

Newsletter - March 2006

MESSAGE FROM THE CHAIR

On behalf of the Council of Obstetric and Paediatric Mortality & Morbidity I would like to welcome you to the inaugural edition of Council's newsletter which will be published on a quarterly basis. The implementation of a newsletter has been in response to a request from the Minister for Health; Hon. David Llewellyn, who has indicated that the Council's recommendations should be more actively disseminated to relevant practitioners including Obstetricians, Paediatricians, Midwives and DONs. The aim of this newsletter is therefore to inform practitioners of recently identified problems which will require attention by some institutions. We hope that you find the comments useful. I would also like to inform you that the Council 2003 Report has now been issued and contains several recommendations. The 2004 Annual Report is currently being progressed following a period of hiatus related to data lag and resource constraints. It is envisaged that it will be near completion by the end of the financial year with the 2005 Annual Report to be released later in the year.



Dr Simon Parsons
Chairperson
Council of Obstetric & Paediatric Mortality & Morbidity

COUNCIL NEWS

The Council of Obstetric and Paediatric Mortality and Morbidity was established under the Perinatal Registry Act of 1994. One of the functions of the Council is to investigate the circumstances surrounding all maternal, Paediatric and perinatal deaths in Tasmania. Four subcommittees have been established under the auspices of the Council to assist in the review of such aspects as all Paediatric deaths (c.f., Paediatric Mortality & Morbidity Sub-Committee); and Maternal deaths (c.f., Maternal Mortality & Morbidity Sub-Committee) etc. Current membership in accordance with the Terms of Reference include Dr Simon Parsons (Chair); Mr Nick Goddard; Professor Allan Carmichael; Dr Geoff Shannon; Dr Elizabeth Hallam; Mr David Fanning; Ms Ros Escott; Dr Peter Dargaville; & Mr Peter Askey-Doran. Whether a new Chairman should be nominated in view of the changes in membership for the next term, will be decided at the next meeting of Council. All members have received a formal invitation from the Minister and following acceptance will hold office for a term not exceeding 3 years.

To date, the Council has achieved a systematic response across the state for important data collection and focus on quality and safety of maternal and paediatric services. Local (hospital) reviews of perinatal deaths and initially infant deaths have been systematically undertaken whereas these had previously followed an ad hoc process. The Council also communicates findings in a manner in which all practitioners are informed on factors that would prevent maternal, infant and later childhood morbidity and mortality.



A Council logo has been developed and is previewed as part of the letterhead in this inaugural edition of the newsletter. Its formal use will need to be ratified by full Council at its next meeting in May. In the meantime, your consideration of this logo and feedback is welcomed.

The development of a website for the Council is also currently being explored. Once completed it will archive newsletters, Annual Reports and various other information relevant to Council's activities for members' record and easy accessibility.

RECENTLY IDENTIFIED PROBLEMS

1. **Group B Strep. Prophylaxis-** There has been at least one case of a woman in labour not receiving the recommended antibiotic regime to prevent this. It is recommended that all hospitals must implement a GBS prophylaxis guideline. A recent statement from the RANZCOG can be accessed: <http://www.ranzcog.edu.au/publications/statements/C-obs19.pdf>.
2. **Delay in transfers-** Unfortunately Tasmania does not have a highly efficient Neonatal or Paediatric emergency transport system due to the aircraft location in Launceston. At some stage we hope to improve the current situation in conjunction with the building and staffing of the new Neonatal and Paediatric Intensive Care and High Dependency Unit in Hobart.
3. **Airway management-** There have been recent incidents of incorrectly located (oesophageal) endotracheal tubes and incorrectly sized endotracheal tubes (leading to subglottic stenosis). The Council recommends involving persons with expertise in airway management when endotracheal tubes require placing.
4. **Management of Septic Shock-** several cases of suboptimal management of septic shock have been identified. The Council recommends all practitioners review recent international guidelines: <http://www.survivingsepsis.org/documents/SSCGuidelines.pdf>
5. **Iatrogenic Hyponatraemia-** fluid guidelines for children have recently evolved with higher content sodium containing solutions and less overall water delivery being recommended for most sick children. Some readers will find the Royal Hobart Hospital Department of Paediatric Guidelines to be helpful. These have been attached at the end of the newsletter for your convenience.
6. **Increased risk of SIDS -** It must be stressed that while bed-sharing is common, it however has been associated with infant death. SIDS recommendations (endorsed by RACP) caution parents that there is an increased risk of SIDS for babies or toddlers co-sleeping with adults if they get caught under bedding or between the wall and bed, fall out of bed or are rolled on by someone who sleeps very deeply or is affected by drugs or alcohol, or their mothers smoke. Current information in relation to safe sleeping does not appear to be getting through and additional support in the community is warranted.

