

A survey of self-reported management of hypernatraemia acquired in Australasian intensive care units

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Intensive care unit-acquired hypernatraemia (IAH)¹ is defined as a plasma sodium level > 150 mmol/L in a patient admitted to the ICU with an initial plasma sodium level < 145 mmol/L. IAH occurs when there is an actual or relative free water deficit; a volume that can be approximated through the use of a correction formula.² The incidence of IAH has been estimated at between 6% and 23%,³⁻⁶ depending on the plasma sodium cut-off used (145–150 mmol/L). Some studies have detailed grades of severity of hypernatraemia.^{1,6} An increasing body of literature has shown an independent association between IAH and increased mortality, detectable from sodium levels > 145 mmol/L and increasing in a non-linear way with higher sodium values.^{1,6}

The three categories of ICU-acquired dysnatraemia are conditions in which:

- free water losses predominate (eg, diabetes insipidus)^{7,8}
- a positive sodium load is observed (frequently targeted in traumatic brain injury)⁹
- there is a combination of the above.

In identifying a strong iatrogenic component, some refer to IAH as an “index of quality of care”,³ and although the condition is common, the response of clinicians to it and the threshold at which treatment is initiated is under investigation. Our survey sought to establish:

- when clinicians initiated therapy
- what changes were made to sodium and water input and through which route
- what adjuncts were used to promote sodium elimination.

Method

Ethics

The Western Health Low Risk Ethics Panel gave prospective approval for the project under their quality assurance pathway, with participant consent being implied through completion of the survey (QA2011.46).

Survey tool

We followed two guides for survey research in medicine.^{10,11} Our survey consisted of a common clinical scenario (Table 1) followed by 10 management questions using an online tool (SurveyMonkey).

ABSTRACT

Objective: To examine self-reported treatment preferences among Australasian consultant intensivists for intensive care-acquired hypernatraemia (IAH).

Design and setting: We used a web-based survey with 10 questions about the management of IAH.

Main outcome measures: We measured number of respondents and response rate, IAH treatment methods, thresholds and the reasons for these.

Results: There were 156 survey respondents, of whom 137 were consultant intensivists, representing a response rate of 31%. Ninety-three percent of responding clinicians (95% CI, 87%–96%) used intravenous fluid (49%; 95% CI, 40%–57%) or enteral nutrition changes (44%; 95% CI, 36%–53%) as their first choice of treatment. As alternative therapies, respondents reported using thiazides (22%; 95% CI, 16%–30%), aldosterone antagonists (20%; 95% CI, 14%–28%) and renal replacement therapy (14%; 95% CI, 9%–21%) less commonly.

Conclusions: There is a wide variety of treatments in use for IAH. Most clinicians initiate treatment at a level greater than the level that is independently associated with increased mortality in the literature.¹ Initial treatment is equally divided between changes in intravenous fluid and changes in enteral nutrition.

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Survey implementation

Permission for electronic distribution of the questionnaire was gained from the Australian and New Zealand Intensive Care Society (ANZICS) Clinical Trials Group and an email containing a link to the survey was circulated to members of the ANZICS emailing list. The survey was therefore distributed to a group whose make-up was unknown but included physiotherapy, nursing and medical staff. All ANZICS full members were included, and that number was obtained from the annual report and used by us as the denominator. We filtered our responses to include only replies from consultant intensivists as we felt that they were more likely to be managing the longitudinal treatment of IAH.

Table 1. Clinical scenario

- In many intensive care unit patients, hypernatraemia can occur in the setting of fluid overload.
- All the following questions refer to ICU patients in whom hypernatraemia is present and a negative fluid balance desired. These patients are often treated with frusemide.

Statistical analysis

Statistical analysis was performed with VassarStats (<http://vassarstats.net>) using the Wilson method to calculate the 95% CI for proportions.^{12,13} A Z test was used to evaluate differences between proportions.

