Learning outcomes

• Calculate maintenance fluids
• Identify the types of dehydration
• Manage dehydration appropriately
• List the signs of a shocked child
• Treat a shocked child with appropriate fluids and volume
• Discuss fluid management in neonatal care
Fluid basics
## Fluid composition

<table>
<thead>
<tr>
<th>IV Fluid</th>
<th>Na⁺ mmol/l</th>
<th>K⁺ mmol/l</th>
<th>Cl⁻ mmol/l</th>
<th>Ca⁺ mmol/l</th>
<th>Lactate mmol/l</th>
<th>Glucose g/l</th>
<th>Calories / l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ringers lactate (Hartmann’s)</td>
<td>130</td>
<td>5.4</td>
<td>112</td>
<td>1.8</td>
<td>27</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Normal saline (0.9% saline)</td>
<td>154</td>
<td>-</td>
<td>154</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5% dextrose</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>Half-strength Darrow’s with 5% dextrose</td>
<td>61</td>
<td>17</td>
<td>52</td>
<td>-</td>
<td>27</td>
<td>50</td>
<td>200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IV Fluid</th>
<th>Na⁺ mmol/l</th>
<th>K⁺ mmol/l</th>
<th>Cl⁻ mmol/l</th>
<th>Bicarbonate mmol/l</th>
<th>Glucose g/l</th>
<th>Magnesium mmol/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO ORS</td>
<td>90</td>
<td>20</td>
<td>80</td>
<td>30</td>
<td>111</td>
<td>-</td>
</tr>
<tr>
<td>ReSoMal</td>
<td>45</td>
<td>40</td>
<td>-</td>
<td>-</td>
<td>125</td>
<td>3</td>
</tr>
</tbody>
</table>
Maintenance fluids

• Assuming no dehydration and no extra losses a child will require over 24 hours
  – 100 ml/kg for the first 10 kg of body weight
  – 50 ml/kg for the second 10 kg of body weight
  – 20 ml/kg for every kg thereafter

• This is the same for PO / NG / IV fluids
# Maintenance fluids

## A 17 kg boy will need

- 100 ml x 10 kg = 1000 ml
- 50 ml x 7 kg = 350 ml
- Total of 1350 ml in 24 hrs
- Which = **56 ml / hr**

## A 35 kg girl will need

- 100 ml x 10 kg = 1000 ml
- 50 ml x 10 kg = 500 ml
- 20 ml x 15 kg = 300 ml
- Total of 1800 ml in 24 hrs
- Which = **75 ml / hr**
How fast should the IVI should ‘drip’

• Standard paediatric giving sets 60 drops = 1 ml
  – So if trying to give 10 ml / hr
  – This is 10 ml x 60 drops = 600 drops per hr
  – Which is 600 drops per 60 minutes = 10 drops per minute
  – So the IVI should be dropping 10 drops per minute
  – This is 1 drop every 6 seconds

• Alternatively 1 drop every 1 second delivers 60 ml / hr
  – So you can divide 60 by the amount you want to give to work out how many seconds to wait between drops
How fast should the IVI should ‘drip’

For a 7.2 kg boy?

• Maintenance fluids are 7.2 kg x 100 ml = 720 ml / 24hrs
• = 30 ml/hr
• 30 ml x 60 = 1800 drops per hour
• Which is 1800 drops per 60 minutes
• So the IVI should be dripping at 30 drops per minute
  – This is 1 drop every 2 seconds

• 60 / 30 = 2; so give 1 drop every 2 seconds
How fast should the IVI should ‘drip’

For a 53kg girl?

