

FLUID AND ELECTROLYTE THERAPY

See also IV and Oral Fluids (p.397).

MAINTENANCE REQUIREMENTS

IV fluid: 4.3% dextrose in 0.18% saline.

Add to each litre: 1g (13 mEq) of potassium chloride (and 1 ampoule - 2 ml - of Intravite if IV maintenance and nil by mouth is to be continued for more than 3 days).

Amount:

0-10 kg: 100 ml/kg/day
 4 ml/kg/hr

11-20 kg: 1000 ml + 50 ml/kg/day for each kg above 10 kg
 40 ml + 2 ml/kg/hr

Above 20 kg: 1500 ml + 20 ml/kg/day for each kg above 20 kg
 60 ml + 1 ml/kg/hr

Examples:

7 kg child requires: 7×100 = 700 mls/day
 7×4 = 28 mls/hr

12 kg child requires: $1000 + (2 \times 50)$ = 1100 mls/day
 $40 + (2 \times 2)$ = 44 mls/hr

25 kg child requires: $1500 + (5 \times 20)$ = 1600 mls/day
 $60 + (5 \times 1)$ = 65 mls/hr

Water requirements are increased by fever and fluid loss.

Reduce the intake to two thirds or less with meningitis, cerebral malaria, coma, heart failure, or renal failure.

DEHYDRATION WITH SHOCK

IV fluid: 2.5% dextrose in half strength Darrow's solution.

Amount: 20 ml/kg fast. Repeat 20 ml/kg fast if still dehydrated. Then:

Under 5 kg:	25 ml/hour
5-9 kg:	50 ml/hour
10-14 kg:	75 ml/hour
>15 kg:	100 ml/hour

Don't forget that oral rehydration is highly effective in dehydrated children without shock (see Diarrhoea, p.103).

POST-OPERATIVE

Maintenance fluid: as above.

Replace gastric sspirate: give an equal volume of intravenous 0.9% sodium chloride with 1g KCl per litre.

PYLORIC STENOSIS

Pre-operative fluids if dehydrated.

Prolonged vomiting will cause hypochloraemic alkalosis due to the loss of HCl in gastric juice. Half strength Darrow's solution is not suitable as replacement fluid in this condition.

- check electrolytes if possible
- give 20 ml/kg of 0.9% sodium chloride IV fast. Repeat this if the child is shocked
- add 2 g (8 ml) KCl to a litre flask of 0.9% sodium chloride, and give 10 ml/kg/hour IV for 2 hours
- continue with 4.3% dextrose in 0.18% normal saline with 2 g KCl /litre at maintenance rates.

Note: It is most important to have the child adequately hydrated and in electrolyte balance before surgery. Surgery should not be done on an emergency basis in pyloric stenosis.

BURNS

See the section on Burns (p.60).

NEONATES

See the table under Neonates - Fluids and Feeds (p.250).

FLUID DISTRIBUTION

	Neonate	Child	Adult
Total water	750 ml/kg	650 ml/kg	550 ml/kg
Intracellular water	350 ml/kg	350 ml/kg	300 ml/kg
Extracellular water	400 ml/kg	300 ml/kg	250 ml/kg
Whole blood	90 ml/kg	80 ml/kg	75 ml/kg
Plasma	40 ml/kg	35 ml/kg	35 ml/kg

COMPOSITION OF FLUID LOSSES

	Na (mEq/l)	K (mEq/l)	Cl (mEq/l)
Gastric	20 - 80	5 - 20	100 - 150
Pancreatic	120 - 140	5 - 15	90 - 120
Small intestine	100 - 140	5 - 15	90 - 130
Bile	120 - 140	5 - 15	80 - 120
Ileostomy	45 - 135	3 - 15	20 - 115
Diarrhoea	10 - 90	10 - 80	10 - 110
Burns (+ protein 4 g%)	140	5	110

COMPOSITION OF IV FLUIDS

	mEq per litre					Dextrose
	Na	Cl	K	Lactate	Ca	
2.5% dextrose in half strength Darrow's	61	52	18	27	-	2.5%
4.3% dextrose in 0.18% sodium chloride	31	31	-	-	-	4.3%
Hartmann's solution	130	110	5	28	4	-
0.9% sodium chloride (normal saline)	150	150	-	-	-	-

SODIUM

1g NaCl contains 17 mEq Na and 17 mEq Cl. The number of mEq of sodium required to replace a deficit = $Wt (kg) \times 0.6 (140 - \text{serum Na})$. Normal saline contains 150 mEq of sodium per litre (give 7 ml of normal saline for each mEq of sodium required to replace the deficit). For example, for a 10 kg child with a serum sodium of 120 mEq/l, give $10 \times 0.6 (140-120) \times 7 = 840$ ml of 0.9% sodium chloride IV over 48 hours. Do not increase the serum sodium by more than 2 mEq/l every hour (and it is safer to increase it even slower than this).

