NICE fluid guidelines – an update

Linkman meeting November 2013

Chris Gildersleve, Cardiff
Declaration of interest

APA Consensus guideline IV fluids in children
2007

NICE GDG - IV fluids therapy in children
2013
Outline

- NPSA Alert 22 2007
- APA Guidelines 2007
- MHRA assessment report 2012
- NICE 2013
Historical snippets

- 1492  First blood transfusion, Pope Innocent VIII?
- 1832  William O’Shaugnessy - “universal stagnation”
- 1832  Thomas Latta - First saline infusion
- 1834  John Mackintosh
        “…..advisable to make the fluid resemble plasma…..”
- 1950  Rochester plastic needle - David Massa
Definitions

- **Tonicity**
  Measure of osmotic pressure gradient of 2 solutions separated by a semi-permeable membrane

- **Isotonic**
  The same solute concentration as plasma

- **Hypotonic**
  A lower solute concentration than plasma
  4% dextrose/0.18% saline
Osmolality
Measure of the osmolar concentration of plasma/kg solvent
\[ \text{mOsmol/kg} \]
280-295 \text{mOsmol/kg}

Osmolarity
Calculation of the osmolar concentration of plasma/L solution
\[ \text{mmol/L} \]
\[ 2\text{Na} + \text{glucose} + \text{urea} \]
Background

Hospital acquired hyponatraemia

2000-07 4 deaths and 1 near miss

2002 RCPCH et al

RCoA News Bulletin 2003

Way et al. BJA 2006; 97: 371-9

Alert
28 March 2007

Reducing the risk of hyponatraemia when administering intravenous infusions to children

The National Patient Safety Agency (NPSA) is issuing advice to healthcare organisations on how to minimise the risks associated with administering infusions to children.

The development of fluid-induced hyponatraemia in the previously well child undergoing elective surgery or with mild illness may not be well recognised by clinicians. To date, the NPSA’s National Reporting and Learning System (NRLS) has received only one incident report (that resulted in no harm), but it is likely that incidents have gone unreported in the UK.

Since 2000, there have been four child deaths (and one near miss) following neurological injury from hospital-acquired hyponatraemia (see definition on page 7) reported in the UK.\(^1\)\(^2\)\(^3\) International literature cites more than 50 cases of serious injury or child death from the same cause, and associated with the administration of hypotonic infusions.\(^4\)

Action for the NHS and the independent sector

The NPSA recommends that NHS and independent sector organisations in England and Wales take the following actions by 30 September 2007 to minimise the risk of hyponatraemia in children:

1 Remove sodium chloride 0.18% with glucose 4% intravenous infusions from stock and general use in areas that treat children. Suitable alternatives must be available. Restrict availability of these intravenous infusions to critical care and specialist wards such as renal, liver and cardiac units.

2 Produce and disseminate clinical guidelines for the fluid management of paediatric patients. These should give clear recommendations for fluid selection, and clinical and laboratory monitoring.

3 Provide adequate training and supervision for all staff involved in the prescribing, administering and monitoring of intravenous infusions for children.

4 Reinforce safer practice by reviewing and improving the design of existing intravenous fluid prescriptions and fluid balance charts for children.

5 Promote the reporting of hospital-acquired hyponatraemia incidents via local risk management reporting systems. Implement an audit programme to ensure NPSA recommendations and local procedures are being adhered to.

For response by:

- All NHS and independent sector organisations in England and Wales

For action by:

- The chief pharmacist/pharmaceutical adviser should lead the response to this alert, supported by the chief executive, medical director, nursing director and clinical governance/health risk manager

We recommend you also inform:

- Clinical governance leads and risk managers
- Clinical directors – paediatrics and child health
- Directors of nursing, midwifery and porters
- Clinical directors – surgery
- Directors of NPSA laboratories
- Medical staff
- Nursing staff
- Pharmacy staff
- Patient advice and liaison service staff in England
- Procurement managers

The NPSA has informed:

- Chief executives of acute trusts, primary care organisations, ambulance trusts, mental health trusts and local health boards in England and Wales
- Directors of NPSA laboratories and clinical governance leads of strategic health authorities (England) and regional offices (Wales)
- Healthcare Commission
- Healthcare Inspectorate Wales
- Medicines and Healthcare products Regulatory Agency
- Business Services Centre (Wales)
- NHS Purchasing and Supply Agency
- Welsh Health Supplies
- Welsh Health Services
- NHS Direct
- Relevant patient organisations and community health councils in Wales
- Independent Healthcare Forum
- Independent Healthcare Advisory Services
- Commission for Social Care Inspection