- Maintenance fluids are
  - 10 kg x 100 ml = 1000 ml
  - 10 kg x 50 ml = 500 ml
  - 33 kg x 20 ml = 660 ml
  - Total fluid / 24hrs = 2160 ml
  - = 90 ml / hr
- This means the drip should be dripping at 90 drops per minute
- This is roughly 1.5 drops per second

- Or 60 / 90 = 0.66; so give 1 drop every 0.6 second
**How to make a dextrose solution**

**To make a fluid with 10% dextrose**

- Dilute at a ratio of 1:4
- For example take 200 ml 50% dextrose and add to 800 ml of 0.9% saline
- Another way of thinking about it is
  - 100 ml of 50% dextrose contains 50 gram of glucose
  - To make a 10% solution you need to add 100 gram of dextrose to 1000 ml of fluid
  - Therefore you would need to add 200 ml of 50% dextrose

**To make a fluid with 5% dextrose**

- Dilute at a ratio of 1:9
- For example take 100 ml 50% dextrose and add to 900 ml 0.9% saline
- Or
  - To make a 5% solution you need to add 50 gram of dextrose 1000 ml of fluid
  - Therefore you would need to add 100 ml of 50% dextrose
Dehydration
## Dehydration

- Hydration status must be assessed in all children with diarrhoea

<table>
<thead>
<tr>
<th>Classification</th>
<th>Signs / symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe dehydration</td>
<td>Two or more of the following signs:-</td>
</tr>
<tr>
<td></td>
<td>• Lethargy / unconsciousness</td>
</tr>
<tr>
<td></td>
<td>• Sunken eyes</td>
</tr>
<tr>
<td></td>
<td>• Unable to drink / drinks poorly</td>
</tr>
<tr>
<td></td>
<td>• Skin pinch goes back very slowly (≥ 2 seconds)</td>
</tr>
<tr>
<td>Some dehydration</td>
<td>Two or more of the following signs: -</td>
</tr>
<tr>
<td></td>
<td>• Restlessness / irritability</td>
</tr>
<tr>
<td></td>
<td>• Sunken eyes</td>
</tr>
<tr>
<td></td>
<td>• Drinks eagerly, thirsty</td>
</tr>
<tr>
<td></td>
<td>• Skin pinch goes back slowly</td>
</tr>
<tr>
<td>No dehydration</td>
<td>No signs of dehydration</td>
</tr>
</tbody>
</table>
Dehydration

Severe dehydration

- Rapid IV rehydration with Ringer’s lactate or 0.9% saline

<table>
<thead>
<tr>
<th>Age</th>
<th>First give 30ml/kg in:</th>
<th>Then give 70ml/kg in:</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 12 months old</td>
<td>1 hour *</td>
<td>5 hours</td>
</tr>
<tr>
<td>≥ 12 months old</td>
<td>30 minutes*</td>
<td>2 ½ hours</td>
</tr>
</tbody>
</table>

* Repeat again if radial pulse is still very weak or not detectable
Dehydration

**Severe dehydration**

- Reassess every 15-30 minutes
- Hydration status not improving → give drip more rapidly
- As soon as the child can drink give ORS (~5 ml/kg/hr)
  - Usually after 3 - 4 hours in infants or 1 - 2 hours in children
- If normally breastfed encourage the mother to continue frequently
- Reassess
  - Infant after 6 hours
  - Child after 3 hours
- Then chose the appropriate management plan
  - Severe / some / no dehydration
Dehydration

Some dehydration

- Give recommended amount of ORS over a 4 hour period

<table>
<thead>
<tr>
<th>Age</th>
<th>&lt; 4 months</th>
<th>4 – 12 months</th>
<th>12 – 2 years</th>
<th>2 – 5 years</th>
<th>5 – 15 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight &lt;5 kg</td>
<td>200 - 400</td>
<td>400 - 600</td>
<td>600 - 800</td>
<td>800 - 1200</td>
<td>1200 - 2000</td>
</tr>
<tr>
<td>Weight 5 - 8 kg</td>
<td>5 - 8 kg</td>
<td>8 - 11 kg</td>
<td>11 - 16 kg</td>
<td>16 - 50 kg</td>
<td>16 - 50 kg</td>
</tr>
<tr>
<td>Weight 8 - 11 kg</td>
<td>8 - 11 kg</td>
<td>8 - 11 kg</td>
<td>16 - 50 kg</td>
<td>16 - 50 kg</td>
<td>16 - 50 kg</td>
</tr>
<tr>
<td>Weight 11 - 16 kg</td>
<td>11 - 16 kg</td>
<td>11 - 16 kg</td>
<td>16 - 50 kg</td>
<td>16 - 50 kg</td>
<td>16 - 50 kg</td>
</tr>
<tr>
<td>Weight 16 - 50 kg</td>
<td>16 - 50 kg</td>
<td>16 - 50 kg</td>
<td>16 - 50 kg</td>
<td>16 - 50 kg</td>
<td>16 - 50 kg</td>
</tr>
</tbody>
</table>
Dehydration

