EXCHANGE TRANSFUSION

UPMC Division of Newborn Medicine
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DEFINITION

- Exchange Transfusion:

Replacing an infant’s blood volume with donor blood or crystalloid by repeatedly removing and replacing small aliquots over a short period of time

Infant blood volume = 85-100 ml/kg

INDICATIONS for Exchange Transfusion

- Hazardous hyperbilirubinemia
- Advanced bilirubin encephalopathy
- Severe anemia
- Polycythemia
- Disseminated intravascular coagulation (DIC)
- Congenital leukemia
- Metabolic toxins
- Drug overdose or toxicity
- Removal of antibodies and abnormal proteins
CONTRAINDICATIONS

• When RISK > BENEFIT

• When simple transfusion or phototherapy would be just as effective with less risk

EQUIPMENT

• Necessary line kits to establish access
• Blood warmer
• Fluid warming tubing set
• Exchange transfusion tray
• Pall filter with secondary set for blood
• Appropriate blood products
• Syringes and tubes for blood tests
• Linen pack (Sterile gowns, hats, masks, gloves)

PREPARATION OF BLOOD

• Obtain IV pole
• Attach blood warmer to IV pole
• Slide warming flat fluid pathway into blood warmer
• Connect tubing in the following order:
  1. Blood bag to Pall filter
  2. Pall filter to secondary set (or blood tubing from exchange kit)
  3. Secondary set to short end of fluid warmer tubing
  4. Prime tubing and ensure all air is expelled
Blood/Fluid Warmer

Empty Warmer

Warmer with tubing inserted

Tubing MUST be inserted BEFORE priming

Blood for Exchange

Blood - Requires two RN for double check

Pall filter to unit of blood

Priming of Tubing with Blood
FORMULAS to determine amount of fluid required for exchange

- Infant blood volume = 85-100 ml/kg
  - Preterm = 100 ml/kg
  - Term = 85 ml/kg
- Single volume exchange exchanges ~ 60% of blood volume
- Double volume exchange exchanges ~ 85% of blood volume

Why is an exchange effective?

In a single volume exchange, ~ 60% of the infant's blood volume is replaced (blue lines).

In a double volume exchange, ~ 85% of the infant's blood volume is replaced (green lines).

Exchange Transfusion for Severe Anemia

- SINGLE VOLUME exchange transfusion is standard for ANEMIA
- Uses PRBCs as replacement
- Need to account for Hct of the unit of PRBC used
- Formula for calculation of volume of exchange

\[
\text{Volume of Exchange} = \frac{\text{Total blood volume} \times \frac{\text{Desired Hct} - \text{Observed Hct}}{\text{Hct of unit} - \text{Observed Hct}}}{\text{Hct of unit} - \text{Observed Hct}}
\]
Exchange Transfusion for Polycythemia

- SINGLE VOLUME exchange is standard for POLYCYTHEMIA
- Used for Hct >70% or
- Hct > 65% with symptoms
- Goal to normalize Hct to < 60%
- Isotonic crystalloid solution is infused as blood is removed
- Formula for calculation of volume of exchange

\[
\text{Volume of Exchange} = \frac{\text{Total blood volume} \times (\text{Observed Hct} - \text{Desired Hct})}{\text{Observed Hct}}
\]

Exchange Transfusion for Hazardous Hyperbilirubinemia and Acute Bilirubin Encephalopathy

- DOUBLE VOLUME EXCHANGE formulas are:
  - Preterm = 2 x 100 ml x weight in kg
  - Term = 2 x 85 ml x weight in kg
- During procedure do not exceed 5 ml/kg per each push-pull cycle and each cycle should last approx. 2-3 minutes
  - May use a smaller volume at onset and increase as tolerated
- Request HCT of PRBC to be ~ 40
- Blood should be cross matched, fresh (<72 hours old), CMV risk reduced, irradiated, sickle negative, leukoreduced

