INTRAVENOUS FLUID THERAPY

PRINCIPLES

- Postnatal physiological weight loss is approximately 5–10% in first week after birth
- Preterm babies have more total body water and may lose 10–15% of their weight in first week after birth
- Postnatal diuresis is delayed in respiratory distress syndrome and in babies who had significant intrapartum stress
- Preterm babies have limited capacity to excrete sodium in first 48 hr
- Sodium chloride 0.9% contributes a significant chloride (Cl^-) load which can exacerbate metabolic acidosis
- Liberal sodium and water intake before onset of natural diuresis is associated with increased incidence of patent ductus arteriosus, necrotising enterocolitis and chronic lung disease
- After diuresis, a positive sodium balance is necessary for tissue growth
- Preterm babies, especially if born <29 weeks' gestation, lose excessive sodium through immature kidneys
- Babies <28 weeks have significant transepidermal water (TEW) loss
- TEW loss leads to hypothermia, loss of calories and dehydration, and causes excessive weight loss and hypernatraemia

MONITORING

Weigh

- On admission
- Daily for intensive care babies: twice daily if fluid balance is a problem
- use in-line scales if available

Serum sodium

- Daily for intensive care babies
- **Serum**
- admission electrolytes reflect maternal status: need not be acted upon but help to interpret trends

Serum creatinine

- Daily for intensive care babies
- Reflects renal function over longer term
- trend is most useful
- tends to rise over first 2–3 days
- gradually falls over subsequent weeks
- absence of postnatal drop is significant

Serum urea

- Not useful in monitoring fluid balance; reflects nutritional status and nitrogen load

Urine output

- All babies undergo diuresis during first 2–3 days of life. Strict input/output to be measured until urine output normalises
- Review 8-hrly for intensive care babies
- 2–4 mL/kg/hr normal hydration
- <1 mL/kg/hr requires investigation except in first 24 hr after birth
- >6–7 mL/kg/hr suggests impaired concentrating ability or excess fluids

NORMAL REQUIREMENTS

Humidification

- If <29 weeks, humidify incubator to ≥60%

- If ventilated or on CPAP ventilator, set humidifier at 39°C negative 2 to ensure maximal humidification of inspired gas

Normal fluid volume requirements

	Fluid volume (mL/kg/day)	
Day of life	**<1000 g**	**≥1000 g**
1	90	60
2	120	90
3	150	120
4	150	150

- **Day 1**
  - glucose 10%
  - if birth weight <1000 g or 1001–1500 g and baby not anticipated to reach 100 mL/kg/day enterally by day 5, start parenteral nutrition (PN) (see **Parenteral nutrition** guideline)
- **Day 2**
  - glucose 10% and potassium 10 mmol in 500 mL (depending on electrolyte results) or PN
  - use sodium chloride 0.45% in arterial line fluids
  - add sodium only when there is diuresis, or weight loss >6% of birth weight
- **Day 3**
  - glucose 10%, sodium chloride 0.18% and potassium 10 mmol in 500 mL or PN (with potassium 2 mmol/kg/day and sodium 4 mmol/kg/day)
- **After day 4**
  - glucose 10% (with maintenance electrolytes adjusted according to daily U&E) or PN
- Fluid volume requirements are a guide and can be increased faster or slower depending on serum sodium values, urine output and changes in weight
- Fluid volume for extreme preterm babies:
  - consider clinical context
  - monitor above parameters closely
- Babies receiving phototherapy may require extra fluids depending on type of phototherapy

HYPONATRAEMIA (<130 mmol/L)

- Response to treatment should be proportionate to degree of hyponatraemia.
- May cause hypotonia and apnoea. If acute and severe (<120 mmol/L) is associated with cerebral oedema and seizures

Causes

Excessive free water

- Reflection of maternal electrolyte status in first 24 hr
- Failure to excrete fetal extracellular fluid will lead to oedema without weight gain
- Water overload: diagnose clinically by oedema and weight gain
- Excessive IV fluids
- Inappropriate secretion of ADH in babies following major cerebral insults, or with severe lung disease
  - treatment with indometacin or ibuprofen

Excessive losses

- Prematurity (most common cause after aged 48 hr)
- Adrenal insufficiency
- GI losses
- Diuretic therapy (older babies)
- Inherited renal tubular disorders

Inadequate intake

- Preterm breastfed babies aged >7 days

Management depends on cause

Excessive IV fluids and failure to excrete fetal ECF
Management
- Reduce fluid intake to 75% of expected

Inappropriate ADH
Clinical features
- Weight gain, oedema, poor urine output
- Serum osmolality low (<275 mOsm/kg) with urine not maximally dilute (osmolality >100 mOsm/kg)

Management
- Reduce fluid intake to 75% of expected
- Consider sodium infusion only if serum sodium <120 mmol/L

Risk of accidental hypernatraemia when using sodium chloride 30%. Use with caution and always dilute before use

Acute renal failure
Management
- Reduce intake to match insensible losses + urine output
- Seek advice from tier 2 staff/consultant