SUBCOMMITTEES

PAEDIATRIC Mortality & Morbidity

This subcommittee continues to meet regularly on the 3rd Thursday of every second month (unless otherwise specified). Current members include Dr Elizabeth Hallam (Chair), Dr Chris Lawrence, Dr Thomas (Geoff) Shannon, Dr Simon Parsons and Mr David Fanning.



Chair's Contact details: Dr Liz Hallam; email: lizhallam@bigpond.com

PERINATAL Mortality & Morbidity

It was agreed at the last meeting of Council that membership of this subcommittee be revised to include a neonatologist, midwife and obstetrician.

Chair's Contact details: Dr Simon Parsons, email: simon.parsons@dhhs.tas.gov.au

MATERNAL Mortality & Morbidity

It was agreed at the last meeting of Council that this subcommittee be reviewed and meet on a more regular basis to look at both mortality and morbidity.

Chair's Contact Details: Dr Shelby Jarrell; email: shelby.jarrell@dhhs.tas.gov.au

DATA MANAGEMENT

This subcommittee has not met for a considerable period of time. Council recommended that it may be necessary to meet with the current Chair, Dr Rupert Sherwood to ascertain how the subcommittee operates and review membership.

Chair's Contact details: Dr Rupert Sherwood; email: rupert.sherwood@dhhs.tas.gov.au

MEMBERSHIP CHANGES

With the resignation of Dr Melwyn D'Mello from Council, RANZCOG has been contacted to seek a new nomination and representative on the Council. Dr James Brodribb has recently been nominated to represent RANZCOG on Council.

NEW APPOINTMENTS

The new Head of Obstetrics & Gynaecology at the RHH will be Professor Michael Humphrey and he will commence his appointment in June 2006.

MEETINGS FOR 2006

Next Council Meetings:

- Thursday 25 May, 12.30-2.00pm, DSU Meeting Room
- Thursday 24 August, 12.30-2.00pm, DSU Meeting Room
- Thursday 23 November, 12.30-.00pm, DSU Meeting Room

Next Paediatric Mortality & Morbidity Subcommittee Meetings:

- Thursday 23 March, 1.00-2.00pm, Forensic Pathology, Level 4 H Block, RHH
- Thursday 18 May, 1.00-2.00pm, Forensic Pathology, Level 4 H Block, RHH
- Thursday 20 July, 1.00-2.00pm, Forensic Pathology, Level 4 H Block, RHH
- Thursday 20 September, 1.00-2.00pm, Forensic Pathology, Level 4, RHH
- Thursday 16 November, 1.00-2.00pm, Forensic Pathology, Level 4, RHH

Note: All other subcommittee meetings will be advised.

Secretariat Contact Details: Dr Jo Jordan; email: jo.jordan@dhhs.tas.gov.au



INTRAVENOUS FLUIDS, SODIUM GUIDELINES

ROYAL HOBART HOSPITAL

2005-11-19

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The incorrect prescription of maintenance and rehydration intravenous fluids for children is a common cause of morbidity and a significant cause of mortality due to iatrogenic hyponatraemia. There have been >50 reported cases of neurologic morbidity and mortality, including 26 deaths, in the past 10 years¹.

Thus there has been a recent major change in our thinking regarding intravenous fluid administration in sick children². These changes are *not* reflected in even new edition textbooks (Nelson 17th edition, 2004). In summary, traditional maintenance amounts of water, that are based on water requirements to deliver sufficient calories are often inappropriately high for sick children, who frequently exhibit reduced calorie expenditure and reduced free water clearance, probably due to IADH secretion and possibly renal salt wasting. This is particularly a problem in post-operative patients, bronchiolitis, head injury and all sedated and/or ventilated patients.

