Exchange transfusion in neonates

Introduction:
Exchange transfusion (ET) in neonates is used to treat severe hyperbilirubinaemia and anaemia secondary to haemolytic disease of the newborn (HDN). The aim is to remove antibody coated red cells and excess bilirubin and increase haemoglobin (Hb). A double volume ET (160 ml/kg) can remove 90% of the initial red cells and 50% of intravascular bilirubin. ET carries a significant risk of morbidity and mortality due to vascular accidents, cardiac complications, biochemical and haematological disturbances and a low risk of blood borne infections. The estimated mortality is 0.3%. ETs are now rarely required because of intra-uterine transfusions and maternal anti-D prophylaxis.

The need for an exchange transfusion is a consultant led decision.

Initial management if HDN is suspected or proven:
- Evidence of haemolysis antenatally - send mother’s blood for group and cross match.
- Check blood group and save for cross match, FBC, U/Es, total and split bilirubin.
- Admit baby to NICU soon after birth.
- Commence and continue multiple phototherapy. Plot serum bilirubin (SBR) on NICE charts.
- Discuss with Consultant.
- If SBR is higher than the ET threshold and evidence of isoimmune haemolysis - give IVIG 500mg/kg over 4 hours. (Vigam preferred).
- Contact blood bank and request blood for double volume ET 160ml/kg urgently and inform blood bank if baby has received intrauterine transfusions.
- If exchange transfusion likely, discuss with parents.
- Obtain arterial and venous access and check position by X-ray if umbilical lines sited (ideally aim for UAC+UVC).

Indications for exchange transfusion: (Refer NICE CG98 – appendix 1a&1b)
1. Severe hyperbilirubinaemia caused by HDN. For threshold levels see NICE charts.
2. Rate of rise in SBR > 8.5 μmol/l/hour.
3. Clinical signs of acute bilirubin encephalopathy such as hypotonia, lethargy, hypertonia, opisthotonus, irritability and high pitched cry, is an absolute indication.
4. Other conditions such as septicaemia, metabolic disease and disseminated intravascular coagulation (DIC) may worsen HDN.

Vascular access and technique: Any of the three following methods may be used.
- Continuous infusion of blood into the UVC balanced by controlled removal of blood from the UAC (the preferred method).
- Continuous infusion into a peripheral venous line and withdrawal from a peripheral arterial line. It is important to have two secure peripheral lines prior to ET.
- Serial infusion and withdrawal of blood via UVC only (need two three way taps) or double lumen UVC.

Type of blood used for exchange transfusion:
In rhesus haemolytic disease, Rh negative blood compatible with baby’s group is preferred. If group specific blood is not available, ‘O’ negative blood can be used. This should be after discussion with the consultant haematologist and neonatologist. In ABO incompatibility, use group ‘O’ blood, which is Rh specific to baby’s blood group.
Blood units kept specifically for ET are reserved for the NICU in Llantrisant. These units are prepared in CPD (citrate, phosphate, dextrose) rather than Sag M in order to minimise osmotic shifts, they have a low shelf life of only 5 days compared with normal blood units. These units are red cells in CPD (haematocrit 0.5 to 0.6), usually irradiated and negative for CMV. Once irradiated, the blood should be used within 24 hours as potassium levels rise after 24 hours. However, if the baby has received intrauterine transfusions, irradiated blood must be used until 6 months of age or until 6 months corrected age in preterm infants. This is to reduce the risk of graft vs host disease.

Blood Volume:
Double volume exchange is 160ml/kg. Please remember to order an extra 40ml of blood to allow priming of the set.
Investigations prior to exchange transfusion:
- FBC + film, reticulocyte count, clotting screen, total and split bilirubin, U/Es, Ca, Mg, blood gas, plasma glucose and new born blood spot screening.
- G6PD and pyruvate kinase deficiency, if family history is relevant or parents originate from geographical locations such as the Mediterranean region.
- Consider: Septic screen, TORCH screen, metabolic screen, karyotyping.
- Consider IV Antibiotics and cranial USS.

Preparation:
- Nurse on resuscitaire.
- Check temperature.
- Keep nil by mouth for the procedure.
- Aspirate stomach and keep OGT/NGT on free drainage.
- Minimum of two people required to perform safely.
  Medical staff should be bleep free.
  The procedure should be performed aseptically, sterile apron, gloves, cap and mask need to be worn.

Procedure:
Connect the circuit as shown in the diagram – (See appendix 2a/2b/2c)
Overall rate of exchange transfusion is 1-2 ml/kg min.
Eg 3kg baby with a blood volume of 80ml/kg = blood volume is 240mls
Volume to be exchanged is 480mls
rate = 1-2ml/kg/min so exchange rate is 6ml/min
480/6 = 80 minutes to complete the double volume exchange

Remove blood in aliquots of 20ml for babies >3kg, 10ml aliquots for babies 2-3 kg and 5ml aliquots for babies <2kg. Each aliquot should take 3 to 5 minutes to remove. Always start the procedure by infusing the same volume aliquot that will be removed in 3-5 minutes.

In UVC + UAC method, continuous infusion via UVC should be commenced first and then blood should be removed from the UAC after allowing enough time for an aliquot to be administered.

If a double lumen UVC is used – use the proximal lumen for continuously infusing and distal lumen for removal in aliquots.

