EDITORIAL

# Hypernatraemia: balancing is challenging

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As internists we like to think of ourselves as physicians with knowledge of disturbances of the milieu intérieur. Indeed, other specialities often call us for help when they are confronted with fluid and electrolyte disorders. The unrivalled number one of your electrolyte consults will undoubtedly be hyponatraemia. For example, hyponatraemia may arise in the postoperative period due to the combination of inappropriate vasopressin release and hypotonic intravenous fluids.[1] In fact, one of the first reports on acute hyponatraemia was in women undergoing elective surgery in whom the combination of postoperative vasopressin release and hypotonic fluids led to tragic neurological outcomes.[2] It is quite striking to see that the physicians at that time did not link the neurological symptoms to acute hyponatraemia. Instead of immediately infusing hypertonic saline, they pursued additional diagnostic tests such as lumbar punctures, CT and MRI scans.[2] These iatrogenic catastrophes have served as caveat that even simple infusion fluids may turn into deadly weapons when applied inappropriately. Of note, even isotonic intravenous fluids can cause hyponatraemia, for example in the syndrome of inappropriate antidiuretic hormone secretion, although this is less common.[3] Fortunately, based on cautionary tales like these, hypotonic intravenous fluids have largely been banned as maintenance fluids in adult medicine.[4] Surprisingly, however, this has not been the case in paediatrics, where caloric intake rather than tonicity has traditionally dictated the composition of maintenance fluids.[5] Maintenance intravenous fluids in sick children were therefore largely composed of glucose in half-normal saline (i.e., 5% dextrose in 0.45% NaCl). This type of intravenous fluids is hypotonic to begin with, but will become even more hypotonic when glucose is metabolised to carbon dioxide and water.[6] These physiology-based suspicions were recently confirmed by solid evidence from a randomised and blinded clinical trial.[7] Almost 700 acutely ill children who required maintenance intravenous fluids longer than six hours were randomised to receive half-normal saline or Plasma-lyte. Plasma-lyte is one of the new and commercially available balanced fluids with a sodium chloride concentration similar to plasma and the presence of buffers.[8] Hyponatraemia and epileptic seizures were significantly more common in the hypotonic arm of the trial, although the latter outcome was only borderline significant.[7] A recent review on intravenous maintenance fluids in the *New England Journal of Medicine* also focused on indications for maintenance intravenous fluids while preventing hyponatraemia.[9] According to the algorithm presented in this review, Americans, unlike Europeans, still favour glucose in their maintenance fluids, but do so in 0.9% NaCl to prevent hypotonicity. We believe that the addition of glucose to intravenous fluids will only increase the risk of hyperglycaemia without offering substantial nutritional support, although large studies are lacking.[10] Perhaps Americans prefer their intravenous fluids to resemble high-sugar soda beverages?

In contrast to hyponatraemia, hypernatraemia is less common. We expect that most of you will regard hypernatraemia as a simple clinical problem: uncompensated water loss. Treatment: just add water.[11] Indeed, we are all familiar with nursing home residents who are admitted with a serum sodium of 170 mmol/l because fever secondary to a urinary tract infection has made them somnolent and even less capable to express thirst or reach the tap. However, in the intensive care, up to half of patients actually have a positive fluid balance during the development of hypernatraemia.[12] This implies that, in these patients, hypernatraemia must be due to a positive sodium rather than a negative water balance. How can this be? Most studies that addressed this question identified factors that impair the urinary concentrating mechanisms, including acute kidney injury, loop diuretics, mannitol, hyperglycaemia, hypercalcaemia, or hypokalaemia.[13] If the excretion of hypotonic urine is subsequently matched with isotonic intravenous fluids, hypernatraemia with a positive fluid balance may ensue. The article on hypernatraemia in this issue suggests that hypernatraemia due to a positive sodium balance is also occurring on our internal

medicine wards.[14] Felizardo Lopes et al. carefully analysed the characteristics of hypernatraemia (defined as serum sodium ≥ 150 mmol/l) in a 36-bed internal medicine ward. In a 28-month observation period with close to 2000 admissions, they observed 49 patients with hypernatraemia (median serum sodium 152 mmol/l, prevalence 2.6%). As expected, hypernatraemic patients were significantly older and more often bedridden and dependent on the nurses for food and fluids. Remarkably, the patients with hypernatraemia more often had heart failure and liver cirrhosis, conditions that are normally accompanied by hyponatraemia.[15] Hypernatraemia was also associated with a much higher mortality rate (43 vs. 2%), which has been a consistent finding in previous studies,[13,16,17] but may be an epiphenomenon. However, the most striking observation in the study by Felizardo Lopes et al. was that only 39% of patients were admitted with hypernatraemia, whereas 61% developed hypernatraemia during hospitalisation. Of these patients, one third did so with a positive fluid balance. These data are comparable to the intensive care data and suggest that we as internists fail to maintain water and salt balance. The authors attribute these observations to inadequate use of intravenous fluids, which in France is managed by nurses. Recently a Dutch study found that even the use of normal saline to dissolve drugs or keep indwelling venous catheters open, contributes to hypernatraemia.[18] We believe it is the collective responsibility of both nurses and physicians to manage the patients' fluid and electrolyte balance. We argue that intravenous fluids should be regarded as drugs and therefore deserve the same precautions in prescribing.[19] This should not be limited to physicians in internal medicine but to all physicians taking care of hospitalised patients. Considering the data on iatrogenic hyponatraemia and hypernatraemia caused by intravenous fluids, the distilled message of this editorial may even be more simple: stop intravenous fluids as soon as possible!

## DISCLOSURES

None.

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