Excessive renal sodium losses
Management

If possible, stop medication (diuretics, caffeine) that causes excess losses

- Check urinary electrolytes
- Calculate fractional excretion of sodium (FE Na^+ %):
  - FE Na^+ = [(urine Na × plasma creatinine)/(urine creatinine × plasma Na)] × 100
  - normally <1% but in sick preterm babies can be up to 10%
  - affected by sodium intake: increased intake leads to increased fractional clearance
  - if >1%, give sodium supplements
- Calculate sodium deficit
  - = (135 − plasma sodium) × 0.6 × weight in kg
  - replace over 24 hr unless sodium <120 mmol/L or symptomatic (apnoea, fits, irritability)
  - initial treatment should bring serum sodium up to approximately 125 mmol/L
- Use sodium chloride 30% (5 mmol/mL) diluted in maintenance fluids. Ensure bag is mixed well before administration
- See **Renal failure** guideline

Adrenal insufficiency
Clinical features
- Hyperkalaemia
- Excessive weight loss
- Virilisation of females
- Increased pigmentation of both sexes
- Ambiguous genitalia

Management
- Seek consultant advice

Inadequate intake
Clinical features
- Poor weight gain and decreased urinary sodium

Management
- Give increased sodium supplementation
- If receiving diuretics, stop or reduce dose

Excessive sodium intake leading to water retention
Clinical features
- Inappropriate weight gain

Management
- Reduce sodium intake

Treatment of acute symptomatic hyponatraemia with seizures
- Do not manage hyponatraemic encephalopathy using fluid restriction alone
- Give sodium chloride 2.7% 2 mL/kg IV via a central line over 10–15 min
- If symptoms still present, repeat
- Measure serum sodium hourly until symptoms resolve
- when symptoms resolved, ensure serum sodium does not increase by >12 mmol/L/24 hr

HYPERNATRAEMIA (>145 mmol/L)
Prevention
- Prevent high TEW loss
- use plastic wrap to cover babies of <32 weeks' gestation at birth
- nurse in high ambient humidity >80%
- use bubble wrap
- minimise interventions
- humidify ventilator gases

Causes
- Water loss (most commonly)
- TEW
- glycosuria
- Excessive sodium intake
- sodium bicarbonate
- repeated boluses of sodium chloride
- congenital hyperaldosteronism/diabetes insipidus (very rare)

Management depends on cause

Hypernatraemia resulting from water loss
Clinical features
- Leads to weight loss with hypernatraemia

Management
- Increase fluid intake and monitor serum sodium

Osmotic diuresis
Management
- Treat hyperglycaemia with an insulin infusion (see **Hyperglycaemia** guideline)
- Rehydrate with sodium chloride 0.9%

Hypernatraemia resulting from excessive intake
Management
- If acidosis requires treatment, use THAM (trometamol) instead of sodium bicarbonate
- Reduce sodium intake
- Change arterial line fluid to sodium chloride 0.45%
- Minimise number and volume of flushes of IA and IV lines

USING SYRINGE OR VOLUMATIC PUMP TO ADMINISTER IV FLUIDS

- Do not leave bag of fluid connected (blood components excepted)
- Nurse to check hourly:
- infusion rate
- infusion equipment
- site of infusion
- Before removing giving set, close all clamps and switch off pump

IV FLUIDS

Useful information

- Percentage solution = grams in 100 mL (e.g. glucose 10% = 10 g in 100 mL)
- 1 millimole = molecular weight in milligrams

Compositions of commonly available solutions

Fluid	Na mmol/L	K mmol/L	Cl mmol/L	Energy kcal/L
Sodium chloride 0.9% (iso-osmolar, isotonic)	150	-	150	-
Glucose 10% (hyperosmolar, hypotonic)	-	-	-	400
Glucose 10%/sodium chloride 0.18% (hyperosmolar, hypotonic)	30	-	30	400
Albumin 4.5%	150	1	-	-
Sodium chloride 0.45%	75	-	75	-

Useful figures

- Sodium chloride 30% = 5.13 mmol/mL each of Na and Cl
- Sodium chloride 0.9% = 0.154 mmol/mL each of Na and Cl
- Potassium chloride 15% = 2 mmol/mL each of K and Cl
- Calcium gluconate 10% = 0.225 mmol/mL of Ca
- Sodium bicarbonate 8.4% = 1 mmol/mL each of Na and bicarbonate
- Sodium chloride 0.9% 1 mL/hr = 3.7 mmol Na in 24 hr

Osmolality

- Serum osmolality = 2(Na + K) + glucose + urea (normally 285–295 mOsmol/kg)
- Anion gap = $(Na^+ + K^+) - (Cl^- + HCO_3^-)$ normally 7–17 mmol/L
- Normal urine: osmolality 100–300 mOsmol/kg, specific gravity 1004–1015
- Babies can dilute urine up to 100 mOsmol/kg, but can concentrate only up to 700 mOsmol/kg