For information request:

- NPSA/2007/22
Intraoperative practice

- 60.1% hypotonic solution
  
  *Way C et al. BJA 2006; 97: 371-9*

- 43% hypotonic solution
  - 40% drop Na
  - 20% <135 mmol/l

*Survey of practice 2006 vs. 2012 UHW, Cardiff. Ellul T, Gildersleve C*
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For immediate action:
• We recommend you also inform:
  • Clinical governance leads and risk managers
  • Medical directors – paediatrics and child health
  • Clinical directors – specialties
  • Clinical directors – surgery
  • Directors of NHS laboratories
  • Medical staff
  • Nursing staff
  • Pharmacy staff
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  • Procurement managers

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Alert 28 March 2007

Immediate action

Action ✔

Update

Information request

Ref: NPSA/2007/22

Actions

Remove 4% dextrose/0.18% saline

Guidelines

Training and supervision

Prescription/fluid balance charts

Report HAH incidents
Key questions

- Starvation
- Assessment/Monitoring
- Calculation
- Fluid replacement
- Glucose?
- Electrolyte correction
APA Guidelines

2007

Evidence?

Delphi

Update - 2010

CONSENSUS GUIDELINE ON PERIOPERATIVE FLUID MANAGEMENT IN CHILDREN

2007
APA 2007

Summary

Starvation

Assessment

Calculation

Fluid management plan

Electrolyte correction
APA 2007

Summary

- Starvation
- Assessment
- Calculation
- Fluid management plan
- Electrolyte correction

- Isotonic
- Glucose
  - Premature infants
  - Term neonates
  - Dextrose /TPN
  - <3rd centile
  - Prolonged surgery
  - Reduced stress response
- Monitor blood glucose
- 1-2.5% dextrose
APA 2007

Summary

- Isotonic
- Glucose

- Blood
  - Hct 25%
  - Exceptions
  - Albumin vs. artificial colloid

Starvation

Assessment

Calculation

Fluid management plan

Electrolyte correction
APA 2007
Summary

- Starvation Assessment
- Calculation
- Fluid management plan
- Electrolyte correction
- Isotonic Glucose
- Blood
- Monitoring
- Dilutional hyponatraemia
## Solutions

<table>
<thead>
<tr>
<th>Solution</th>
<th>Sodium content (mequiv/L)</th>
<th>Osmolality (mOsmol/kg)</th>
<th>Tonicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaCl 0.9%</td>
<td>154</td>
<td>Isosmolar (308)</td>
<td>Isotonic</td>
</tr>
<tr>
<td>NaCl 0.45%</td>
<td>77</td>
<td>Hyposmolar (154)</td>
<td>Hypotonic</td>
</tr>
<tr>
<td>NaCl 0.45% dextrose 5%</td>
<td>75</td>
<td>Hyperosmolar (432)</td>
<td>Hypotonic</td>
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<tr>
<td>Glucose 5%</td>
<td>-</td>
<td>Isosmolar (278)</td>
<td>Hypotonic</td>
</tr>
<tr>
<td>NaCl 0.9% dextrose 5%</td>
<td>150</td>
<td>Hyperosmolar (586)</td>
<td>Isotonic</td>
</tr>
<tr>
<td>NaCl 0.18% dextrose 4%</td>
<td>31</td>
<td>Isosmolar (284)</td>
<td>Hypotonic</td>
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</table>
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<tr>
<td>Hartmanns</td>
<td>131</td>
<td>Isosmolar (278)</td>
<td>Isotonic</td>
</tr>
<tr>
<td>Human Albumin solution 4.5%</td>
<td>100-160</td>
<td>Isosmolar (275)</td>
<td>Isotonic</td>
</tr>
</tbody>
</table>
“It is generally agreed that the maintenance requirements for water is determined by their caloric expenditure”

2 easily remembered equations

Holliday MA and Segar WE. *The maintenance need for water in parenteral fluid therapy*. *Pediatrics* 1957;19: 823-32
Holliday and Segar

<table>
<thead>
<tr>
<th>Body weight</th>
<th>Estimated energy expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10kg</td>
<td>100 cal/kg/day</td>
</tr>
<tr>
<td>10-20kg</td>
<td>100 + 50</td>
</tr>
<tr>
<td>&gt;20kg</td>
<td>1500 + 20</td>
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</table>

- Caloric cost:
  - insensible loss = 50
  - urinary loss = 66.7
  - (minus 16.7)

  = $100\text{ml}/100\text{cal day}$
### Maintenance fluid

<table>
<thead>
<tr>
<th>Body weight</th>
<th>Maintenance fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>0(3)-10kg</td>
<td>100 ml/kg/day</td>
</tr>
<tr>
<td>10-20kg</td>
<td>100 + 50</td>
</tr>
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“Fortuitously then, average needs for water expressed in ml equals energy expenditure in calories…. ”

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4/2/1 ml/kg/hr
2012 - time for a review?