The above problem has been compounded by a recognition that traditional assessment of dehydration with a classification into 5, 10 and > 10% dehydration has been shown to be incorrect, often overestimating the degree of dehydration by an average of 3.2%. Children with gastroenteritis initially appear dehydrated at only 3-4% loss of total body weight as water, not 5%³. Elevated urea (good specificity) and anion gap (good sensitivity) indicate some degree of dehydration, but can be elevated in only mild dehydration⁴. Several accurate simple clinical scoring systems have been devised recently:

1. Any 2 of following 4 clinical features:

- capillary refill > 2 seconds,
- absent tears,
- dry mucous membranes,
- ill general appearance,

indicate \geq 5% deficit in children 1 month to 5 years old⁵.

¹ [Moritz ML, Ayus JC](#). Prevention of hospital-acquired hyponatremia: a case for using isotonic saline. Paediatrics. 2003 Feb;111(2):227-30. Review.

² [Duke T, Molyneux EM](#). Intravenous fluids for seriously ill children: time to reconsider. Lancet. 2003 Oct 18;362(9392):1320-3. Review.

³ [Mackenzie A, Barnes G, Shann F](#). Clinical signs of dehydration in children. Lancet. 1989 Sep 9;2(8663):605-7.

⁴ [Shaoul R, Okev N, Tamir A, Lanir A, Jaffe M](#). Value of laboratory studies in assessment of dehydration in children. Ann Clin Biochem. 2004 May;41(Pt 3):192-6.

⁵ [Gorelick MH, Shaw KN, Murphy KO](#). Validity and reliability of clinical signs in the diagnosis of dehydration in children. Pediatrics. 1997 May;99(5):E6.

2. 8 point scoring system for children 1 – 36 months of age⁶ used to classify children into minimal dehydration (>0, <3%), mild dehydration (≥3, <6%), moderate dehydration (≥6, <10%), severe dehydration (≥10%):
- General appearance (normal - 0 vs. thirsty, irritable, lethargic, restless - 1 vs. drowsy, cold, sweaty, limp ± comatose - 2)
 - Eyes (normal - 1 vs. slightly sunken - 1 vs. very sunken - 2)
 - Mucous membranes (moist - 0 vs. sticky - 1 vs. dry - 2)
 - Tearing (normal - 1 vs. reduced - 1 vs. absent - 2)

Score	Degree of dehydration	% of body weight lost as water
1-2	minimal	>0, <3
3-4	mild	≥3, <6
5-6	moderate	≥6, <10%
7-8	severe	≥10%

Any child who is hypotensive (age relative, see fluid guidelines) is ≥10% dehydrated.

Traditional markers of dehydration that have been consistently shown to be *inaccurate* are HR, RR, BP, cool peripheries, urine output, skin mottling, and abnormal skin turgor.

⁶ [Friedman JN, Goldman RD, Srivastava R, Parkin PC.](#) Development of a clinical dehydration scale for use in children between 1 and 36 months of age. *J Pediatr.* 2004 Aug;145(2):201-7.

⁷ See DKA guidelines.

⁸ [Wathen JE, MacKenzie T, Bothner JP.](#) Usefulness of the serum electrolyte panel in the management of pediatric dehydration treated with intravenously administered fluids. *Pediatrics.* 2004 Nov;114(5):1227-34.

⁹ [Reid SR, Losek JD.](#) Hypoglycemia complicating dehydration in children with acute gastroenteritis. *J Emerg Med.* 2005 Aug;29(2):141-5.

¹⁰ Note evidence for this common belief is lacking.

¹¹ [Grunhagen DJ, de Boer MG, de Beaufort AJ, Walther FJ.](#) Transepidermal water loss during halogen spotlight phototherapy in preterm infants. *Pediatr Res.* 2002 Mar;51(3):402-5.

¹² Recent RCT from Sydney comparing NS with N/2 indicates that NS may be the preferred solution in terms of managing and preventing hyponatraemia in dehydrated children. [Neville KA, Verge CF, Rosenberg AR, O'Meara MW, Walker JL.](#) Isotonic is better than hypotonic saline for intravenous rehydration of children with gastroenteritis: a prospective randomised study. *Arch Dis Child.* 2006 Mar;91(3):226-32. Epub 2005 Dec 13.

