

# Hyponatraemic Encephalopathy in Children

Peter Crean

Royal Belfast Hospital for Sick Children

## **MINISTER ANNOUNCES CHILD DEATHS INQUIRY**

Minister with responsibility for Health, Social Services and Public Safety, Angela Smith, today announced that she has appointed Mr John O'Hara QC to conduct an inquiry into the issues raised by the recent UTV Insight programme 'When Hospitals Kill'.

The Minister said: "I regard it as very important that the general public should have confidence in the health service and in the standards of performance of all who work in it. This television programme has raised a number of serious issues and allegations which need to be investigated.

"The death of a child is tragic and is something which my Department takes very seriously. I have spoken to the families who were involved in the programme and have told them that there will be a fully independent investigation.

"I am grateful to John O'Hara for agreeing to undertake this inquiry and I know that he will pursue a rigorous investigation of the issues."

### **NOTES TO EDITORS:**

The UTV Insight programme 'When Hospitals Kill' was broadcast on Thursday, 21 October 2004. It focused on the death of three children, Lucy Crawford, Raychel Ferguson and Adam Strain.

# Dilutional hyponatraemia in children

- Review of 24,412 consecutive paediatric surgical admissions (1989-91)
- Na  $\leq$  128 mmol/l in **83 of 24,412** postoperative surgical cases (0.34%)
- 7 deaths (<0.03%)
- Report of 16 cases of respiratory arrest with hyponatraemia (1984-1990)

# Symptomatic dilutional hyponatraemia in 16 children

## Presentations

Tonsillectomy (5)

Tonsillitis (2)

Elbow Fracture (2)

Fractures (RTA) (2)

VP shunt

Undescended testicle

Epistaxis

Appendicitis

Pneumonia

## Outcomes

Died (10)

Vegetative quadriplegia

Vegetative blind

Vegetative (3)

Mental retardation

# Postoperative hyponatraemic encephalopathy in children

- Prepubertal children more susceptible
- Usually involves a combination of:
  - Intravenous hyponatraemic fluids
  - Elevated ADH
  - Respiratory insufficiency secondary to hyponatraemic encephalopathy

# What is going wrong?

- Poorly challenged, old data applied to wrong patient groups
- No account taken of illness and hormonal responses to stress

# Anti-Diuretic Hormone

- Causes water retention and urinary sodium loss inappropriate for serum sodium concentration
- May cause severe unexpected hyponatraemia in stressed patients (even if appropriate levels of sodium are given)
- Treatment of excessive ADH production:
  - **Fluid restriction**

# any CHILD is AT RISK OF

# RECEIVING PRESCRIBED FLUIDS HYPONATRAEMIA

## INTRODUCTION

- Any child on IV fluids or oral rehydration is potentially at risk of hyponatraemia.
- Hyponatraemia is potentially extremely serious, a rapid fall in sodium leading to cerebral oedema, seizures and death. Warning signs of hyponatraemia may be non-specific and include nausea, malaise and headache.
- Hyponatraemia most often reflects failure to excrete water. Stress, pain and nausea are all potent stimulators of anti-diuretic hormones (ADH), which inhibit water excretion.
- Complications of hyponatraemia most often occur due to the administration of excess or inappropriate fluid to a sick child, usually intravenously.
- Hyponatraemia may also occur in a child receiving excess or inappropriate oral rehydration fluids.
- Hyponatraemia can occur in a variety of clinical situations, even in a child who is not overtly "sick". Particular risks include:
  - Post-operative patients
  - CNS injuries
  - Bronchiolitis
  - Burns
  - Vomiting

## BASELINE ASSESSMENT

Before starting IV fluids, the following must be measured and recorded:

- **Weight:** accurately in kg. (In a bed-based child use best estimate.) Plot on centile chart or refer to normal range.
- **U&E:** take serum sodium into consideration.

