

Review article

Neonatal Exchange Blood Transfusion: A Reliable Method in Hemolytic Diseases

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Abstract

An exchange transfusion involves removing almost whole of patient blood and substitution with donor blood so as to get rid of abnormal blood constituents and existing toxins while maintaining adequate circulating blood volume. It is primarily performed to remove antibodies and excess bilirubin in isoimmune disease, the incidence of exchange transfusion is decreasing secondary to the prevention, and improved prenatal management of alloimmune hemolytic disease and improvements in the management of neonatal hyperbilirubinaemia. Exchange transfusion involves the consequent withdrawal and injection of aliquots of blood, through arterial and venous lines, either peripheral or central. The volume of blood for exchange is calculated using an estimate of the neonate's existing blood volume. Double volume, single volume and partial exchange transfusions are available. The most usually reported adverse events during or soon after exchange transfusion are umbilical or peripheral access device related complications; air emboli; thrombosis; hemorrhage. Other potential complications related to exchange transfusion are arrhythmias, bradycardia, and septicemia, blood born infection and hypo or hyperthermia.

Keywords: Exchange blood transfusion, Alloimmune Hemolytic diseases.

Introduction

Exchange blood transfusion is the most reliable and effective method for reduction of bilirubin level in case of hyperbilirubinemia to prevent kernicterus and anemia. Early exchange reduces the need for subsequent exchange and improves congestive cardiac failure in hydropic infants. Double volume exchange transfusion is mainly used for the management of hyperbilirubinaemia and haemolytic disease of the newborn, when other methods of treatment such as early and intensive use of phototherapy have been ineffective [1].

Indications

- 1 Alloimmune haemolytic disease of the newborn
- 2 Remove bilirubin in the blood circulation to reduce levels and prevent kernicterus
- 3 Replace antibody-coated red cells with antigen-negative red cells

Severe hyperbilirubinaemia secondary to alloimmune haemolytic disease of the newborn is the most common reason for exchange transfusion in the neonatal intensive care unit.

1. Significant unconjugated hyperbilirubinaemia with risk of kernicterus due to any cause when intensive phototherapy is unsuccessful
2. Severe anaemia (when there is normal or

increase in current blood volume)

3. Antibodies in maternal autoimmune disease
4. Polycythaemia (to reduce haematocrit, usually achieved with partial exchange transfusion using normal saline replacement)

Aims of an exchange transfusion

1. To lower the serum bilirubin level and reduce the risk of brain damage (kernicterus);
2. To remove the infants' affected red blood cells and circulating maternal antibodies to reduce red cell destruction;
3. To correct anaemia and treat any potential for heart failure whilst maintaining euvolemia[2]

Nature and amount of blood for EBT

- **In Rh-isoimmunization-** Rh-negative, ABO compatible blood is used
- **In ABO-incompatibility-** O group, Rh-compatible blood is used
- Have a known haematocrit of 0.5-0.6
- Appropriate group based on infant and maternal blood group and antibodies
- Negative for antigens determined by maternal antibodies
- Leukocyte depleted
- Irradiated and used within 24 hours of irradiation
- CMV negative
- As fresh as possible (ensure at least less than 5 days old)

Fresh blood collected less than 72 hours is preferred and quantity used is 160-180ml/kg for one exchange transfusion to replace 80-90 percent of fetal blood.

Volume of RBCs and FFP to be ordered

The volume required is related to the reason for exchange and is determined by the formula below.

- 1. Single volume exchange** (anaemia with normovolaemia)-*Estimated blood volume* is calculated by gestational age and timing of cord clamping ranging from 53 - 105 ml/kg/min. Mean blood volume was seventy ml/kg (early umbilical cord clamping) versus 90ml/kg (delayed umbilical cord clamping for infants having 480-2060g weight).

Estimated single blood volume = 85ml x weight (kg)

- 2. Double volume exchange** (for established hyperbilirubinaemia or to prevent hyperbilirubinaemia) Estimated double volume to be exchanged (ml) = estimated blood volume x two x infant weight (kg)
Preterm/Term baby = 85ml x 2 x weight (kg) = 170 ml x weight (kg)

Double volume exchange removes more than 80% of the infant's red blood cells. At the end of the exchange blood transfusion the bilirubin should be about half of pre exchange level. It will replace at about 4 hours to 2/3rds the pre-exchange level [3].

- 3. Partial exchange transfusion** (for polycythaemia using normal saline) where desired haematocrit following exchange transfusion is 0.55, the volume of exchange (mls) can be estimated by (actual Hct - desired Hct) x (infant's blood volume) ÷ actual Hct

Notes

- levels in the first 24 hours are less certain due to a wide range of physiological and pathological problems and a range of responses to phototherapy
- immediate exchange transfusion is recommended in infants showing signs of acute bilirubin encephalopathy or if total serum bilirubin is > 85 micromol/L above these levels
- risk factors include alloimmune haemolytic disease, G6PD deficiency, asphyxia, significant lethargy, temperature instability, sepsis and acidosis

- use total serum bilirubin

Procedure

Access for procedure:

Usually a 5 FG umbilical catheter is placed to a level that allows free flowing withdrawal of blood .