Some dehydration

• Show the mother how to give the ORS
  – < 2 years a teaspoonful every 1-2 minutes
  – > 2 years frequent sips from a cup
• If the child vomits
  – Wait 10 minutes, then resume ORS more slowly
• Advise breastfeeding mothers to continue
• Reassess after 4 hours, checking for signs of dehydration
Dehydration

**No dehydration**

- Give extra fluid
- Breastfeed frequently and for longer at each feed
- If being exclusively breastfed, give ORS in addition
- In non-exclusively breastfed children give ORS / food based fluids (soup, rice water, yoghurt drinks) / clean water

- To prevent dehydration from developing, advise the mother to give extra fluids – as much as the child will take:
  - For children <2 years, about 50-100ml after each loose stool
  - For children >2 years, about 100-200ml after each loose stool
Dehydration

No dehydration

• Tell the mother to give small sips from a cup
• If the child vomits, wait 10 minutes and then give more slowly
• She should continue giving extra fluid until the diarrhoea stops
• Teach the mother how to mix and give ORS solution and give her two packets of ORS to take home

• Advise the mother to return if the child:
  – Is more sick
  – Is unable to drink / breastfeed
  – Drinks poorly
  – Develops a fever
  – Develops blood in the stool
• If the child has not improved after 5 days they should return for further review
Dehydration

Teach this mother how to use ORS
Dehydration

Malnutrition and dehydration
• Tends to be over diagnosed
• Do not use IV fluids unless the child is shocked
• Give ReSoMal rehydration fluid orally or by NG
  – 5 ml/kg every 30 minutes for the first 2 hours
  – Then 5 – 10 ml/kg/hr for the next 4-10 hours

Hypoglycaemia and dehydration
• Always check the blood sugar
• If < 3 mmol give 1 ml/kg of 50% dextrose IV / PO
Shock
Shock

• Commonest cause in children is fluid loss
  – Due to severe diarrhoea
  – Due to bleeding
  – Due to capillary leak in sepsis / severe infection

• It is important to replace this fluid quickly

• Amount and type of fluid given depends on:
  – Age / weight of child
  – Child’s nutritional status
Assessing for Shock

• Signs of shock include:
  
  • **Cold hands**
  
  • **Capillary refill > 3 seconds**
    – Apply pressure to nail bed for 5 seconds
    – Release and observe time for pink colour to return
  
  • **Weak pulse and tachycardia**

  = SHOCK
Managing shock

• Give oxygen

• Stop bleeding by applying firm direct pressure

• Make sure the child is warm

• Establish IV / IO access

• Give fluids
Managing shock WITHOUT malnutrition

20 ml / kg Ringer’s Lactate or 0.9% Saline as fast as possible

Reassess circulation  ↓  No improvement

Repeat 20 ml / kg Ringer’s / Saline

Reassess circulation  ↓  No improvement

Repeat 20 ml / kg Ringer’s / Saline

Reassess circulation  ↓  No improvement

Give 20 ml / kg blood over 30 minutes

If improvement commence maintenance fluids / PO fluids as soon as able
Chart 7. How to give IV fluids rapidly for shock (child not severely malnourished)

- Check that the child is not severely malnourished (in the child with severe malnutrition see section 1.4, page 4 and Chart 8).
- Insert an intravenous line (and draw blood for emergency laboratory investigations).
- Attach Ringer’s lactate or normal saline—make sure the infusion is running well.
- Infuse 20 ml/kg as rapidly as possible.

