

Papers

A study of current fluid prescribing practice and measures to prevent hyponatraemia in Northern Ireland's paediatric departments

Jarlath McAloon, Raj Kottyal

Accepted 30 August 2005

SUMMARY

Guidance on the prevention of hyponatraemia in children was issued by DHSSPSNI in March 2002. Two years later Dr Henrietta Campbell, the Chief Medical Officer, wrote to the Chief Executives of acute and combined trusts to seek assurances that the guideline had been incorporated into clinical practice and its implementation monitored. This paper reports the findings of the first prospective study undertaken to examine practice following introduction of the guidance. The evidence suggests that implementation has so far been incomplete and highlights problem areas. The paper reflects on potential explanations for the findings and makes practical suggestions for improvement.

INTRODUCTION

In November 2004, following the broadcast of the UTV Insight programme 'When Hospitals Kill' alleging that three children had died unnecessarily, the Minister with responsibility for Health, Social Services and Public Safety, Angela Smith announced that she had appointed Mr John O'Hara QC, to lead an inquiry into their hyponatraemia-related deaths. Examination of the care and treatment in relation to the management of fluid balance and the choice and administration of intravenous fluids will be a key component of the Inquiry in all three cases. Earlier in the same year Dr Henrietta Campbell, the Chief Medical Officer (CMO), had written to the Chief Executives of acute and combined trusts to seek assurances that the guidance issued by DHSSPSNI in 2002 on the prevention of hyponatraemia in children receiving prescribed fluids¹ had been both implemented and incorporated into clinical practice. In 2003, to promote further awareness and also to elaborate on the rationale underpinning the guideline, Jenkins and colleagues² in an Editorial in this journal highlighted the clinical situations where children are at greatest risk for developing elevated vasopressin levels, described associated risk factors and discussed how the choice of prescribed fluids can

contribute to dilutional hyponatraemia. Specifically the guideline recommends 0.9% saline as an appropriate crystalloid for resuscitation; directs that the anticipated Na⁺, K⁺ and glucose requirements, for which age is an essential factor, should determine the type of maintenance fluid and proposes that for most replacement scenarios fluid with minimum sodium content 130mmol/l should be used. Also incorporated is advice on patient assessment that includes checking the weight of the child; advice on how to calculate fluid requirements and details of the clinical and biochemical monitoring required while in receipt of IV fluids.

In response to the CMO's request for assurance that the guidance had been implemented the prospective

Paediatric Department, Antrim Hospital.

Jarlath McAloon, MPhil, Consultant Paediatrician.

Raj Kottyal, MB, Senior House Officer.

Correspondence to Dr Jarlath McAloon, Paediatric Department, Antrim Hospital, 45 Bush Road, Antrim, BT41 2RL.

Tel: (028) 94424000.

Fax: (028) 94424294.

E-mail: jarlath.mcaloon@uh.n-i.nhs.uk

study described in this paper, the first to examine guideline adherence in local paediatric units, was undertaken to examine practice and to identify any component(s) presenting implementation difficulty and if present to in turn reflect on possible practical solutions.

METHODS

All eight acute paediatric inpatient units in Northern Ireland were invited by one of the authors (JMA), through a lead clinician, to participate in a simultaneous snapshot of paediatric practice around the Province and readily accepted. It was proposed that the management of all patients in receipt of intravenous (IV) fluids between 12.00 and 14.00hrs on the same day in May 2003, and who had also been in receipt of IV fluids in the previous twenty-four hours, would be assessed for compliance with the guidance. This time window was chosen in the expectation that a morning ward round would normally by then have been conducted, thus providing a pragmatic method of targeting a high risk group requiring ongoing therapy post baseline assessment and for whom there would have been adequate opportunity for management plans, monitoring and associated decision making to have been put in place. Neonates and intensive care patients, whose management is different, were excluded. The lead clinicians were asked to inform the relevant Clinical Director(s) that the study was being planned; asked to identify a medical assistant for local data collection and to ensure that the date was kept confidential in order to avoid a positive influence on clinician behaviour. To facilitate maximum participation coordinators were reminded of the study date in the preceding week. The same single page data collection form, previously piloted and refined by a paediatric SHO (RK) during two one week trial periods at Antrim Hospital, was used in each contributing unit. Details of diagnosis, presence of dehydration, weight recording, fluid prescription and clinical and biochemical monitoring were transcribed from the case notes, fluid prescription and fluid balance sheets.

Details of the specific elements involved in monitoring, such as records of urinary output and vomiting were, for practical reasons, not included. Instead it was assumed that a documented record of any reassessment of requirements indicated that assessment of all the key components had occurred.