POTASSIUM

The total body potassium deficit cannot be calculated from the serum potassium. 1 g of KCl contains 13.4 mEq K and 13.4 mEq Cl. The MAXIMUM safe rate of K infusion IV = 0.3 mEq/kg/hour (beware of K concentrations over 4 g/litre in IV fluid).

Eg: For an 8 kg child with hypokalaemia, with IV fluid at 25 ml/hour:
 $8 \times 0.3 = 2.4$ mEq K MAXIMUM in 25 ml
 $2.4 \text{ mEq in } 25 \text{ ml} = 2.4 \times 1000/25$ or 96 mEq/l. 96 mEq K = $96/13.4$ or 7g KCl per litre.
To be safe, add only half this amount (3.5 g) to each litre.

Oral potassium can be given as electrolyte mixture (see section below), eg to children on diuretics. 1,000,000u of potassium benzyl (crystalline) penicillin contains approximately 1 mEq K.

BLOOD GASES

If blood gases are available, the number of ml of 8.4% bicarbonate required to correct an acidosis is equal to: the base deficit \times wt (kg) / 3. It is usual to give half this calculated amount, and then repeat the blood gas estimation.

CALCIUM

10 ml 10% calcium gluconate = 4.5 mEq (2.2 mmol) Ca.
10 ml 10% calcium chloride = 14 mEq (7 mmol) Ca.
10 mEq calcium = 5 mmol.
The usual dose of 10% calcium gluconate (0.22 mmol/l) is 0.5 ml/kg IV slowly stat, then 5 ml/kg/day.
The usual dose of 10% calcium chloride (0.7 mmol/l) is 0.2 ml/kg IV slowly stat, then 2 ml/kg/day.

MAGNESIUM

The usual parenteral dose of 50% magnesium sulphate is 0.2 ml/kg IM daily (or BD in severe cases). Or add 5 ml 50% MgSO₄ to each litre of maintenance IV fluid. Magnesium can be given orally as electrolyte mixture (see p.230).

MOLES

No. millimoles = no. mEq / valence = mass (mg) / mol. wt.

ELECTROLYTE MIXTURE

This is given to children with severe malnutrition or chronic diarrhoea. Either give 5 ml TID or add 5 ml to each 240 ml of milk feed. Add 50g potassium chloride, 10g magnesium hydroxide (or 40g magnesium sulphate) and 2g zinc sulphate to 1 litre of water. Label clearly: SHAKE WELL BEFORE USE.

REFERENCES

- Schierhout G, Roberts I. BMJ 316:961-964, 1998. Fluid resuscitation with colloid or crystalloid solutions in critically ill patients: a systematic review of randomised trials.
- Winters RW. The body fluids in pediatrics, Little Brown.
- Advanced paediatric life support. The practical approach. 3rd ed. London: BMJ Books, 2001.

FOREIGN BODIES

EAR

Sedate the child with chloral hydrate 50 mg/kg (maximum 2g) or Vallergran (trimeprazine) 2-4 mg/kg oral. Attempt to remove the object using suction (cut the end off the suction catheter) and, if this fails, try irrigation. General anaesthesia may be required. You may be able to hook the foreign body out with a bent paper clip (but be careful not to push it in further).

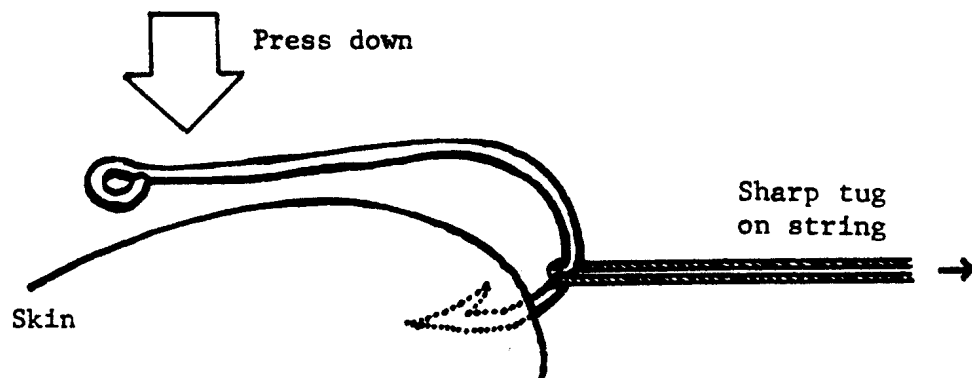
EYE

Foreign bodies often lodge in the upper recess (evert the upper lid). It may be necessary to give ketamine to an uncooperative child.

A corneal foreign body is best seen with lateral illumination. Use local anaesthesia in older children. Ketamine will be needed in most children under 8 years of age. Stain the eye with fluorescein to detect a residual corneal ulcer and, if you find one, apply chloramphenicol eye ointment QID for 3 days. Intraocular foreign body should be referred to an ophthalmologist urgently.

FISH HOOK

Loop a piece of string (or fishing line) around the bend of the hook where it enters the skin. Depress the eye end of the hook with your index finger to disengage the barb. Give a strong, sharp tug on the string to remove the hook. Tetanus toxoid should be given.



