Acknowledgement

These guidelines have been based (with permission) on those from Royal Children’s Hospital, Melbourne, Australia. (www.rch.org.au/clinicalguide/cpg.cfm)

Background

- Whenever possible the enteral route should be used for fluids. These guidelines only apply to children who cannot receive enteral fluids.

- Incorrectly prescribed intravenous fluids are potentially very dangerous. The safe use of IV fluid therapy in children requires accurate prescribing (correct choice of fluid and rate) and careful monitoring. More adverse events are described from fluid administration than for any individual medication. If you are in any doubt about a child’s fluids orders ask a senior doctor.

- These guidelines apply to most children beyond the newborn period. See separate ADHB Newborn Services neonatal guidelines for children under one month of age. There are also separate guidelines for children with specific medical conditions (gastroenteritis, diabetic ketoacidosis, meningitis) and for children in PICU. Refer to the Gastroenteritis guidelines for management of children with electrolyte disturbance.

- Always check orders that you have written, and ensure that you double check on orders written by other staff when you take over the child's care.

- Goals of therapy are to maintain (or improve) hydration and electrolyte balance. Fluids are composed of water, electrolytes and sometimes nutrition (glucose or other). Each needs careful consideration.

- Even elective, “well” children may have abnormal fluid balance and regulation post operatively due to the surgery, to pain or the anaesthesia. They require just as much care and monitoring.

- There is often confusion about the difference between oral and IV fluid requirements for young infants. The water requirement is identical for both routes of administration. The relatively low energy density of milk means that infants need 150-200mls/kg/day to obtain adequate nutrition.
Well child with normal hydration

How much fluid?

Well children with normal hydration but no oral intake require an amount of fluid that is often termed "maintenance". Maintenance fluid is that volume of daily fluid intake which replaces the insensible losses (from breathing, through the skin, and in the stool), and at the same time allows excretion of the daily production of excess solute load (urea, creatinine, electrolytes etc) in a volume of urine that is of an osmolarity similar to plasma.

A child’s maintenance fluid requirement decreases proportionately with increasing age (and weight). The following calculations approximate the maintenance fluid requirement of well children according to weight in kg.

<table>
<thead>
<tr>
<th>Patients weight</th>
<th>mls/day</th>
<th>mls/hour</th>
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<tbody>
<tr>
<td>3 to 10kg</td>
<td>100 x wt</td>
<td>4 x wt</td>
</tr>
<tr>
<td>10 - 20kg</td>
<td>1000 + 50 x (wt-10)</td>
<td>40 + 2 x (wt-10)</td>
</tr>
<tr>
<td>&gt;20kg</td>
<td>1500 + 20 x (wt-20)</td>
<td>60 + 1 x (wt-20)</td>
</tr>
</tbody>
</table>

100mls/hour (2500mls/day) is the normal maximum amount.

You might recognise these as the "100, 50, 20" and "4,2,1" rules of thumb.

Weight (kg)  | 4  | 6  | 8  | 10 | 12 | 14 | 16 | 20 | 30 | 40 | 50 | 60 | 70 |
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</tr>
</thead>
<tbody>
<tr>
<td>ml/hr</td>
<td>16</td>
<td>24</td>
<td>32</td>
<td>40</td>
<td>44</td>
<td>48</td>
<td>52</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

In Starship fluid is prescribed in 500ml bags. The standard fluid prescribed for maintenance in well children with normal hydration is:

0.45% NaCl with 2.5% Dextrose +10mmol KCl in 500ml

Note – Oncology in certain circumstances use 1 litre bags. This is an exception not a rule.

Do not use this solution:

- If the serum potassium is elevated
- If the serum sodium is low
- For volume resuscitation
- For replacement of fluid deficit in dehydrated children
- For initial treatment of children with acute neurological conditions (eg meningitis)
Unwell children (+/- abnormal hydration)

How much Fluid?

Fluid resuscitation for shock is the first priority

Hypovolaemia

- Give boluses of 10-20ml/kg of normal (0.9%) saline, which may be repeated.
  Do not include this fluid volume in any subsequent calculations

Then consider the need for maintenance fluid, deficit fluid (to replace fluid lost from dehydration), and ongoing losses (to replace abnormal losses from e.g. drain sites).

Maintenance

Remember that the maintenance fluid volume may need to be adjusted in some unwell children.

- Less if in a basal state (ie very inactive lying in bed). -25%
- More in children under radiant heaters. +20 to 50%
- More in children with fever. +10 to 20%
- Less in children with excessive secretion of Antidiuretic Hormone (ADH) eg pneumonia, meningitis, significant pain, head injury Varies (-20 to -40%)
- More if unable to concentrate urine (eg some renal diseases, Diabetes insipidus) Varies

Deficit

A child's water deficit in mls can be calculated following an estimation of the degree of dehydration expressed as % of body weight. (eg: a 10kg child who is 5% dehydrated has a water deficit of 500mls)

Precise calculation of water deficit due to dehydration using clinical signs is usually inaccurate. The best method relies on the difference between the current body weight and the immediate pre-morbid weight. Unfortunately the latter is often unavailable.