¹³ [van den Berghe G, Wouters P, Weekers F, Verwaest C, Bruyninckx F, Schetz M, Vlasselaers D, Ferdinande P, Lauwers P, Bouillon R.](#) Intensive insulin therapy in the critically ill patients. *N Engl J Med.* 2001 Nov 8;345(19):1359-67.

¹⁴ [Srinivasan V, Spinella PC, Drott HR, Roth CL, Helfaer MA, Nadkarni V.](#) Association of timing, duration, and intensity of hyperglycemia with intensive care unit mortality in critically ill children.

Pediatr Crit Care Med. 2004 Jul;5(4):329-36. [Branco RG, Garcia PC, Piva JP, Casartelli CH, Seibel V, Tasker RC.](#) Glucose level and risk of mortality in pediatric septic shock. *Pediatr Crit Care Med.* 2005 Jul;6(4):470-2.

¹⁵ [Kanaan U, Dell KM, Hoagland J, O'Riordan MA, Furman L.](#) Accelerated intravenous rehydration. *Clin Pediatr (Phila).* 2003 May;42(4):317-24. [Reid SR, Bonadio WA.](#) Outpatient rapid intravenous rehydration to correct dehydration and resolve vomiting in children with acute gastroenteritis. *Ann Emerg Med.* 1996 Sep;28(3):318-23.

¹⁶ [Sarnaik AP, Meert K, Hackbarth R, Fleischmann L.](#) Management of hyponatremic seizures in children with hypertonic saline: a safe and effective strategy. *Crit Care Med.* 1991 Jun;19(6):758-62.

Of note is that the degree of dehydration in DKA cannot be accurately predicted, but averages 8%⁷.

Routine measurement of electrolytes, urea and bicarbonate alter management in only 10% of cases of dehydration due to gastroenteritis⁸, but it is recommended that all children requiring hospital admission should have U&Es and glucose checked at least initially.

Hypoglycaemia occurs in up to 9.2% of children with dehydration due to acute gastroenteritis⁹.

Another common source of error is in neonates when traditional teaching is that newborns should be upgraded over the first week of life to 150 ml/kg/day of fluid. This 'optimal' amount simply reflects the volume of 20 Cal per 30 mL of formula required to give adequate calories for normal growth. Term infants and many preterm infants require much less water than this when relying on IV hydration and should be managed the same as older infants and children in this regard.

Maintenance total daily IV fluid rate

Patients weight	mls/day	mls/hour
3 to 10kg	100 x wt	4 x wt
10 - 20kg	1000 + 50 x (wt-10)	40 + 2 x (wt-10)
>20kg	1500 + 20 x (wt-20)	60 + 1 x (wt-20)

Alternatively:

4 ml/kg/hour for first 10 kg
 + 2 ml/kg/hour for next 10 kg
 + 1 ml/kg/hour for each kg above 20 kg

The following calculator or table may also be used to estimate maintenance fluid requirements.

Weight (kg)	4	6	8	10	12	14	16	20	30	40	50	60	70
ml/hr	16	24	32	40	44	48	52	60	70	80	90	100	100

Most hospitalized children do not require full maintenance fluids and thus should be corrected for:

Less if in a basal state (i.e. very inactive lying in bed, e.g. post-operative).	-25%
Less in children on mechanical ventilation with humidified gases.	-25%
More in children with fever ¹⁰ .	+10 to 20%
Less in children with excessive secretion of Antidiuretic Hormone (ADH) e.g. pneumonia, meningitis, cerebral oedema, head injury, HIE	Varies (-20 to 40%)
More if unable to concentrate urine (eg some renal diseases, Diabetes insipidus)	Varies
Less if in established renal failure – insensible losses only plus urine output	20-40% of normal maintenance + UO
More of under phototherapy for preterm infants in humidified incubator ¹¹	+ 0.35 ml/kg/HR
Burns	See separate guideline

The recommended fluid to be infused as maintenance and replacement for with normal serum electrolytes in children is:

0.45% NaCl with 5% Glucose + 20mmol KCl / litre¹²

Do not use this solution:

- If the serum potassium is elevated
- If the child is anuric or oliguric
- If the serum sodium is very low
- For volume resuscitation
- For replacement of fluid deficit in dehydrated children until normal urine output is established (unless K is low – see potassium guidelines)
- For initial treatment of children with acute neurological conditions (eg meningitis, head trauma)

- Preterm and term infants to 28 days of corrected age infants (see below)

The glucose content delivers only ~20% of normal caloric requirements and is designed to prevent starvation ketosis and maintain normoglycaemia. For fluid restricted children higher concentrations of glucose may be required to achieve this, but one must beware of the fact that high blood glucose levels may be independent predictors of mortality in critically ill children and adults^{13 14}.

Fluids in Dehydration

Firstly administer an initial bolus of fluid to correct hypovolaemia:

Hypovolaemia:

Give boluses of 10-20ml/kg of normal (0.9%) saline, which may be repeated as required.

Do not include this fluid volume in any subsequent calculations.

Then calculate:

Maintenance + Deficit (replaced over usually 24 hours) + Ongoing losses

and calculate hourly fluid rate.

Deficit

A child's water deficit in mLs can be calculated following an estimation of the degree of dehydration expressed as a percentage of body weight. (e.g. a 10kg child who is 5% dehydrated has a water deficit of 500mls)

Precise calculation of water deficit due to dehydration using clinical signs is usually inaccurate. The best method relies on the difference between the current body weight and the immediate pre-morbid weight. Unfortunately the latter is often unavailable.

Clinical signs of dehydration give only an approximation of the deficit.

Clinically the child may be placed in one of four categories:

Minimal dehydration (<3%)	No clinical signs
Mild dehydration (3-6%)	Some physical signs
Moderate dehydration (6-10%)	Multiple physical signs present
Severe dehydration (> 10%)	May be shocked

The deficit is replaced over a time period that varies according to the child's condition.

Replacement may be relatively rapid (~24 hours) in most cases of gastroenteritis and other causes of normonatraemic dehydration.

NOTE: In gastroenteritis rehydration can be achieved by oral or nasogastric fluids with the deficit replaced over 6 hours.

The replacement rate should be slower (~48 hrs) in diabetic ketoacidosis and meningitis, and in states of hypernatraemia (the serum sodium should not fall by > 0.5 mmol/litre/hour – see below).

More accelerated IVT rehydration regimes have been reported replacing the deficit over 2-4 hrs. Normal saline *without* potassium solution should be considered the base fluid of choice for such regimes.¹⁵

Ongoing losses (eg from drains)

These are best measured and replaced - calculations may be based on each previous hour, or each 4 hour period depending on the situation. Normal (0.9%) saline may be sufficient, alternatively 4% albumin may be used if protein is being lost.

Fluids available at RHH	Alternative names
0.9% NaCl	Normal saline
0.45% NaCl with 5% Glucose and 20 mmol/L KCl	Usual maintenance and replacement solution
0.45% NaCl with 5% Glucose	1/2 Normal saline with glucose

All children on IV fluids should be weighed prior to the commencement of therapy, then at least daily.

All children on IV fluids should have serum electrolytes and glucose checked before commencing the infusion (typically when the IV is placed) and again within 24 hours if IV therapy is to continue.

For sick children with abnormal potassium or sodium measurements, check the electrolytes and glucose 4-6 hours after commencing, and then according to results and the clinical situation but at least daily.

Neonates

Maintenance fluid requirements

Day 1	2-3 ml/kg/hour (60 ml/kg/day)
Day 2	3 ml/kg/hour (80 ml/kg/day)
Day 3-1 month	4 ml/kg/hour (100 ml/kg/day)

Adjust this according previous section (e.g. need less if ventilated). Preterm neonates < 28 weeks gestation may need significantly more water in the first few days due to excessive skin losses. This can be as high as 200 ml/kg/day in ELBW infants, although this is now unusual with modern humidified incubators.