Results

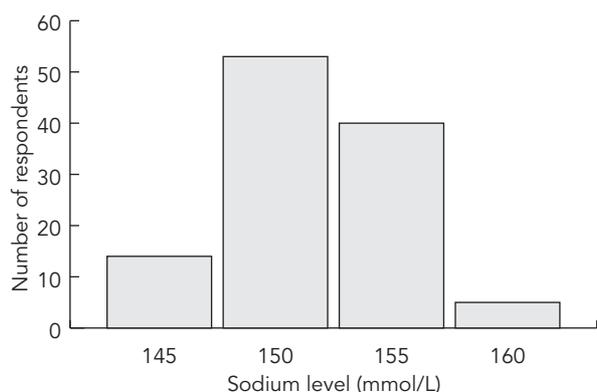
Respondents

There were 156 respondents, of whom 137 were full ANZICS members, representing a response rate of 31%.¹⁴ We used 137 as the denominator for all our subsequent statistics unless otherwise stated.

Threshold and rationale for commencing therapy

The self-reported treatment thresholds for IAH are shown in Figure 1 (112 intensivists replied to this question). When asked why a particular treatment threshold was chosen, 65% (95% CI, 57%–72%) cited clinical experience and 31% (95% CI, 24%–39%) expressed a wish to return the sodium level to within the normal range. Thirteen of 109 consultants who answered the question (12%; 95% CI, 8%–19%) chose to use the free-text option with the most common remarks centring on the patient's diagnosis and speed of onset of their dysnatraemia.

Figure 1. Self-reported treatment thresholds in intensive care unit-acquired hypernatraemia*



* N = 112 respondents.

Altering sodium and water intake

When choosing a treatment, 93% of responding clinicians (95% CI, 87%–96%) used intravenous fluid (49%; 95% CI, 40%–57%) or enteral nutrition changes (44%; 95% CI, 36%–53%) most often. There was no significant difference between the proportions choosing each of these as their preferred modality. A minority of responders (7%; 95% CI, 4%–12%) disagreed with the statement that there is little evidence to support any one particular method for treating hypernatraemia.

When choosing an intravenous fluid, 79% used 5% dextrose (95% CI, 71%–84%), 12% used sterile water (95% CI, 8%–19%), 6% used 4% dextrose and 0.19% saline (95% CI, 3%–11%), and 3% used 0.45% saline (95% CI, 1%–7%).

Altering sodium elimination

Methods less commonly used to promote a negative sodium balance included thiazides (22%; 95% CI, 16%–30%), aldosterone antagonists (20%; 95% CI, 14%–28%) and renal replacement therapy (14%; 95% CI, 9%–21%).

Open-ended questions

The final survey question, an open-ended one (“what comments do you have regarding the treatment of hypernatraemia in the critically ill patient?”), was answered by 57 clinicians, and several themes emerged.

- Twenty-three clinicians stated that their choice of therapy would depend on the clinical situation, without specific reference to our clinical scenario.
- Twelve recognised the iatrogenic contribution of fluid resuscitation practices.
- Seven respondents expressed opinions on the significance (ie, that it was harmless or harmful) of IAH.
- Three acknowledged the difficulty in balancing the detrimental effects of hypervolaemia and hypernatraemia.

Discussion

Our survey was the first to examine the treatment practices for IAH among Australasian intensivists. There was wide variation in the reported treatment thresholds for IAH. Patients with a normal plasma sodium level on ICU admission who subsequently develop a level > 145 mmol/L have a twofold increase in mortality compared with those who remain eunatraemic.¹ Only 12% of responders to our survey initiated treatment at 145 mmol/L.

The treatment of hypernatraemia can be rationalised by assessing the water and sodium balances. Hypernatraemia represents a free water deficit which can be replaced enterally or intravenously. There was no significant difference in the proportions of respondents choosing between

these two modalities. The most popular intravenous fluid choice was 5% dextrose.

In researching the survey, we observed the use of different agents to promote natriuresis. These natriuretic agents were used as first-line treatment by a minority of responders. A pilot survey investigating the effectiveness of the aldosterone antagonist spironolactone in IAH showed no benefit over placebo.¹⁵ To our knowledge, no studies have examined the effectiveness of thiazide diuretics in this role.