<table>
<thead>
<tr>
<th>Age/weight</th>
<th>Volume of Ringer’s lactate or normal saline solution (20 ml/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 months (&lt;4 kg)</td>
<td>75 ml</td>
</tr>
<tr>
<td>2–&lt;4 months (4–&lt;6 kg)</td>
<td>100 ml</td>
</tr>
<tr>
<td>4–&lt;12 months (6–&lt;10 kg)</td>
<td>150 ml</td>
</tr>
<tr>
<td>1–&lt;3 years (10–&lt;14 kg)</td>
<td>250 ml</td>
</tr>
<tr>
<td>3–&lt;5 years (14–19 kg)</td>
<td>350 ml</td>
</tr>
</tbody>
</table>

**Reassess child after appropriate volume has run in**

- **Reassess after first infusion:** If no improvement, repeat 20 ml/kg as rapidly as possible.
- **Reassess after second infusion:** If no improvement, repeat 20 ml/kg as rapidly as possible.
- **Reassess after third infusion:** If no improvement, give blood 20 ml/kg over 30 minutes.
- **Reassess after fourth infusion:** If no improvement, see treatment guidelines.

After improvement at any stage (pulse slows, faster capillary refill), go to Chart 11, page 14.

If the child is severely malnourished, the fluid volume and rate are different—see Chart 8.
Shock WITH malnutrition

• Children with severe malnutrition:
  – Are difficult assess
  – Are at risk of cardiac failure
  – Are at risk of hypoglycaemia
  – Need more cautious fluid management with different fluids
  – Need very close monitoring

• The malnourished child usually has shock because of dehydration / sepsis
Assessing for malnutrition

**Marasmus**

- Look at arms, legs, chest, buttocks
- Appears to be ‘skin and bone’
- Skin looks too large for body
- Head may appear large
Assessing for malnutrition

**Kwashiorkor**

- Oedema of both feet
  - Press top of foot gently with thumb
  - Look for a definite dent in tissues

**Other signs**

- Thin, sparse, depigmented hair
- Peeling skin rash (‘flaky paint’)

Managing shock WITH malnutrition

- General principles
- Weigh the child
- Monitor for hypoglycaemia
- Avoid IV fluid if possible
- Monitor closely for signs of cardiac failure/ increasing respiratory distress/ worsening oedema

- If able to drink/ tolerate NG give oral fluid as in severe dehydration
  - ReSoMal:
    - 5ml/kg every 30 mins for 2 hours, then
    - 5-10ml/kg/hour for 4-10 hours
Managing shock WITH malnutrition

• If unconscious or vomiting all fluids then use IV fluids
  – Half strength Darrow’s with 5% dextrose
  – Ringer’s Lactate with 5% dextrose
  – 0.9% saline with 5% dextrose

• Give 15 ml/kg over 1 hr – observe RR and HR

• If RR and HR improve child probably has dehydration and needs more fluid

• Give another 15 ml/kg over 1 hr

• Start oral fluids and F75 when able (10 ml /kg/hr for up to 10 hrs)
Managing shock WITH malnutrition

• If no improvement after first 15 ml/kg the child is probably septic rather than dehydrated

• THIS child needs blood 10 ml/kg over 3 hrs

• If blood not available run IV VERY slowly (4ml/kg/hour) until it arrives

• Give oral fluids and F75 as soon as able

• Start antibiotics
Chart 8. How to give IV fluids for shock in a child with severe malnutrition

Give this treatment only if the child has signs of shock and is lethargic or has lost consciousness:

- Insert an IV line (and draw blood for emergency laboratory investigations)
- Weigh the child (or estimate the weight) to calculate the volume of fluid to be given
- Give IV fluid 15 ml/kg over 1 hour. Use one of the following solutions (in order of preference):
  - Ringer’s lactate with 5% glucose (dextrose); or
  - half-normal saline with 5% glucose (dextrose); or
  - half-strength Darrow’s solution with 5% glucose (dextrose); or, if these are unavailable,
  - Ringer’s lactate.

