# INTRAVENOUS FLUIDS FOR BABIES IN INCUBATORS

## PRINCIPLES

- Postnatal physiological weight loss is about 5-10%
- Postnatal diuresis is delayed in Respiratory Distress Syndrome (RDS)
- Preterm babies have limited capacity to excrete sodium in first 48 hr
- Liberal sodium and water intake before onset of natural diuresis is associated with an increased incidence of patent ductus arteriosus (PDA), necrotizing enterocolitis (NEC) and chronic lung disease (CLD)
- After diuresis, a positive sodium balance is necessary for tissue growth
- Preterm babies, especially born <29 weeks gestation lose excessive sodium through immature kidneys
- Babies <28 weeks have significant transepidermal water loss (TEW)
- TEW loss leads to hypothermia, loss of calories and dehydration, and causes excessive weight loss and hypernatraemia

## MONITORING

**Weigh**

- On admission
- Once daily – twice daily in babies ≤26 weeks gestation during first week, or if fluid balance is a problem
- use in-line scales if available

**Serum sodium**

- On admission in babies ≤28 weeks gestation
- Once daily in babies <28 weeks gestation, babies on IV fluids, TPN or unwell
- If electrolyte problems or ≤26 weeks, measure twice daily
- admission electrolytes reflect maternal status – need not be acted upon but help to interpret trends
- serum urea not useful in monitoring fluid balance – reflects nutritional status and nitrogen load

**Serum creatinine**

- Daily
- 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

**Urine output**

- Review 8-12 hrly
- 2-4 mL/kg/hr normal hydration
- <1 mL/kg/hr requires investigation
- >6-7 mL/kg/hr suggests impaired concentrating ability or excess fluids

## NORMAL REQUIREMENTS

**Humidification**

- If <29 weeks, humidify incubator 80%
- 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/24 hr) | |
|---|---|---|
| **Day of life** | **<1000 g** | **>1000 g** |
| 1 | 90 | 60 |
| 2 | 120 | 90 |
| 3 | 150 | 120 |
| 4 | 150 | 150 |

- **Day 1**
- glucose 10%
- **Day 2**
- glucose 10% and potassium 10 mmol in 500 mL
- if birth weight <1000 g, use TPN (with potassium 2 mmol/kg/day)
- 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 TPN (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 TPN

***Daily electrolyte requirements***

- Sodium 2-4 mmol/kg/day (5 mmol = 1 mL sodium chloride 30%)
- infants ≤30 weeks need at least 4 mmol/kg/day to overcome renal tubular loss
- Potassium 2 mmol/kg/day (2 mmol = 1 mL of potassium chloride 15%)
- Calcium 0.45 mmol/kg/day (0.45 mmol = 2 mL of calcium gluconate 10%) if supplementation required

# HYPONATRAEMIA (<130 MMOL/L)

Response to treatment should be proportionate to degree of hyponatraemia

**Causes**

- May reflect maternal electrolyte status in first 24 hr
- **Excessive free water** owing to:
- failure to excrete fetal ECF – common in first few postnatal days and failure to lose weight provides a clue to this aetiology
- inappropriate secretion of ADH in babies with major cerebral insults, or severe lung disease
- treatment with indometacin or ibuprofen
- **Excessive losses** – common beyond first few postnatal days in preterm infants and can be exacerbated by concomitant diuretic therapy, caffeine, diarrhoea, or adrenal disorders
- **Deficient intake** – preterm breast milk is poor in sodium, and breast-milk fed babies often develop hyponatremia beyond first week

***Management depends on cause***

**Excessive IV fluids**

- Reduce fluid intake by 20%

**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 by approximately 20-40%
- Sodium infusion only if serum sodium <120 mmol/L

**Acute renal failure**

- Reduce intake to match insensible losses + urine output
- Seek advice from a senior colleague

**Excessive renal sodium losses**

> ***Stop medication (diuretics, caffeine) that causes excess losses if possible***

***Check urinary electrolytes***

- Calculate urinary sodium losses from a spot urine sample using the formula: urinary sodium loss (mmol/kg/d) = 100 x $U_{Na}/U_{creat}$
- formula gives approximate urinary Na losses, and can be used to ensure losses are matched by oral/IV intake

***Increase sodium intake and monitor trend***

> ***Consider fluid retention when dealing with low sodium – may need restriction of fluid or reduction in supplementary sodium (over supplementation also leads to fluid retention***)