- February 2012
  N Ireland enquiry restarts

- October 2012
  Hypotonic saline
  MHRA Safety warning

- November 2012
  NICE announces new guideline

The Inquiry into Hyponatraemia-related deaths
http://www.ihrndni.org/index.htm

- Established 2004
- 5 children
- Adjourned 2005
- Restarted 2012
MHRA and hypotonic saline

2001 Safety review
No reference to 4% dextrose/0.18% saline

2002/3 RCPCH and RCoA

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- Restrict availability
- Assessment and monitoring if used
- Hyponatraemic encephalopathy
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NICE guideline
Intravenous fluids therapy in children
Chair: Dr Peter Crean
Intravenous fluids therapy in children

*NICE timeline*

- Draft scope released - July 2013
- Stakeholder comments received - September 2013
- GDG recruitment
- First GDG meeting - end November 2013 (Final scope)
- November 2015 - Guideline published

http://guidance.nice.org.uk/CG/Wave0/655
Have we moved on?

**2007**
- Remove D4%/018% saline from stock and restrict availability
- Guidelines
- Training and supervision
- Safer prescribing/charting
- Reporting of hyponatraemic encephalopathy and audit

**2012**
- Dextrose 4%/0.18% saline contraindicated
- Remove from stock and restrict availability
- If used monitor and assess (ADH)
- Hyponatraemic encephalopathy
Moving on?

- **Awareness**
  
  *e.g. UHW 100% isotonic solution intraoperatively 2012*

- **Guidelines**
  - APA 2007
  - Institutional
    
    *Royal Children’s Hospital, Melbourne*
    

  
  *Toronto Sickkids*
  
Draft Scope

**In**
- Term infants >2wks
- Assessment and monitoring
- Resuscitation
- Maintenance
- Hyper/hyponatraemia
- Training and education

**Out**
- Adults >16yrs
- Term babies < 2 weeks (42 PCA)
- Blood/blood products
- Inotropes
- TPN
- Preparation and storage
- Ethical issues @end of life
<table>
<thead>
<tr>
<th><strong>Questions</strong></th>
<th><strong>Comments</strong></th>
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</thead>
<tbody>
<tr>
<td>How to calculate?</td>
<td>Simple as possible</td>
</tr>
<tr>
<td>Neonatal physiology?</td>
<td>72 hours</td>
</tr>
<tr>
<td>2 wk limit?</td>
<td>No, all term neonates</td>
</tr>
<tr>
<td>Special cases?</td>
<td>The surgical child</td>
</tr>
<tr>
<td></td>
<td>Difficulties of assessment and monitoring</td>
</tr>
<tr>
<td></td>
<td>Standardise fluid prescription chart</td>
</tr>
</tbody>
</table>
Review question: What is the most clinically and cost effective......?

- Calculating maintenance fluid requirements?
  - Weight
  - BSA
  - AN other
Newer solutions?

- **Plasma-Lyte 148**
  - Na: 140
  - Cl: 98
  - K: 5
  - Mg: 1.5
  - Acetate: 27
  - Gluconate: 23
Newer solutions
-different problems

- Plasma-Lyte 148
  - Alkalosis

- Hartmanns
  - K
  - Lactate

- N Saline
  - Hyperchloreaemic acidosis
Newer solutions?

- **Hartmanns + 1% dextrose**
  - European consensus statement for intraoperative fluid therapy in children.
  

  A novel isotonic balanced electrolyte solution with 1% glucose for intraoperative fluid therapy in neonates.

  *Sumpelmann R et al. Paediatr Anaesth 2011; 21:1114-8*
Summary

- 4% dextrose/0.18% saline is contraindicated
- Acute hyponatraemic encephalopathy is a medical emergency
- Guidelines are overdue
- Assessment, calculation, prescription and monitoring