

Intravenous Fluid Therapy in Children and Young People in Hospital

Neal Willis

Consultant Anaesthetist

Royal Hospital for Children

Glasgow

Aims of IV Fluid Therapy

- Maintain tissue perfusion
- Maintain blood glucose
- Maintain electrolytes

(until enteral route is available and functioning)

The Problem with Children...

- Heterogeneity of patient group
- Wide choice of IV fluid

24 hours' IV fluid for a 15kg child

Fluid	Sodium	Chloride	Potassium	Glucose
0.9% NaCl	192	192	-	-
0.9% NaCl + 5% glc + 0.15% KCl	192	217	25	62.5g
0.45% NaCl	96	96	-	-
0.45% NaCl + 5% glc + 0.15% KCl	94	119	25	62.5g
Plasmalyte 148	175	122	6.25	-
Plasmalyte 148 + 5% glc	175	122	6.25	62.5g
Hartmann's	141	139	6.25	-
0.18% + 4% glc	37.5	37.5	-	50g

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The Problem...

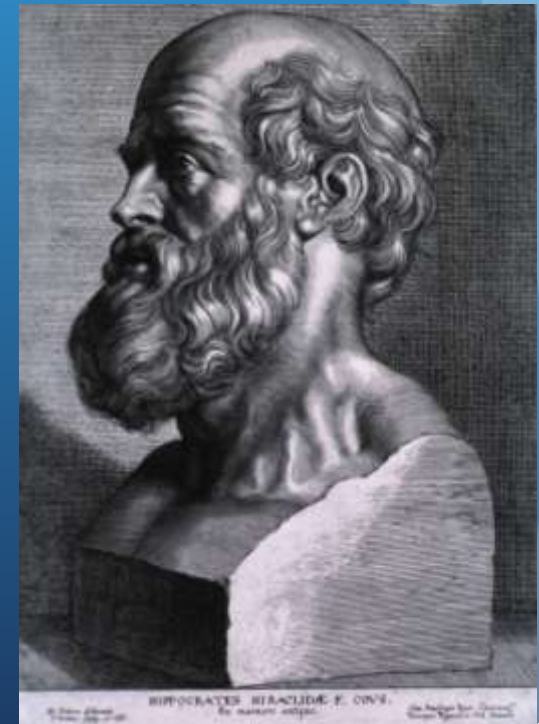
- Deficit in formal training and education
- Relatively difficult to monitor in children
- Not dealing with 'normal' physiology

The Physiology of the Problem

- Similar physiology seen in both seriously ill and post-operative children
- Increased antidiuretic hormone (ADH) activity
- Inappropriate expansion and dilution of extracellular fluid volume

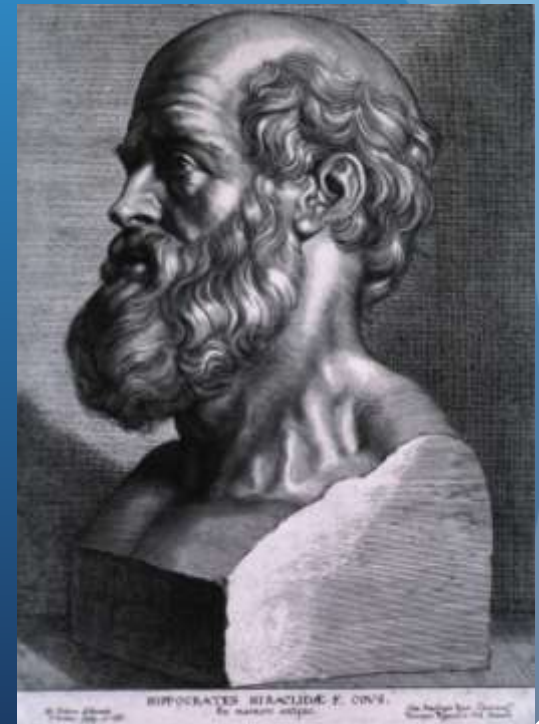
The Physiology of the Problem

- Hippocrates (460-370BC)
- *“When pneumonia is at its height, the case is beyond remedy if he is not purged, and it is bad if he has dyspnoea, and urine that is thin and acrid, and if sweats come out about the neck and head, for such sweats are bad, as proceeding from the suffocation, rales, and the violence of the disease which is obtaining the upper hand”*



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The Scope of the Problem

- Cooke, 1972
- Mor, 1975
- Potts, 1985
- Jackson, 2000

Patient Safety Alert:

