

Issue and challenges of fluid removal in the critically ill

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The administration of i.v. fluids and i.v. sodium is, together with the administration of oxygen, the most common medical intervention in the critically ill. It can take the form of fluid resuscitation with single or intermittent boluses of significant amounts of fluid, or be implemented as continuous slow volume infusion or as a combination of both or as i.v. nutrition or as vehicle for intermittent or continuous infusion of drugs.^{1–4} The speed, amount, timing, and physiological targets for such fluid delivery are determined by clinicians on the basis of physiological reasoning, observational evidence, personal preference, local culture, mentorship, marketing forces, heuristic bias, guidelines, and expert opinion in a manner that makes reproducibility essentially impossible and creates enormous challenges to researchers. In addition, such fluid therapy often occurs in patients who have a high incidence of oliguria, diminished glomerular filtration rate,⁵ or both due to chronic kidney disease, acute kidney disease, or both and in whom the pre-morbid dry weight is often unknown and the optimal intravascular, extravascular, and cellular fluid status uncertain. Finally, in many cases, the untested and almost magical belief that fluid therapy is both necessary and life-saving fuels the additional belief that **more must be better**, especially during the early phase of critical illness. Such belief persists without a hint of self-doubt **despite randomized controlled evidence to the contrary in septic African children**.⁶ In this environment, it should come as no surprise that clinically important fluid and sodium **overload** are relatively **common** in critically ill patients.^{7,8} **How to deal with such fluid overload remains a matter of controversy**. However, accumulating evidence **linking fluid overload with unfavourable outcomes** is now prompting clinicians to apply greater attention to its early treatment and may, one day, similarly incite a desire to prevent it. In response to such concerns, the 12th ADQI conference has focused on fluid management and two groups of experts within the conference have specifically dedicated themselves to reviewing the evidence and proposing the way forward in handling fluid overload either by pharmacological or by mechanical removal of fluids in patients who are clinically assessed as requiring fluid removal.^{7,8} It is not surprising that these investigators found that, outside of extreme situations, **little evidence exists to guide the indications, timing, extent, mode, duration, monitoring, and target setting for fluid removal**. In fact and somewhat predictably, the issues surrounding such fluid removal appear to mirror in reverse those associated with fluid resuscitation. Should fluid removal

happen early or should clinicians wait until greater haemodynamic and clinical stability has been achieved? If so, what is the sufficient degree of haemodynamic stability that gives the 'green light' to proceed to fluid removal? Should such fluid removal proceed aggressively or slowly? Should clinicians give a **furosemide challenge** (like one gives a fluid challenge) or should one use a furosemide infusion (like one may use a continuous infusion of fluid)? Should an increase in vasopressor requirements lead to cessation of fluid removal (like it may lead to additional fluid in the early phase of resuscitation)? What measures of fluid status are most appropriate to guide fluid removal? Unfortunately, as the ADQI experts point out, there is **little quality evidence to inform such decisions**. Nonetheless, the available evidence suggests that **achieving a neutral fluid balance in acute respiratory distress syndrome patients makes a significant difference to time on the ventilator** and can be pursued safely and should therefore be a therapeutic target.⁹ In such patients, fluid removal in the presence of a positive fluid balance and haemodynamic stability is indicated. In surgical patients having colorectal surgery, a fluid conservative therapy may be similarly desirable.¹⁰ Whether it is desirable in all patients receiving major abdominal surgery will fortunately be clarified by the **RELIEF (Restrictive vs Liberal Fluid Therapy in Major Abdominal Surgery)**¹¹ trial which is currently **under way**. Beyond such areas of relative certainty, the best way to remove fluids remains uncertain. In some patients, **water and sodium removal can be achieved with loop diuretics**. In others, **loop diuretics achieve a water diuresis, but little sodium excretion** resulting in **hypernatraemia**. In others, because of limited renal function, **little can be achieved** and, if fluid removal is considered a priority, the renal replacement therapy is needed. Studying the impact of such therapies will remain a major challenge for critical care investigators because these interventions do not address the underlying disease and simply modulate the management of the physiological consequences of disease and of misguided iatrogenic interventions. The ability to demonstrate that optimal fluid removal can change patient-centred outcomes will therefore likely require the randomization of thousands of patients. This may prove impossible. Moreover, in patients with **dramatic fluid overload (>15–20% of dry body weight)**, lack of equipoise will not permit randomization making trials even less likely to show differences in outcomes.^{12–14} These issues are likely to lead to continued evidence-poor and clinician preference-driven management of fluid removal. If so,

then the comprehensive review, analysis, and reflection provided by the ADQI group should be welcome as an important educational process for clinicians to improve their knowledge base and make rational, if not evidence-based, therapeutic choices.