Consistency of data interpretation for the purpose of comparing actual management with expected

guideline management was facilitated by having the same experienced clinician (JMA) analyse the returned data forms and cross reference the diagnosis and assessment of fluid balance status against the record of prescription for each individual patient. Also, when the adequacy of data return permitted all calculations of fluid volumes prescribed were recalculated by JMA. To facilitate collation of information a prescription for maintenance fluids was judged to be inconsistent with the guideline if the volume prescribed was greater than $\pm 5\%$ and inappropriate if greater than $\pm 10\%$ of the guideline calculation. The rationale for this percentage limit is that in terms of degrees of dehydration a larger variation could correspond to incorrect management e.g. treating a moderately dehydrated patient for mild dehydration or vice versa.

As the recruitable numbers able to satisfy the strict inclusion criteria were small an identical exercise was repeated on two further days, one in June 2003 and one in January 2004.

RESULTS

There were thirty-eight eligible children for whom forms with complete/near complete data were returned. All units contributed at least one patient. Twenty-six children had a medical diagnosis and twelve had a surgical problem, eight of whom were in the post operative period. Four children had conditions for which not all elements of the guidance were relevant (see sections b, e). The grades of staff prescribing the fluids were PRHO (4); first term SHO (19); second term SHO (5); SpR (5); SAS (1); consultant (3) with one unknown. The results for adherence to each key component of the guideline are described below with the main findings summarised in table 1.

a. Was the child's weight recorded?

Data were returned for thirty-five children. Weight was measured in 33 cases and estimated in 2.

b. Was the calculation for maintenance IV fluid volume consistent with the guidance?

Of the thirty-seven children with this data returned there were two children receiving fluid treatment in association with chemotherapy and one with a diagnosis of benign intracranial hypertension in whom an alternative protocol was being followed and for whom the guideline maintenance calculation was not applicable. Eighty-two percent of relevant calculations

TABLE I

<i>Guideline adherence question</i>	<i>Total</i>	<i>yes</i>	<i>no</i>
b. was maintenance calculation consistent with guidance?	34	28	6
c. was IV fluid composition appropriate?	35	35	0
d. were maintenance & replacement prescribed separately	7	2	5
e. was fluid balance assessed at least 12 hourly?	33	15	18
f. was U&E checked at least once per 24 hours?	34	30	4
g. was oral intake considered in IV prescription?	23	12	11

Adherence to DHSSPSNI guidance¹ on prescribed fluids and hyponatraemia

were consistent with the guidance. There were three calculations judged guideline inconsistent and three others judged inappropriate.

- c. Was the composition of IV fluids used appropriate?

Data were returned for thirty children who had received either maintenance fluids alone or both resuscitation and maintenance fluids plus five other children who also had a prescription for replacement and/or ongoing losses. The electrolyte and glucose content of the fluid utilised was suitable in all thirty-five cases.

- d. Were maintenance and replacement fluids prescribed separately?

The return for this question provided information on a further two children i.e. a total of seven, who had both maintenance and replacement losses prescribed. Two of the seven had replacement prescribed separately but five did not.

- e. Was fluid balance assessed at least every twelve hours?

Of thirty-seven data returns the guidance was considered applicable only to thirty-three as three were following an alternative fluid regimen and one was terminally ill. Forty-five percent had documented evidence of reassessment of requirements in the first twelve hours of treatment. Sixty-six percent had reassessment within the first twenty-four hours. Thirty-three percent had no record of reassessment.

- f. Was U&E checked at least once per twenty-fours?

There were thirty-four data returns for whom

the guidance was applicable. Twelve percent had not had a U&E checked any time in the preceding 24 hours. There were no children with severe hyponatraemia ($\text{Na}^+ < 130\text{mmol/l}$) though nine children had a $\text{Na}^+ < 135\text{mmol/l}$ at some point.

- g. Was the oral fluid intake considered in the most recent IV fluid prescription?

Allowance for oral intake occurred in only fifty-two percent of the twenty-three children for whom the guidance was relevant.

- h. What oral fluids were used during this period?

Information was provided for seventeen of the twenty-three treated with both oral and IV fluids and is summarised in table 2.

Table II

<i>Fluid type</i>	<i>n</i>
Water	2
water and juice	4
water and soup	1
Juice	2
juice and milk	1
Milk	5
rehydration solution	2

Types of oral fluid administered concurrently with IV fluids

DISCUSSION

While the number of children in the study was inevitably small the information obtained should be a valid reflection of clinical practice following issue of the guidance and it is consequently important. As the study period included three induction periods for new/ changing medical staff it is reasonable to conclude that there was sufficient opportunity for the guideline to be both fully disseminated and introduced. Also the patients reported were those with the highest risk of fluid therapy associated complications for whom greatest awareness and attention to the application of the management guidelines would be expected.

The standard for weight, namely that it should always be measured or estimated in a bed bound child, was met. However this may not necessarily reflect guideline conscious behaviour as recording of weight has become part of normal paediatric practice regardless of diagnosis.