## FLUID REQUIREMENTS

Fluid needs should be assessed by a doctor competent in determining a child's fluid requirement. Accurate calculation is essential and includes:

### Maintenance Fluid

- 100ml/kg for first 10kg body wt, plus
- 50ml/kg for the next 10kg, plus
- 20ml/kg for each kg thereafter, up to max of 70kg. (This provides the total 24 hr calculation; divide by 24 to get the ml/hr).

### Replacement Fluid

- Must always be considered and prescribed separately
- Must reflect fluid loss in both volume and composition (lab analysis of the acid/base content of fluid loss may be helpful).

## CHOICE OF FLUID

- **Maintenance fluids** must in all instances be diluted by the anticipated sodium and potassium requirements. The glucose requirements, particularly of very young children, must also be met.
- **Replacement fluids** must reflect fluid loss. In most situations this implies a minimum sodium content of 130mmol/l.
- **When resuscitating** a child with clinical signs of shock, if a decision is made to administer a crystalloid, normal (0.9%) saline is an appropriate choice, while awaiting the serum sodium.
- The composition of oral rehydration fluids should also be carefully considered in light of the U&E analysis.

Hyponatraemia may occur in any child receiving any IV fluid or oral rehydration. Vigilance is needed for all children receiving fluids.

## MONITOR

- **Clinical state:** including hydration status. Pain, vomiting and general well-being should be documented.
- **Fluid balance:** must be assessed at least every 12 hours by an experienced member of clinical staff.

**Intake:** All oral fluids (including medicines) must be recorded and IV intake reduced by equivalent amount.

**Output:** Measure and record all losses (urine, vomiting, diarrhoea, etc.) as accurately as possible.

If a child does not reach prescribed fluids after 12 hours of starting, their requirements should be reassessed by a senior member of medical staff.

- **Biochemistry:** Blood sampling for U&E is essential at least once a day - more often if there are significant fluid losses or if clinical concern is not so expected.

The rate at which sodium falls is as important as the plasma level. A sodium that falls quickly may be accompanied by rapid fluid shifts with major clinical consequences.

Consider using an indwelling heparinised cannula to facilitate repeat U&Es.

Do not take samples from the same limb as the IV infusion. Capillary samples are adequate if venous sampling is not practical.

Urine osmolality/sodium: Very useful in hyponatraemia. Compare to plasma osmolality and consult a senior Paediatrician or a Chemical Pathologist if interpreting results.

## SEEK ADVICE

Advice and clinical input should be obtained from a senior member of medical staff, for example a Consultant Paediatrician, Consultant Anaesthetist or Consultant Chemical Pathologist.

- In the event of problems that cannot be resolved locally, help should be sought from Consultant Paediatricians/ Anaesthetists at the PICU, RBHSC.

- In November 2002 the Royal College of Anaesthetists circulated a flier from the RCPCH detailing concerns regarding water overload with severe hyponatraemia after infusion of 4% glucose/0.18% saline
- Issue discussed by both the Medicines Control Agency/ Committee on Safety of Medicines and by the Joint RCPCH/NPPG Standing Committee on Medicines
- Letter also appeared in Bulletin 18 The Royal College of Anaesthetists March 2003

# Perioperative fluid therapy in children - a survey of current prescribing practice

- Questionnaire regarding perioperative fluid management in children sent to consultant anaesthetists working in variety of hospital settings
- North Western and Bristol Schools of Anaesthesia
- 477 sent - 289 replies received
- Of these 203 anaesthetised children
  - 59.1% 'occasional' – no sessions
  - 32% had an interest – regular sessions < 50% workload
  - 7.9% specialist paediatric anaesthetist

# Results

- 76.7% no departmental policy for fluid prescription
- 58.1% unaware of RCPCH concerns
- 60.1% used glucose containing low sodium solutions intraoperatively and 75.2% did so postoperatively
- 34.9% used only Hartmann's or 0.9% saline
- Anaesthetists working in specialist hospitals
  - 5.1 times more likely to prescribe isotonic fluids intraoperatively
  - 13.2 times more likely to restrict fluids postoperatively
  - All prescribed hypotonic fluids postoperatively