In the UVC only method, blood should be infused and removed in aliquots. Two three way taps should be attached, the proximal tap should be used to infuse and distal tap should be used to remove blood (please remember to close the tap towards the pump while removing blood). Every in/out aliquot should be documented in the ET fluid balance chart. (See appendix 3b)

During exchange transfusion:
- Monitor Heart Rate and SpO₂ continuously and check BP every 20 minutes.
- Continue phototherapy and always perform double volume exchange.
- Continue IV maintenance fluids.
  Check blood gas and glucose half-way through the transfusion. (Take sample from a separate site particularly if UVC only is used).

Following exchange transfusion:
- Watch for potential complications such as thrombocytopaenia, deranged clotting hyperkalemia, hypocalcemia, hypomagnesemia, hypothermia and NEC.
- Check FBC, clotting, U/Es, bilirubin, Ca, Mg, glucose and gas.
- Maintain continuous multiple phototherapy
- Commence PO Folic acid 500micrograms od as at risk of continued haemolysis.

Follow up:
Ensure FBC, reticulocyte count and SBR are checked within a week after discharge. Parents should be warned of the possibility of ongoing haemolysis, signs and symptoms of anaemia, in which case to seek medical advice urgently. Is it not unusual for these patients to need later transfusions around 2-3 months of age.

References:
2. Neonatal jaundice Feb 2010 - NICE clinical guideline 98

K Damodaran, C Scone, S Cherian July 2012 to be re-evaluated July 2015
## Threshold table

Consensus-based bilirubin thresholds for management of babies 38 weeks or more gestational age with hyperbilirubinæmia

<table>
<thead>
<tr>
<th>Age (hours)</th>
<th>Bilirubin measurement (micromol/litre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>–</td>
</tr>
<tr>
<td>6</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>12</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>18</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>24</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>30</td>
<td>&gt; 112</td>
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<tr>
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<td>&gt; 125</td>
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<tr>
<td>66</td>
<td>&gt; 187</td>
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<tr>
<td>72</td>
<td>&gt; 200</td>
</tr>
<tr>
<td>78</td>
<td>–</td>
</tr>
<tr>
<td>84</td>
<td>–</td>
</tr>
<tr>
<td>90</td>
<td>–</td>
</tr>
<tr>
<td>96+</td>
<td>–</td>
</tr>
</tbody>
</table>

**Action**

- Repeat bilirubin measurement in 6–12 hours
- Consider phototherapy and repeat bilirubin measurement in 6 hours
- Start phototherapy
- Perform an exchange transfusion unless the bilirubin level falls below threshold while the treatment is being prepared
**Exchange transfusion pathway**

Offer information to parents and carers about exchange transfusions and intravenous immunoglobulin (IVIG) including:
- why the treatment is being considered
- anticipated duration of treatment
- possible adverse effects
- when it will be possible for parents or carers to see and hold the baby
- the need to admit the baby to intensive care for an exchange transfusion (if needed)

Prepare for exchange transfusion
- Initiate/maintain continuous multiple phototherapy
- Use IVIG (500 mg/kg over 4 hours) for babies with Rhesus or ABO haemolytic disease if serum bilirubin level rises by more than 8.5 micromol/litre/hour

Serum bilirubin level falls to below threshold for exchange transfusion

Baby has:
- bilirubin level that remains above threshold for exchange transfusion and/or
- clinical signs of acute bilirubin encephalopathy

Continue multiple phototherapy and perform exchange transfusion

Continue multiple phototherapy and measure bilirubin level within 2 hours of exchange transfusion and manage according to threshold table and treatment threshold graphs

Go to ‘Manage hyperbilirubinaemia’ box in ‘Investigation pathway’ (see pages 10-11)
Equipment required for exchange transfusion in neonates

1. Full resuscitation equipment
2. Monitoring equipment
3. ALARIS signature edition gold infusion pump
4. ALARIS medical blood administration set
5. Blood warming coil
6. Drainage bag (Bile bag)
7. Gowns, towels, sterile gloves
8. UAC, UVC
9. Pack for insertion of catheters
10. Scalpel blades
11. Sutures
12. Chloraprep
13. 3 way taps
14. 0.9% saline – for flush
15. 5ml + 10 ml+ 20ml syringes
16. 2 x FBC bottles
17. 2 x U/Es bottles
18. 2 x plasma glucose bottles
19. 2x Coagulation bottles
20. Exchange transfusion chart
Exchange transfusion in neonates- fluid balance and observations
Remember to start infusing blood/aliquot in to patient before removing blood/aliquots.

<table>
<thead>
<tr>
<th>Time</th>
<th>In (ml)</th>
<th>Out (ml)</th>
<th>Balance (ml)</th>
<th>Heart Rate (bpm)</th>
<th>SpO₂ %</th>
<th>BP (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume in</td>
<td>Cumulative volume - in</td>
<td>Volume out</td>
<td>Cumulative volume - out</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Method 1
Exchange transfusion in neonates - (UVC + UAC)

Same principle applies for peripheral venous and arterial lines

ALARIS Blood giving set

ALARIS Pump

Blood coil warming machine

UVC

UAC

In

Out

Drainage bag

5/10/20ml
Method 2a
Exchange transfusion in neonates
- (UVC only, double lumen)
Method 2b
Exchange transfusion in neonates
- (UVC only, single lumen)