The standard achievement rate (82%) for maintenance fluid calculation was also high but with some evidence of the co-existence of potentially significant variation from advised practice. Jenkins and colleagues² acknowledge that guidance on maintenance fluid requirements is general guidance and emphasise that assessment should be individualised. We allowed for this in our evaluation by accepting a total calculated volume within +/- 5% of the guideline value as meeting the standard. Of the six children whose calculation was outside the guideline there were three whose prescriptions were classified as inappropriate, two being underestimates and the third an overestimate. The two underestimates were in a fifteen year old (-17%) on day 1 post appendicectomy with a first term SHO as prescriber and in a thirteen year old (-19%) with urinary infection and prescriber not indicated. The overestimated child was a six year old (+27%) admitted with vomiting and constipation but no dehydration and for whom the prescriber was a first term SHO. The management of his child is of concern though close monitoring did take place with the U&E checked on four occasions and the lowest Na⁺ recorded was 134mmol/l.

While there was full compliance in implementing the standard for appropriate fluid choice problems were encountered at the next step, namely recording the prescription. A separate prescription for maintenance and replacement fluids is recommended to reduce the potential risk of excess fluid administration resulting from a combined prescription inadvertently over running the deficit correction period. Separation of

the prescriptions did not occur in seventy percent of relevant situations. While this may reflect lack of clinical awareness, another factor may be lack of user friendliness of available prescription sheets.

Monitoring of hydration status and fluid balance is essential. The guideline specifies that reassessment should occur at least twelve hourly but this was only recorded in the minority of cases. It is unlikely that this finding is attributable more to poor record keeping than lack of reassessment as there were four children identified who had no U&E checked during twenty-four hours of IV therapy, three of whom had actually been on full maintenance. These three included two post-operative, hence relatively high risk, patients aged 6 weeks and 11 years and a 8 year old with septic arthritis. The rigour of some assessments is also of concern as, contrary to advice, no consideration had been allowed for the oral intake in fifty percent of relevant prescriptions.

The guidance mentions hyponatraemic risk in association with use of inappropriate oral fluids but there were only two children whose oral fluid was a commercial rehydration solution (*Table 1*). The prevalent use of hypotonic solutions in this high risk group suggests that common practice needs to be reviewed.

In summary the evidence is that implementation of the Regional guidance has so far been incomplete. This could indicate that there is inadequate guideline awareness due to failure of training programmes and/ or failure of units to provide direction to junior staff. An alternative explanation is that there may be intrinsic operational hindrances to implementing the guideline. If not done already, units should organise a review by nursing, pharmacy and medical staff, both junior and senior, to identify the difficulties and possible solutions. Relevant issues for discussion and action could include: the redesign of prescription sheets to facilitate separation of prescriptions when only one IV infusion/line is present; the facility to indicate required infusion finish times; the provision of action boxes on fluid balance sheets to trigger clinical and biochemical reassessments; appending for reference a simplified maintenance fluid calculation formula on the back of prescription sheets; outlining clinical descriptions for assessment of hydration status on the back of fluid balance forms; provision of oral fluid management information and advice for carers and the introduction of a method for effective nursing and medical handover of management plans for all children receiving IV fluids. Redrafted or new documentation could be

standardised in all trusts and a consensus should be developed on the appropriate use of hypotonic oral fluids with the original guideline Working Group providing a strategic overview.

To conclude, it is probable that the current guidelines will be modified in conjunction with the developing evidence base on appropriate fluid therapy in situations where physiology is not normal, such as illness or postoperatively. Internationally best practice is still controversial^{3,4} and preparation of definitive protocols is not yet possible, unlike hyperkalaemia where a consensus is now being reached.⁵ Until then it is essential that all clinicians in Northern Ireland caring for children in receipt of fluid therapy know of the associated risks and are aware of our Regional best practice guidance and that paediatric departments initiate a process of regular monitoring of guidance adherence as part of their multidisciplinary audit and clinical governance programme.

The Authors have no conflict of interest.

ACKNOWLEDGEMENTS

The willing collaboration of Mr A Bailie, Drs A Bell, C Corkey, N Corrigan, J O'Donohoe, M Rollins, M Smith in arranging the data collection is acknowledged. Thanks to Dr J Jenkins for reviewing the paper and his helpful suggestions for improvement.

REFERENCES

1. DHSSPS. Published information: hyponatraemia wall chart. 2002. Available from URL: <http://www.dhsspsni.gov.uk/publications/2002/Hypno%20WallChart.pdf>
2. Jenkins J, Taylor B, McCarthy M. Prevention of hyponatraemia in children receiving fluid therapy. *Ulster Med J* 2003; **72(2)**: 69-72.
3. Duke T, Molyneux E. Intravenous fluids for seriously ill children: time to reconsider. *Lancet* 2003; **362(9392)**: 1320-23.
4. Moritz M, Ayus J. Hospital-acquired hyponatraemia: why are there still deaths? *Pediatrics* 2004; **113(5)**: 1395-6.
5. McVeigh G. Management of hyperkalaemia in adults. *Ulster Med J* 2005; **74(2)**: 75-77.