Electrolyte and glucose content

For VLBW preterm neonates and neonates with arterial lines in place, sodium containing solutions are not usually required in the first 48 hours. Use 10% dextrose in water. Occasionally VLBW infants have hyperglycaemia and glucose concentration requirement is only 5%. For all other infants the appropriate starting maintenance intravenous fluid is 0.45% NaCl plus 10% dextrose. This is not a stock solution and is approximated by adding 34 mmol NaCl (10 mls or 1 ampoule of 20% NaCl) to 500 mls of 10% dextrose.

Hyponatraemia

If hyponatraemia is due to salt loss only (without dehydration and not due to water excess), the rehydration regime should be modified:

1. Seizures due to hyponatraemia (usually Na < 125 mmol/L): give 5 mls/kg of 3% Saline bolus (raises ~ Na 4 mmol/L), repeat if required.¹⁶
2. Na < 130 (not convulsing): use 0.9% Normal Saline plus 5% dextrose (plus 10% dextrose in neonate) as base fluid.
3. Na ≥ 130: Use standard solution of 0.45% Saline plus 5% dextrose (plus 10% dextrose in neonate). If Na does not rise use 1:1 mix of 0.9% and 0.45% NaCl

Frusemide can be used as it causes more water than salt loss from the kidneys – but is only indicated if water overload is the cause.

Measure Na concentration 6 hourly. Avoid rapid rise in Na (≤ 2 mmol/HR).

If hyponatraemia is due to Na loss alone, sodium deficit can be estimated from:

$$\text{Sodium deficit in mls of saline} = \text{Wt} \times 4 \times \frac{(140 - [\text{Na}])}{\% \text{ Saline}}$$

% Saline will be either 3%, 0.9% (normal) or 0.45% (N/2)

DO NOT CORRECT CHRONIC HYPONATRAEMIA as this can cause central pontine demyelinosiis.

Hypernatraemia

If hypernatraemia is due to water loss alone, then the water deficit is calculated by:

$$\text{Deficit of water (litres)} = 0.6 \times \text{Wt} \times (1 - 140/[\text{Na}])$$

Water deficit should be replaced over 48 hours usually as 0.45 % Saline, unless Na > 160 when 0.9% Saline should be used to slow the rate of Na decline.

Follow Na concentration 6 hourly. Avoid rapid fall in Na (≤ 0.5 mmol/HR).

Severe hypernatraemia (Na > 160) is associated with central venous thrombosis, subdural haemorrhage and cerebral infarction.

Rehydration solution should initially be 0.45% NaCl, but the salt content may need further reducing if [Na] does not fall appropriately.

Derivation of formulas for the interested:

Assume sodium space of body is 0.6 x true body weight (TBW) in liters (0.6 x TBW is the portion of body containing sodium)

Measured body weight at time of dehydration is actual body weight (ABW) in kg

Measured sodium is [Na]

Desired sodium is 140

Total sodium content of body is constant

And

$$TBW = ABW + \text{water deficit}$$

Then

$$0.6 (ABW + \text{water deficit}) \times 140 = 0.6 \times ABW \times [Na]$$

Solving this equation

$$\mathbf{1. \text{ Water deficit (liters)} = ABW \times ([Na]/140 - 1)}$$

However if you assume that the water deficit is derived partially from tissues that do not contain sodium then:

The [Na] reflects the water deficit from the sodium space only, not whole body loss, thus

$$0.6 \times TBW \times 140 = [(0.6 \times ABW) + \text{deficit}] \times [Na]$$

$$0.6 (ABW + \text{deficit}) \times 140 = \{(0.6 \times ABW) + \text{deficit}\} \times [Na]$$

Which is difficult to solve.

An alternative is to say

$$0.6 \times TBW \times 140 = \{0.6 \times TBW - \text{deficit}\} \times [Na]$$

Which can be solved, except that the TBW is not known at the time of the calculation and thus one is forced to use ABW, making the calculation inaccurate

$$\mathbf{2. \text{ Deficit (liters)} = 0.6 \times TBW \times (1-140/[Na])}$$

Example:

ABW 10 kg

[Na] 150

Using 1.

$$\text{Deficit} = 10 \{(150/140)-1\} = 0.714 \text{ litres}$$

Using 2.

$$\text{Deficit} = 0.6 \times 10 \{1-(140/150)\} = 0.4 \text{ litres (slight underestimate as ABW is less than TBW)}$$

Which is the correct formula?