Supplementary material

Supplementary material is available at *British Journal of Anaesthesia* online.

Declaration of interest

None declared.

References

- 1 Bihari S, Peake SL, Seppelt I. Sodium administration in critically ill patients in Australia and New Zealand: a multicentre point prevalence study. *Crit Care Resusc* 2013; **15**: 294–300
- 2 Bihari S, Baldwin CE, Bersten AD. Fluid balance does not predict estimated sodium balance in critically ill mechanically ventilated patients. *Crit Care Resusc* 2013; **15**: 126–33
- 3 Gattas DJ, Saxena MK. Is maintenance fluid therapy in need of maintenance? *Crit Care Resusc* 2013; **15**: 255–6
- 4 Saxena MK. Should sodium be the real target of fluid restriction. *Crit Care Resusc* 2013; **15**: 75–7
- 5 Myburgh J, Finfer S, Bellomo R, et al. Hydroxyethyl starch or saline for fluid resuscitation in intensive care. *N Engl J Med* 2012; **367**: 1901–11
- 6 Maitland K, Kiguli S, Opoka RO, et al. Mortality after fluid bolus in African children with severe infection. *N Engl J Med* 2011; **364**: 2483–95
- 7 Goldstein S, Bagshaw S, Cecconi M, et al. Pharmacological management of fluid overload. *Br J Anaesth* 2014; **113**: 756–63
- 8 Rosner MH, Ostermann M, Murugan R, et al. Indications and management of mechanical fluid removal in critical illness. *Br J Anaesth* 2014; **113**: 764–71
- 9 Wiedemann HP, Wheeler AP, Bernard GR, et al. Comparison of two fluid-management strategies in acute lung injury. *N Engl J Med* 2006; **354**: 2564–7
- 10 Brandstrup B, Tonnesen H, Beier-Holgersen R, et al. Effects of intravenous fluid restriction on postoperative complications: comparison of two perioperative fluid regimens: a randomized assessor-blinded multicenter trial. *Ann Surg* 2003; **238**: 641–8
- 11 Glassford N, Myles P, Bellomo R. The Australian approach to perioperative fluid balance. *Curr Opin Anesthesiol* 2012; **25**: 102–10
- 12 Arikan AA, Zappitelli M, Goldstein SL, Naipaul A, Jefferson LS, Loftis LL. Fluid overload is associated with impaired oxygenation and morbidity in critically ill children. *Pediatr Crit Care Med* 2012; **13**: 253–8
- 13 Sutherland SM, Zappitelli M, Alexander SR, et al. Fluid overload and mortality in children receiving continuous renal replacement therapy: the prospective pediatric continuous renal replacement therapy registry. *Am J Kidney Dis* 2010; **55**: 316–25
- 14 Bouchard J, Soroko SB, Chertow GM, et al. Fluid accumulation, survival and recovery of kidney function in critically ill patients with acute kidney injury. *Kidney Int* 2009; **76**: 422–7

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Expert consensus: a flawed process for producing guidelines for the management of fluid therapy in the critically ill†

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The 12th Consensus Conference of the Acute Dialysis Quality Initiative (ADQI XII) addresses the highly topical and controversial issues of fluid administration and removal in the context of perioperative and critical care medicine. The stated goal of the initiative is to develop consensus and evidence-based recommendations for patient care using a methodology that departs from current accepted best practice. In describing their methodology, the lead authors argue that the evidence used to develop the guidelines should not be limited to published randomized clinical trials (RCTs) but should include data from observational studies and ‘even expert opinion’.¹ This view ignores the inherent biases of

observational data and the even greater risk that ‘expert’ opinion may be influenced by academic and financial competing interests.^{2–5} It is inconceivable that a new pharmaceutical would be given marketing authorization based on observational studies and expert opinion; yet, fluid guidelines have the potential to do as much good and potentially more harm than any single drug. In addition to influencing clinical practice, guidelines are used as marketing tools, to support malpractice lawsuits, and as performance measures.² Given these uses, the scientific rigour used to develop guidelines must match that required of a company seeking to market a drug. In recent years, independent research groups have demonstrated that it is possible to conduct high-quality large-scale randomized trials in perioperative and critical care medicine, including

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