Reducing the risk of hyponatraemia when administering intravenous infusions to children



- Between 2000 and 2007 there were 4 child deaths and one near-miss following neurological injury from hospital-acquired hyponatraemia reported in the UK
- Internationally, more than 50 cases of serious injury or child death, associated with the administration of hypotonic solutions

Intravenous fluid therapy in children and young people in hospital

NICE guideline

Published: 9 December 2015

[nice.org.uk/guidance/ng29](https://www.nice.org.uk/guidance/ng29)

Overview of Recommendations

- Assessing need for IV fluid therapy
- Neonates
- Children and Young People
- Derangement of plasma sodium
- Ongoing training and education

Patient Assessment and Monitoring

- Daily body weight
- Input, output and balance over last 24 hours
- Special instructions for prescribing, including relevant history
- An assessment of the fluid status
- The results of lab and point-of-care testing, including FBC, urea, creatinine, chloride, sodium, potassium, blood glucose and urinary electrolyte concentrations
- Details of any ongoing losses
- Calculation of fluid needs for routine maintenance, replacement, redistribution and resuscitation
- Fluid and electrolyte prescription
- Types and volumes of fluid input and output (urine, gastric and other), recorded hourly and with running totals
- 12-hourly fluid balance subtotals
- 24-hourly fluid balance totals
- 12-hourly reassessments of the fluid prescription, current hydration status, whether oral fluids can be started, urine and other outputs

Patient Assessment and Monitoring

- Measure plasma electrolytes and glucose when starting IV fluids, and at least every 24 hours thereafter
- 12-hourly full assessment and documentation of fluid status and expected fluid requirement

Term Neonates

(Infants aged 28 days and under)

Fluid Resuscitation

Use glucose-free crystalloids that contain sodium in the range 131-154mmol/l, with a bolus of 10-20ml/kg over less than 10 minutes

Reassess after completion of IV fluid bolus and decide whether they need more fluids

Seek expert advice if 40-60ml/kg is required as part of initial fluid resuscitation

Term Neonates

(Infants aged 28 days and under)

Fluid Maintenance

Calculate routine fluid maintenance based on age;

Birth to day 1:	50-60ml/kg/day
Day 2:	70-80ml/kg/day
Day 3:	80-100ml/kg/day
Day 4:	100-120ml/kg/day
Day 5-28:	120-150ml/kg/day

Initially use isotonic crystalloids that contain sodium in the range 131-154mmol/l with 5-10% glucose

Fluid	Sodium (mmol/l)	Chloride (mmol/l)	Potassium (mmol/l)	Glucose (mmol/l)
0.9% NaCl	154	154	-	-
0.9% NaCl + 5% glc + 0.15% KCl	154	174	20	50g
Plasmalyte 148	140	98	5	-
Plasmalyte 148 + 5% glc	140	98	5	50g
Hartmann's	131	111	5	-

Children and Young People

(Aged 29 days to under 16 years)

Fluid Resuscitation

Use glucose-free crystalloids that contain sodium in the range 131-154mmol/l, with a bolus of 20ml/kg over less than 10 minutes

Take into account pre-existing conditions; smaller volumes may be required

Reassess after completion of IV fluid bolus and decide whether they need more fluids

Seek expert advice if 40-60ml/kg is required as part of initial fluid resuscitation

Children and Young People

(Aged 29 days to under 16 years)

Fluid Maintenance

Calculate routine fluid maintenance using the Holliday-Segar formula;

100ml/kg/day for 1st 10kg of weight

50ml/kg/day for next 10kg of weight

20ml/kg/day for each kg over 20kg

(Males rarely need >2500ml/24hr and females rarely >2000ml/24hr)

Initially use isotonic crystalloids that contain sodium in the range 131-154mmol/l

Fluid	Sodium (mmol/l)	Chloride (mmol/l)	Potassium (mmol/l)	Glucose (mmol/l)
0.9% NaCl	154	154	-	-
Plasmalyte 148	140	98	5	-
Hartmann's	131	111	5	-

Replacement and Redistribution

- Adjust the IV prescription (in addition to maintenance needs) to account for existing deficits, ongoing losses or abnormal distribution
- Consider isotonic crystalloids that contain sodium in the range 131-154mmol/l for redistribution
- Use 0.9% sodium chloride containing potassium to replace ongoing losses
- Base subsequent fluid prescriptions on the plasma electrolyte concentrations and blood glucose measurements

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Vomiting and nasogastric tube loss

Gastric fluid contains:

- 20–60 mmol Na⁺/l
- 14 mmol K⁺/l
- 140 mmol Cl⁻/l
- 60–80 mmol H⁺/l

Excessive loss causes a hypochloaemic (hypokalaemic), metabolic alkalosis. Correction requires supplemental K⁺ and Cl⁻.