Recent evidence suggests that an early negative fluid balance predicts a better prognosis,¹⁶ and for this reason it is likely that IAH will become more common. There is a recognised iatrogenic contribution through early fluid resuscitation volumes and types; practices that are subject to ongoing studies. In our scenario, the treatment aim was for a negative fluid balance. It may be that concerns about hypernatraemia achieved through pursuing a negative balance may be offset by the risks of hypervolaemia.

Our survey has several limitations. First, a response rate of 31% for an electronic survey is lower than that reported previously.¹¹ The wording of the scenario preceding the questions was deliberately simple but may have biased responses. Some respondents misinterpreted this cohort; validating their responses with free text comments pertaining to other specific causes of hypernatraemia (eg, traumatic brain injury). It is difficult to apply a one-size-fits-all approach to the management of IAH in patients who may have conflicting pathologies; there may be other reasons why one treatment modality may be favoured over another for a particular patient.

In summary, our survey highlighted a discrepancy between self-reported treatment thresholds for IAH and levels independently associated with increased mortality. What is unclear is whether treating this disturbance by lowering sodium levels will lead to a change in mortality or whether IAH can be feasibly prevented by attention to sodium loading. If we chose to treat IAH, at what plasma sodium level should we start, and is one modality more effective than any other?

Competing interests

None declared.

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References

- 1 Darmon M, Timsit JF, Francais A, et al. Association between hypernatraemia acquired in the ICU and mortality: a cohort study. *Nephrol Dial Transplant* 2010; 25: 2510-5.
- 2 MedCalc. Hyponatremia & hypernatremia. <http://www.medcalc.com/sodium.html> (accessed Jan 2014).
- 3 Polderman KH, Schreuder WO, Strack van Schijndel RJ, Thijs LG. Hypernatremia in the intensive care unit: an indicator of the quality of care? *Crit Care Med* 1999; 27: 1105-8.
- 4 Lindner G, Funk GC, Schwarz C, et al. Hypernatremia in the critically ill is an independent predictor of mortality. *Am J Kidney Dis* 2007; 50: 952-7.
- 5 Stelfox HT, Ahmed SB, Khandwala F, et al. The epidemiology of intensive care unit-acquired hyponatremia and hypernatremia in medical-surgical intensive care units. *Crit Care* 2008; 12: R162.
- 6 O'Donoghue SD, Dulhunty JM, Bandeshe HK, et al. Acquired hypernatraemia is an independent predictor of mortality in critically ill patients. *Anaesthesia* 2009; 64: 514-20.
- 7 Pokaharel M, Block CA. Dysnatremia in the ICU. *Curr Opin Crit Care* 2011; 17: 581-93.
- 8 Hoorn EJ, Betjes MG, Weigel J, Zietse R. Hypernatraemia in critically ill patients: too little water and too much salt. *Nephrol Dial Transplant* 2008; 23: 1562-8.
- 9 Brain Trauma Foundation. Guidelines. <https://www.brain-trauma.org/coma-guidelines> (accessed Jan 2014).
- 10 Story DA, Gin V, na Ranong V, et al. Inconsistent survey reporting in anesthesia journals. *Anesth Analg* 2011; 113: 591-5.
- 11 Jones D, Story D, Clavisi O, et al. An introductory guide to survey research in anaesthesia. *Anaesth Intensive Care* 2006; 34: 245-53.
- 12 Newcombe R. Two-sided confidence intervals for the single proportion: comparison of seven methods. *Stat Med* 1998; 17: 857-72.
- 13 Wilson EB. Probable inference, the law of succession, and statistical inference. *J Am Stat Assoc* 1927; 22: 209-12. doi: 10.1080/01621459.1927.10502953.
- 14 Australian and New Zealand Intensive Care Society. ANZICS Annual Report 2011. http://www.anzics.com.au/downloads/doc_download/524-anzics-annual-report-2011 (accessed Jan 2014).
- 15 Apte Y, Bellomo R, Warrillow S, et al. Pilot randomised double-blind controlled trial of high-dose spironolactone in critically ill patients receiving frusemide infusion. *Crit Care Resusc* 2008; 10: 306-11.
- 16 Boyd J, Forbes J, Nakada T, et al. Fluid resuscitation in septic shock: a positive fluid balance and elevated central venous pressure are associated with increased mortality. *Crit Care Med* 2011; 39: 259-65. □