PROCEDURE for Exchange Transfusion

- Ensure patient appropriately monitored
- Ensure access for exchange transfusion in place
  - UAC and UVC (use with standard stopcocks)
  - Can be done with only UVC (use with special stopcock from exchange tray or two 3 way stopcocks in tandem)
    - Adverse events have been reported to be higher in the UVC/UAC method then with a single line
- Check blood according to hospital policy
EXCHANGE TRAY

- Exchange tray is opened by physician/NNP
- Request that physician/NNP assembles discard bag and straight tubing from inside exchange tray
- Physician/NNP attaches DISCARD BAG and tubing to appropriate stopcock
  - Standard stopcock if using two lines (UAC/UVC) goes to UAC line
  - Special stopcock if using single line (UVC/central line)
  - Two 3 way stopcocks in tandem if using a single line (UVC/central line)

BLOOD TUBING

- Blood tubing is attached to stopcock
  - Standard stopcock if using two lines (UAC/UVC) goes to UVC line
  - Special stopcock if using single line (UVC/central line)
  - Two 3 way stopcocks in tandem if using a single line (UVC/central line)

Special 4 way stopcock

Special four-way stopcock
(1) male adapter to infant line.
(2) female adapter to waste container.
(3) attachment to blood tubing.
(4) off position (180 degrees from adapter to waste container), allowing injection through rubber-stopped port below syringe.

The stopcock is used in clockwise rotation when correctly assembled.
Two 3 way Stopcocks in Tandem

PATIENT PREPARATION

• Prepare patient on warmer bed or isolette
• Make sure patient is NPO for procedure and preferably 4 hours prior to procedure
• Consider PIV for maintenance fluids and medications – Obtaining placement of PIV should not delay exchange transfusion
• Review hospital policy for procedure

TECHNIQUE for EXCHANGE TRANSFUSION

• PUSH-PULL with TWO LINES
  – INFUSION via VENOUS line
  – REMOVAL via ARTERIAL line
• Using special stopcock
  – Review positions
  – Rotate clockwise
    • Withdraw from patient
    • Clear to waste bag
    • Draw new blood
    • Infuse into patient
LAB STUDIES

• Pre-transfusion
  – Tests based on clinical indications for diagnostic reasons
  – Bilirubin
  – CBC with differential, platelets
  – Reticulocyte count
  – Complete metabolic profile
  – Coagulation profile
  – Blood gas
  – Ionized Calcium
  – Glucose
  – Newborn screen

• X-rays for line placement

LAB STUDIES

• During Transfusion
  – Glucose every 30 minutes
  – Ionized calcium
  – Additional labs as clinically indicated

• After Transfusion
  – Bilirubin
  – Hbg, Hct, platelets
  – Reticulocyte count
  – Electrolytes
  – Blood gas
  – Ionized calcium
  – Glucose
  – Additional labs as clinically indicated

COMPLICATIONS

• Hypocalcemia
• Hypoglycemia
• Hyperglycemia
• Hyperkalemia
• Thrombocytopenia
• Neutropenia
• Umbilical artery or vein thrombosis
• Vasospasm

• Apnea
• Hypotension
• Hypertension
• Bradycardia
• IVH
• Air embolization
• Infection
• NEC
In I-view select special procedures band and then exchange transfusion to document. Record amount of blood in and blood out. You will need to change the time frame to every 5 minutes. Record frequent vital signs during the exchange procedure.

An exchange transfusion record is included in the exchange transfusion tray. Record the times and corresponding amounts of blood in and blood out. You can use this sheet but will need to transfer the information into the EMR.

A Comment on Calcium

• Donor blood contains citrate that can bind ionic Ca and Mg

• This Ca-chelating effect can produce significant hypocalcemia
When to Give Calcium

• Rapid infusion of Ca can cause severe bradycardia and should only be given if clinically indicated
  – Documented hypocalcemia
  – Changes in the Q-T interval
  – In rare instances a patient may show symptoms of hypocalcemia such as agitation and tachycardia during an exchange and may not reliably correlate to low iCa levels

• You are now ready to participate in an exchange transfusion simulation