'Pure' water loss (e.g. fever, dehydration, hyperventilation)

Mainly insensible water loss (i.e. relatively low electrolyte content); results in potential hyponatraemia.

Biliary drainage loss

- 145 mmol Na⁺/l
- 5 mmol K⁺/l
- 105 mmol Cl⁻/l
- 30 mmol HCO₃⁻/l

Pancreatic drain or fistula

- 125–136 mmol Na⁺/l
- 8 mmol K⁺/l
- 56 mmol Cl⁻/l
- 85 mmol HCO₃⁻/l

Diarrhoea or excess colostomy loss

- 30–140 mmol Na⁺/l
- 30–70 mmol K⁺/l
- 20–80 mmol HCO₃⁻/l

Jejunal loss via stoma or fistula

- 140 mmol Na⁺/l
- 5 mmol K⁺/l
- 135 mmol Cl⁻/l
- 8 mmol HCO₃⁻/l

High volume ileal loss via new stoma, high stoma or fistula

- 100–140 mmol Na⁺/l
- 4–5 mmol K⁺/l
- 75–125 mmol Cl⁻/l
- 0–30 mmol HCO₃⁻/l

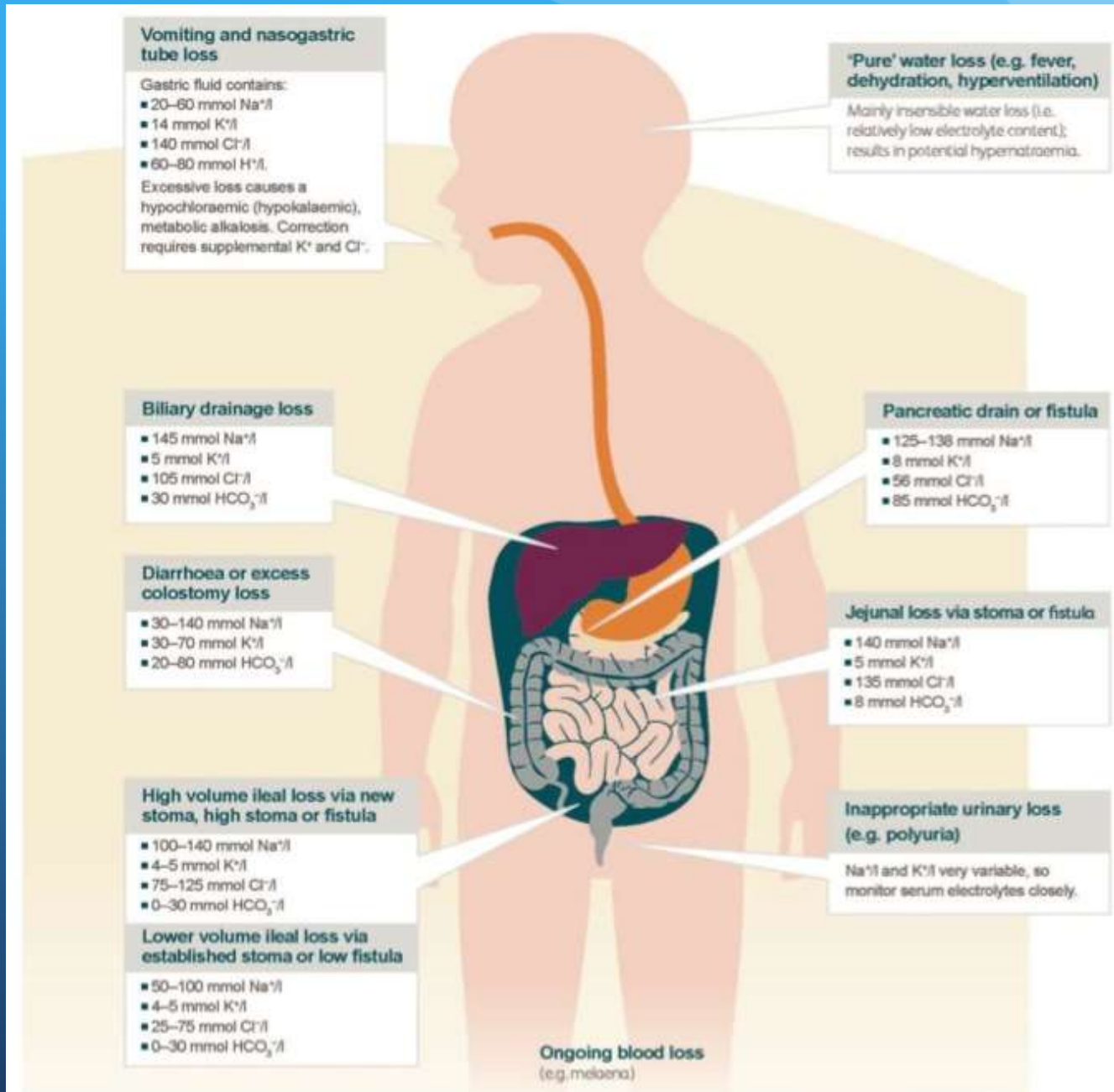
Inappropriate urinary loss (e.g. polyuria)

