Fluid management in preterm infants

Fluid management in the preterm infant is challenging, necessitating frequent clinical assessment. Many factors influence fluid balance, thus it is vital that a careful fluid management plan is made and regularly reviewed. If in doubt, a senior colleague should be consulted. Total body water (TBW) is made up of intracellular and extra-cellular compartments; the latter divided into vascular and extra-vascular spaces (Figure 1). Extra-cellular water (ECW) constitutes a large proportion of the fetal body composition, and reduces abruptly soon after birth causing weight loss (Figure 2).

![Figure 1: Body water compartments. ISF, Interstitial fluid. (Lorenz 2003)](image1)

**Postnatal adaptation**

This process is delayed in preterm infants due to:
- Delay in reduction of pulmonary vascular resistance (PVR) due to respiratory disease
- Reduced glomerular filtration rate (GFR)
- Reduced ability to excrete sodium

It can also be delayed following surgery due to elevated ADH levels.

High PVR in utero drops at birth due to lung expansion, allowing an increase in pulmonary blood flow. Increased blood flow from the lungs stretches the left atrium and stimulates secretion of atrial natriuretic peptide (ANP) causing sodium loss, diuresis and weight loss (Modi 2003). The negative sodium and water balance lasts for 2 – 4 days. Early administration of sodium can inhibit postnatal adaptation and delay the reduction of ECF. Fall in PVR is the main determinant of loss of ECF after birth (Modi 2004). Preterm kidneys have lower GFRs, and fewer ion transporters, and therefore less ability to both excrete and reabsorb sodium and water (Hartnoll 2003). However, antenatal steroids promote maturation of the sodium-excreting capacity of the kidney and may help in postnatal adaptation.

**Transepidermal water loss**

(TEWL) is the continuous passive diffusion of water through the stratum corneum (Cartlidge 2000). It decreases with rising gestation and increasing postnatal age. TEWL can be as high as 140ml/kg/d during the first few days of life in a 24-26 week neonate (figure 3). Nursing an infant in a humid environment reduces TEWL, and a reduction from 140ml/kg/d to less than 40ml/kg/d can be achieved by keeping the incubator humidity at 90%.

**Fluid balance**

Input = PN + other infusions + flushes + enteral feeds
Output = urine output (measured) + stool (<5ml/kg/d) + insensible losses (through respiratory tract = 6 – 9ml/kg/d + TEWL)

**Prescribing Fluids**

Usually start at 60-80ml/kg/d and increase progressively to a target of 180ml/kg/d.
Adjust according to:

**Clinical examination:** Peripheral oedema may signify fluid overload.
- Skin turgor reduced if dehydrated, but remember that this is a late sign in the neonate.

**Weight:** Rapid weight changes suggest water loss or gain. Extremely preterm infants may benefit from frequent weight assessment in the first few days of life.

**Urine output:** If excessive may need to consider giving more fluid, but be careful not to drive this process. If reduced may signify dehydration or poor renal function. These two conditions require different fluid prescriptions, so urine output should not be considered in isolation.
Serum Sodium: May signify water loss or gain or sodium loss or gain. Hypernatraemia in the first few days is usually caused by dehydration. U&E’s may need to be measured 8-12 hourly initially.

Serum Urea: If high, may signify dehydration and increased fluid requirement. Serum urea is not related to amino-acid intake in infants receiving parenteral nutrition (Ridout et al. 2004).

Fluid balance: Remember that the recorded ‘balance’ does not account for insensible losses. Assess humidity in incubator.

Baseline fluid requirements ml/kg/day (TEWL + Renal losses)

<table>
<thead>
<tr>
<th>Day</th>
<th>Bt Wt &lt;1.5Kg Total Volume</th>
<th>Bt Wt &gt;1.5Kg Total Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>110</td>
<td>90</td>
</tr>
<tr>
<td>3</td>
<td>130</td>
<td>110</td>
</tr>
<tr>
<td>4</td>
<td>160</td>
<td>140</td>
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<tr>
<td>5</td>
<td>170</td>
<td>150</td>
</tr>
<tr>
<td>6+</td>
<td>180</td>
<td>160</td>
</tr>
</tbody>
</table>

The above volumes serve as a guide, and the individual clinical assessment may suggest a different regimen.

Prescribing Sodium
- No or minimal sodium until natriuresis/diuresis (usually day 1 – 2).
- Start @ 2mmol/kg/d. Babies need a positive sodium balance to grow (Haycock 1993), and preterm infants will have a higher sodium need than term babies. Sodium requirement for an extreme preterm neonate is often > 5 mmol/kg/d.

Prescribing Potassium
- 1 – 2mmol/kg/d during the first 24 hours.
- Monitor urine output – i.e. beware when urine output is reduced.
- Infants with ileus, poor peristalsis and those on inotropes or with cardiovascular compromise aim for potassium > 4mmol/l.

Prescribing Calcium
- 1 mmol/kg/d within the first 24 hours.
- Ensure ionised calcium >1mmol/l, this can be checked on the gas machine.

Prescribing Glucose
- Normal in utero delivery rate is 4 – 6 mg/kg/min. To encourage growth aim for a glucose infusion rate (GIR) of 5 – 8mg/kg/min. Neonates rarely require a GIR of more than 10-12mg/kg/min.
- Dextrose concentrations >12.5% require a central line.

References:

Dr M Chakraborty, Dr S Barr July 2013 to be re-evaluated July 2016