- Calculate sodium deficit
- = (135 – plasma sodium) x 0.6 x weight in kg
- replace over 24 hr unless sodium <120 or symptomatic (apnoea, fits, irritability)
- initial treatment should bring serum sodium up to about 125 mmol/L
- use sodium chloride 30% (5 mmol/mL) diluted – see **Neonatal Formulary**
- Once serum sodium corrected, use value from urinary Na losses (see above) to ensure adequate daily Na supplementation
- If sodium intake >5 mmol/kg/day, discuss with consultant (this amount should be sufficient to overcome normal tubular losses), and exclude other causes (e.g. medication, fluid retention and, very rarely, endocrine causes)

**Adrenal insufficiency**

***Clinical features***

- Hyperkalaemia
- Excessive weight loss
- Virilization 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 taking diuretics, stop or reduce dose

**Excessive sodium intake leading to water retention**

***Clinical features***

- Inappropriate weight gain

***Management***

- Reduce sodium intake

# HYPERNATRAEMIA (>145 MMOL/L)

**Prevention**

- Prevent high transepidermal water loss
- use plastic wrap to cover babies of <30 weeks gestation at birth
- nurse in high ambient humidity >80%
- use bubble wrap
- minimise interventions
- reduce need to open incubators
- humidify ventilator gases
- set humidifier temperature (Fisher Paykell recommend 39°C negative 2)

**Causes**

- Water loss
- transepidermal water loss
- 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***

- Weight loss and hypernatraemia

***Management***

- Increase fluid intake and monitor serum sodium
- If undergoing phototherapy, increase fluid intake by 10 mL/kg/day in very preterm babies

**Osmotic diuresis**

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

**Hypernatraemia resulting from excessive intake**

- If acidosis requires treatment, use THAM 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

# PRESCRIBING ELECTROLYTE ADDITIVES TO IV FLUIDS

- Use birth weight of baby until birth weight regained

**Calculate daily fluid requirement**

- Include volumes of any additional infusions (e.g. IA line, sedation) in calculations of intake

**Calculate hrly infusion rate of maintenance**

- Volume of IV fluid to be infused over 24 hr (V) = total to be infused – other fluids

**Calculate amount of calcium gluconate**

- Amount of calcium gluconate 10% to be added per 24 hr = 2 mL/kg calcium gluconate 10% (Y mL) per V mL of fluid
- Amount of calcium gluconate 10% to be added to a 500 mL bag (X) = Y x (500) divided by V mL

***Worked example in a 2 kg baby on 120 mL/kg with UAC at 1 mL/kg***

Y (calcium gluconate 10 %) = 2 mL/kg x 2 = 4 mL
V = (120 mL/kg x 2 = 240 mL) – (UAC at 1.0 mL/hr = 24 mL) = 216 mL
X mL (calcium gluconate 10%) = 4 mL (Y) x 500, divided by 216 (V) = 9.3 mL (round to nearest 0.5) = 9.5 mL

**Calculate amount of potassium**

- Use standard potassium-containing infusates
- 10 mmol/500 mL should meet daily maintenance requirements;
- for correction of hypokalaemia, use bag containing 20 mmol/500 mL

***Avoid addition of potassium to existing infusates wherever possible***

# IV FLUIDS – some useful information

- Percentage solution = grams in 100 mL (e.g. glucose 10% = 10 g in 100 mL)
- One 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% | 150 | - | 150 | - |
| glucose 10% | - | - | - | 400 |
| glucose 10% / sodium chloride 0.18% | 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 *strong KCl*
- Calcium gluconate 10% = 0.225 mmol/mL
- Sodium bicarbonate 8.4% = 1 mmol Na/mL
- Sodium chloride 1 mL/hr 0.9% = 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
- Neonates can dilute urine up to 100 mOsmol/kg, but can concentrate only up to 700 mOsmol/kg

***Glucose***

- To make glucose 12.5%, add 30 mL of glucose 50% to 470 mL of glucose 10%
- To make glucose 15%, add 60 mL of glucose 50% to 440 mL of glucose 10%
- Glucose 20% is commercially available
- Glucose 10% with sodium chloride 0.18% and 10 mmol potassium chloride is not commercially available but can be made up using 3 mL sodium chloride 30% and a 500 mL bag of glucose 10% with 10 mmol potassium chloride