Intravenous Fluid Therapy in Children and Young People in Hospital

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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

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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
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
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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)

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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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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
• Intravenous fluid therapy in children and young people in hospital. NICE Guidelines [NG29]. Published date: December 2015


• Mor J, Ben-Galim E, Abrahamov A. Inappropriate Antidiuretic Hormone secretion in an infant with severe pneumonia. Am J Dis Child 1975; 129: 133-35


• Jackson J, Bolte RG. Risks of intravenous administration of hypotonic fluids for paediatric patients ED and prehospital settings: lets remove the handle from the pump. Am J Emerg Med 2000; 18: 269-70