<table>
<thead>
<tr>
<th>Weight</th>
<th>Volume IV fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Give over 1 hour (15 ml/kg)</td>
</tr>
<tr>
<td>4 kg</td>
<td>60 ml</td>
</tr>
<tr>
<td>6 kg</td>
<td>90 ml</td>
</tr>
<tr>
<td>8 kg</td>
<td>120 ml</td>
</tr>
<tr>
<td>10 kg</td>
<td>150 ml</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weight</th>
<th>Volume IV fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Give over 1 hour (15 ml/kg)</td>
</tr>
<tr>
<td>12 kg</td>
<td>150 ml</td>
</tr>
<tr>
<td>14 kg</td>
<td>210 ml</td>
</tr>
<tr>
<td>16 kg</td>
<td>240 ml</td>
</tr>
<tr>
<td>18 kg</td>
<td>270 ml</td>
</tr>
</tbody>
</table>

- Measure the pulse and breathing rate at the start and every 5–10 minutes.

If there are signs of improvement (pulse and breathing rates fell):
- Give repeat IV 15 ml/kg over 1 hour; then
- Switch to oral or nasogastric rehydration with ReSoMal (see page 83), 10 ml/kg/h up to 10 hours;
- Initiate refeeding with starter F-75 (see page 85).

If the child fails to improve after the first 15 ml/kg IV, assume the child has septic shock:
- Give maintenance IV fluid (4 ml/kg/h) while waiting for blood;
- When blood is available, transfuse fresh whole blood at 10 ml/kg slowly over 3 hours (use packed cells if in cardiac failure); then
- Initiate refeeding with starter F-75 (see page 85).

If the child deteriorates during the IV rehydration (breathing increases by 5 breaths/min or pulse by 25 beats/min), stop the infusion because IV fluid can worsen the child’s condition.
Neonates
Fluid management in neonates

• Encourage breastfeeding frequently to prevent hypoglycaemia
• If unable to feed give EBM via NGT

• If IV fluids are given, reduce the IV fluids as the volume of milk feeds increases
• Babies over 3 days of age need sodium added to their IV fluids

• Increase the amount of fluid given over the first 3-5 days (total amount oral and IV)
  – Day 1  60ml/kg/day
  – Day 2  90ml/kg/day
  – Day 3  120ml/kg/day
  – Then increase to 150ml/kg/day
Scenario 1

- 30 kg girl presented with a history suggestive of acute gastroenteritis
- On examination
  - Lethargic
  - Sunken eyed
  - Skin turgor = 3 seconds
Scenario 1

- What type of dehydration?
  - **Severe dehydration**

- What type of fluid are you going to give?
  - **Ringer’s lactate / 0.9% Saline**

- How much fluid are you going to give and over what time frame?
  - **30ml x 30 kg = 900 ml over 30 minutes**

- On reassessing the child has improved, how much fluid are you now going to give?
  - **70 ml x 30 kg = 2100ml over 2.5 hrs = 840 ml/hr**
Scenario 2

- 1 year old boy = 6.5 kg
- History of diarrhoea and vomiting for 2 days
- On assessment
  - Lethargic and unresponsive
  - Icy cold
  - CRT 4 seconds
  - Unable to feel radial pulse
  - RR 60, HR 180
Scenario 2

• What is the diagnosis in this child?
  – **Marasmus with shock**

• Should the child have IV fluids?
  – **Yes**

• What type of IV fluids are you going to use?
  – **Half strength Darrow’s with 5% dextrose**

• How much fluid are you going to give and over what time frame?
  – **15 ml x 6.5 kg = ~100 ml over 1 hr**
Scenario 2

• After 1 hour you reassess
  – The child is more awake
  – The hands are warmer
  – The CRT is 2 seconds
  – The radial pulse is palpable
  – RR 40, HR 150

• What is your next plan?
  – **Start oral fluids / F75** 10 ml x 6.5 kg = 65 ml every hr for 10 hrs
Scenario 3

- 12 kg boy
- Needs IV maintenance fluids as NBM
- Set up the IV fluids
- Run the fluids at the correct rate
  - Total of 1100 ml in 24 hours
  - ≈ 46 ml / hr
  - 46 ml x 60 = 2760 drops per hour
  - Which is 2760 drops per 60 minutes
  - So the IVI should be dripping at 46 drops per minute
  - This is 1 drop every 1.3 seconds
- Label the fluid appropriately
Thank you