. Use aseptic technique and ensure ALL connections are tight. Note: Over tightening the Shuttle Set can crack/break the set.

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Exchange Transfusion Tray-Dual Catheter Diagram

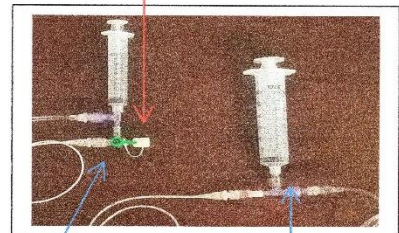


Part Number: ETT-NW

Neonatal Exchange Transfusion Tray

- 1 CSR Wrap
- 4 Documentation Sheets
- 1 Blood Tubing 67" w/bag spike and 150 micron filter
- 1 Blood waste bag w/Velcro loops
- 1 Extension set with MLL and FLL on opposite end
- 1 Shuttle Set
- 1 Syringe 10ml
- 1 Syringe 30ml
- 1 label for Waste Blood Syringe
- 1 Label for New Blood Syringe

Note: Close the tethered cap to prevent waste blood from leaking out.



SS-1660.13 is the Shuttle Set diagram for dual catheter exchange transfusion.

**Ensure ALL connections are tight before starting the exchange transfusion. Note: Over tightening the Shuttle Set can crack or break the Set.*

- Standard clinical or hospital protocol must be established and performed by persons trained in the procedure and knowledgeable of the inherent risks.
- Do not use if package has been opened or damaged.
- Follow physician's instructions in opening package and using contents.
- Sterile, Latex Free, Non-DEHP

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