Isovolumetric exchange

- The preferred method in this nursery is the **isovolumetric or simultaneous exchange** where access is via an umbilical venous catheter (blood in) and an umbilical arterial catheter (blood out).
- If either umbilical vessel is not available then the **RBCs** can be withdrawn via a peripheral arterial cannula and donor RBCs / FFP infused through a venous cannula [4].
- Using this method the RBCs are slowly withdrawn from the umbilical arterial catheter (or peripheral arterial line) in pre-determined aliquots with simultaneous replacement of donor RBCs / FFP through the umbilical venous line (or peripheral venous line) using the same aliquot size.. The process should not be hurried and should take a minimum of two hours or more depending on the volume of blood to be exchanged.

Push pull method

- When using the same catheter that is the RBCs / FFP are pushed in and pulled out through the same umbilical venous catheter. The least time for this procedure is 2 hours or it depends on the volume of blood to be exchanged.

Rate of exchange

- A suggested rate is 30 aliquots over 2 hours that is, 4 minutes each cycle. This is regardless of whether the isovolumetric or push-pull methodology is utilized.

Strict sterile technique got to be maintained throughout procedure. Record baseline observations (infant temperature, heart rate, respiratory rate, blood pressure, oxygen requirement, oxygen saturations, neurological status) prior to commencement of procedure. One medical practitioner may perform an exchange transfusion using venous 1 line technique. A second medical practitioner or experienced licensed nurse should be ready to assist in the procedure.

Exchange transfusion involves the systematic withdrawal and injection of aliquots of blood, through arterial and venous lines, either peripheral or central. Note arterial lines (umbilical or

peripheral) should only be used for withdrawal of infant blood, not for injection of donor blood. Aliquots usually tolerated for exchange transfusion-Less than 1500g - 5ml, 1500g - 2500g - 10ml, 2500g - 3500g - 15ml ,Greater than 3500-20ml. Small aliquots changed at a slower rate are usually highly tolerated by infants with vascular instability. As a guide the time for every in/out should be around 5-10 minutes (withdrawal and infusion of blood ought to be performed at the constant rate). In and out aliquots are repeated orderly till the desired volume for changed is reached. In and out aliquots should be called out, so that the nurse recording the procedure can keep an accurate tally. Always check 3-way tap settings to make sure that the blood withdrawal and infusion flows within the correct direction to stop accidental loss or infusion of blood. Blood glucose and arterial blood gas should be monitored at least pre, mid and Post Exchange and more frequently as indicated to manage metabolic and electrolyte imbalance [5].

Registered nurse ought to observe the infant throughout the exchange transfusion and record the subsequent on the Exchange Transfusion Record Sheet:

- Volume of blood withdrawn and injected at the completion of each cycle (aliquot)
- Infant's vital signs, oxygen requirement, oxygen saturations, blood warmer temperature and general condition of child- **every 15 minutes**
- If phototherapy lights remains working during procedure they should be turned off frequently to assess infant colour and general condition. Observe the child for clinical signs of complications of exchange transfusion (i.e. agitation due to hypocalcaemia, signs of hypoglycemia)
- Administration of medications as required
- Routine observations should continue to be recorded on the N ICU/ observation chart each hour as per standard procedure.

Every 100ml of blood changed, flush line with 0.9% sodium chloride, administer 1ml of 10% calcium glaciante (diluted with 1ml of Water for Injection) by slow push followed by a 0.9% sodium chloride flush. The calcium gluconate should not come into direct contact with donor red cells or clotting might occur. Monitor vital signs during calcium gluconate administration to assess the cardiac activity [5].

Note: The last withdrawal volume should be saved for Post Exchange blood tests.

Post procedure care

- Continuously monitor vital signs and record 30 minutely for first 4 hours post procedure.
- Follow routine NICU monitoring protocols
- Perform blood glucose levels soon after the procedure and then hourly till it remains stable
- Measure serum bilirubin levels one hour after exchange transfusion and repeat in every 6 hours.
- Carry on phototherapy until bilirubin levels are within normal range. Anticipate increase in serum bilirubin (up to 60% of pre-exchange level) 2-4 hours after procedure
- Observe catheter sites for signs of bleeding
- Keep neonate NBM for at least 4 hours after exchange transfusion, or longer at the direction of the medical officer. As exchange transfusion carries a possible risk of necrotizing enterocolitis (especially in the preterm baby) examine the abdomen and the auscultate the bowel sounds. Observe for signs of feed intolerance when feeding is recommenced
- Full blood examination and urea and electrolytes, haematocrit and ABG on a regular basis until infant stable (as directed by medical officer)
- The medical officer performing the transfusion should record the procedure in the progress notes

Complications

The usually identified adverse events during or immediately after exchange transfusion:

- Catheter related complications- air emboli, thrombosis, haemorrhage
- Haemodynamic complications - hypo or hypertension, intraventricular haemorrhage
- Hypo or hyperglycaemia
- Hypocalcaemia, hyperkalaemia, acidaemia

Potential complications related to exchange transfusion:

- Arrhythmias
- Bradycardia
- Neutropenia
- dilutional coagulopathy
- Feed intolerance
- necrotizing enterocolitis
- Septicaemia
- Hypo or hyperthermia

Conclusion

Exchange blood transfusion is a life saving procedure for newborns with hemolytic diseases. The experts of the field should be ready for the procedure with their knowledge and skill. Health care professionals should forecast the need for the procedure and recommend this for the needy infants. Though the procedure has complications we cannot disregard the role of this procedure in alleviating toxins and bilirubin level in blood.

Reference

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