Clinical signs of dehydration give only an approximation of the deficit.
In mild-moderate dehydration the useful clinical signs include:

- Cool pale peripheries with prolonged capillary return time.
- Decreased skin turgor
- Deep (acidotic) breathing
- Increased thirst

Other signs including irritability/lethargy, sunken eyes, dry mucus membranes, and sunken fontanelle are commonly mentioned but have not been shown to be useful in mild-moderate dehydration. They may appear in more severe cases.

Clinically the child may be placed in one of three categories:

**Mild/No dehydration (<4%)**
- No clinical signs

**Moderate dehydration (4-6%)**
- Some physical signs

**Severe dehydration (>7%)**
- Multiple physical signs present and child may also have acidosis and hypotension

The deficit is replaced over a time period that varies according to the child’s condition.

Replacement may be rapid in most cases of gastroenteritis (although usually this is best achieved by oral or nasogastric fluids), but should be slower in diabetic ketoacidosis and meningitis, and much slower in states of hypernatraemia (aim to rehydrate over 48 hours, the serum sodium should not fall by >1mmol/litre/hour).

**Ongoing losses (e.g. from drains)**

These are best measured and replaced - calculations may be based on each previous hour, or each 4 hour period depending on the situation. Normal (0.9%) saline may be sufficient, or 5% albumin may be used if sufficient protein is being lost to lower the serum albumin.
INTRAVENOUS FLUIDS

Which Fluid?

Good fluid solutions for sick children include:

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Alternative names</th>
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</thead>
<tbody>
<tr>
<td>0.9% NaCl</td>
<td>Normal saline</td>
</tr>
<tr>
<td>0.45% NaCl with 2.5% Dextrose</td>
<td>Half Normal saline with glucose</td>
</tr>
</tbody>
</table>

0.9% Saline is suitable for initial volume resuscitation in hypovolaemia and ongoing fluid therapy in older children with normal blood glucose.

0.45% Saline with 2.5% Dextrose is a suitable for ongoing fluid therapy for most children.

If in doubt, you will not go far wrong if you use 0.45% Saline with 2.5% Dextrose with potassium chloride 10mmol /500mol bag in most circumstances.

0.18% NaCl with 4% glucose is **NOT** appropriate as a choice of fluid without consultation.

Monitoring

- All children on IV fluids should be weighed prior to the commencement of therapy and then daily. Ensure you request this on the treatment orders.
- Unwell children on IV fluids should have serum electrolytes and glucose checked before commencing the infusion (typically when the IV is placed) and again within 24 hours if IV therapy is to continue.
- Sick children should have a clinical review at 4-6 hours after commencing fluids.
Special Fluids

Small infants, children with low blood glucose or children with high metabolic requirements will require fluids with a higher glucose concentration. Infusions of glucose >15% usually require central venous access.

Outside the newborn period, do not use these fluids apart from exceptional circumstances and check the serum sodium regularly

10% Dextrose
Sometimes used by infusion in neonates and children with metabolic disorders. Check blood glucose regularly.

15-20% Dextrose
Very occasionally used by infusion in children with metabolic disorders. Check blood glucose regularly.

Post Operative Fluids

The following recommendations apply for the first 12-24 hours following major surgical procedures, for example laparotomy and tumour resection, emergency bowel resection, surgery for perforated appendicitis with peritonitis. ADH, glucocorticoid and mineralocorticoid secretion is increased and oral intake is delayed. These recommendations do not apply to head injured or renal failure patients.

Choice of fluid:
Plasmalyte, 0.9% Saline, 0.9% saline + 2.5% dextrose or 0.45% Saline with glucose

Glucose content:
< 6 months old: 5%
> 6 months old: 2.5%

‘Maintenance’ fluid rate:
2/3 ‘maintenance’ rate (i.e. use 4:2:1 rule and take 2/3 of this amount per hour)
Full maintenance rate can be used after minor surgery

Replacement:
Monitor clinically for signs of hypovolaemia secondary to ‘3rd spacing’ or haemorrhage
Give 10 ml/kg bolus of Normal Saline if clinically indicated
Contact senior surgical staff immediately if any concerns

Monitoring:

Glucose:
Children <6 months, 4 hourly BSL for 4-24 hours, until stable

Sodium:
U&E morning after surgery, or sooner if indicated

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Intravenous Fluid
Pyloric Stenosis

Resuscitation:
10-20 ml/kg bolus of Normal Saline as clinically indicated to correct hypovolaemia

‘Maintenance’ and correction of metabolic alkalosis:
- 5% dextrose + 0.45% NaCl + 10mmol KCl (after baby has passed urine) per 500ml bag
- Rate = 150 ml/kg/day (6 ml/kg/hour)

Monitor:
U&E, chloride, capillary or venous (but not arterial) gas