NOSE

Management is similar to the ear. Sedate the child with chloral hydrate or Vallergran and apply local anaesthetic with adrenaline. Try suction first, then irrigation. You may be able to hook the foreign body out with a bent paper clip (but be careful not to push it in further).

PHARYNX

Spray the area with local anaesthetic. Visualise the object with a spatula or laryngeal mirror and a good light. Remove it with forceps.

SOFT TISSUES

A foreign body may be very hard to find in the soft tissues at operation, even if they have been localised by x-ray. Use general anaesthesia and an Esmarch tourniquet. Do not forget to give tetanus toxoid.

SWALLOWED

Ingestion of a foreign body is commonest in the first year of life. If a foreign body lodges in the oesophagus, the child should be referred to a Base Hospital, where the object will be removed endoscopically. There is a danger of perforation and mediastinitis. Once in the stomach, most foreign bodies will pass safely; the exception is a very long hairpin which may lodge at the duodeno-jejunal flexure and perforate, so that a laparotomy is necessary.

X-rays of the head, neck, chest and abdomen may be needed. A swallowed object may lodge in the nasopharynx following vomiting.

Perform laparotomy for

- a long sharp object lodged at the duodeno-jejunal flexure
- a sharp object in the abdomen that does not progress for 14 days
- a blunt object in the abdomen that does not progress for 28 days.

TRACHEA, LARYNX OR BRONCHUS

There is acute onset of coughing, often with stridor or wheeze. An expiratory chest x-ray may show air-trapping (the film is darker on the side of the foreign body). Refer the child to a specialist surgeon for endoscopic removal of the foreign body (which may have to be done through a tracheostomy) under general anaesthesia. This should NEVER be attempted by an inexperienced doctor.

URINARY TRACT

These should always be removed. An open operation is usually necessary, although small objects in the bladder can sometimes be removed through a cystoscope.

FROG BREATHING

This technique of ventilation is only suitable for temporary use in babies under about 5 kg.

1. Insert a size 8 or 10 nasogastric tube through one nostril on free drainage. This is necessary to prevent overinflation of the stomach, with respiratory embarrassment.
2. Give nasopharyngeal oxygen at 2 litres per minute. The oxygen cannula should be inserted to a depth equal to the distance between the ala nasae (the side of the baby's nose) and the tragus (the front of the ear) - do not push it in any further than this, or it may go into the oesophagus.
3. With your left hand, lift up the baby's chin slightly, extend the neck and pinch the mouth shut. With your right hand, pinch the baby's nose for about 2 seconds, so that oxygen fills the lungs. Then release the nose for about 2 seconds and allow the elastic recoil of the lungs to empty them - be sure to allow adequate time for them to empty. You should be able to watch the chest expanding and deflating.
4. This technique should give about 12 to 15 breaths a minute. Ensure that the stomach does not inflate. If ventilation is inadequate, endotracheal intubation (p.113) is required.

GLUCOSE 6 PHOSPHATE DEHYDROGENASE DEFICIENCY (G6PD)

A high incidence of G6PD deficiency is related to the incidence of malaria (Nature 190:1120, 1961). In Papua New Guinea, many different variants of G6PD deficiency have been found. Fortunately only a few of these variants are associated with severe haemolysis. The diagnosis may be missed if G6PD deficiency is tested for immediately after a haemolytic crisis, because young red blood cells with relatively high enzyme levels predominate at that time.

Drugs that often cause haemolysis in G6PD deficient patients	Drugs that usually cause haemolysis only with severe G6PD deficiency, or in the presence of severe illness (eg infection)
ANALGESICS Acetanilide	ANALGESICS Acetylsalicylic acid Phenacetin
ANTIMALARIALS Pamaquine Pentaquine (Mepacrine) Primaquine Quinocide	ANTIMALARIALS Chloroquine Quinine Quinacrine (Atabrine)
SULPHONAMIDES Sulphanilamide N-Acetylsulphanilamide Sulphapyridine Sulphamethoxyipyridazine	SULPHONAMIDES Sulphadiazine Sulphamerazine Sulphisoxazole (Gantrisin) Sulphathiazole
NITROFURANTOINS Furazolidone (Furoxone) Nitrofurazone (Furacin) Nitrofurantoin	MISCELLANEOUS Aniline Antazolene (Antistine) Ascorbic acid Chloramphenicol BAL Diphenhydramine Vitamin K (aqueous) Methylene blue Procaine amide Probenecid Naladixic acid (?)
SUPLHONES Sulphoxone (Dapsone)	INFECTIONS Respiratory viruses Infectious hepatitis Infectious mononucleosis Bacterial pneumonia Malaria
MISCELLANEOUS Naphthalene Phenylhydrazine Fava beans	DIABETIC ACIDOSIS

REFERENCE

Young G P. Med J Aust 1:876, 1974, G6PD deficiency in PNG.