Na⁺/l and K⁺/l very variable, so monitor serum electrolytes closely.

Lower volume ileal loss via established stoma or low fistula

- 50–100 mmol Na⁺/l
- 4–5 mmol K⁺/l
- 25–75 mmol Cl⁻/l
- 0–30 mmol HCO₃⁻/l

Ongoing blood loss
(e.g. melæna)



So what could go wrong?



Asymptomatic Hyponatraemia

- Immediately review fluid status
- If receiving hypotonic fluid, change to an isotonic fluid
- If hypervolaemic or at risk of hypervolaemia, restrict IV maintenance fluids to 50-80% maintenance needs

Symptoms of Hyponatraemia

- Headache
- Nausea and vomiting
- Confusion, disorientation
- Irritability
- Lethargy
- Reduced LOC
- Convulsions
- Coma
- Apnoea
- (Death)

The Physiology of the Problem

- The intact blood-brain barrier prevents free movement of sodium
- Water moves freely to balance osmotic gradient



Symptomatic Hyponatraemia

- Immediately review the fluid status and seek expert advice.
- Consider the following treatment, in a controlled environment:
- Bolus 2ml/kg (max 100ml) 2.7% NaCl over 15 minutes
- Further bolus 2ml/kg if symptoms still present
- If symptoms still present, check plasma [Na] and consider a third bolus of 2ml/kg
- Ensure rate of rise of [Na] does not exceed 12mmol/l in 24 hours

Hypernatraemia

- Review fluid status immediately
- If evidence of dehydration, calculate water deficit and replace over 48 hours, initially with 0.9% NaCl
- If no evidence of dehydration and an isotonic fluid is being used, consider changing to a hypotonic fluid
- If fluid status uncertain, measure plasma and urine [Na]
- Ensure rate of fall of [Na] does not exceed 12mmol/l in 24 hours
- Measure plasma electrolytes every 4-6 hours for the first 24 hours

Resources Available to Support

<https://www.nice.org.uk/guidance/ng29/resources>

Guidance Tools and resources Information for the public Evidence History

Tools and resources Share

Tools to help you put the guidance into practice.

Educational resources

Algorithms

[Algorithms for IV fluid therapy in children and young people in hospital \(set of 6\)](#)
09 December 2015 PDF 1.25 MB

E-learning modules

Online learning tool

[Online learning tool](#)

Guidance into practice

[About the Into practice guide](#)
[Using NICE guidance and quality standards to improve practice](#)

Tailored education support

[Diagram of ongoing losses for children and young people](#)

[Diagram of ongoing losses for children and young people](#)
09 December 2015 PDF 177.24 KB

[Intravenous fluid types for children and young people](#)

[Intravenous fluid types for children and young people](#)
09 December 2015 PDF 67.14 KB

'Do not do' recommendations

['Do not do' recommendations](#)

Baseline assessment

[Baseline assessment tool](#)

[Baseline assessment tool](#)
09 December 2015 Excel 979 KB

Costing report

[Resource impact report](#)

[Resource impact report](#)
09 December 2015 PDF 173.85 KB

Research recommendations

[Research recommendations information](#)

Thank You

- Intravenous fluid therapy in children and young people in hospital. NICE Guidelines [NG29]. Published date: December 2015
- Reducing the risk of hyponatraemia when administering intravenous infusions to children. National Patient Safety Agency. Published 28th March 2007.
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