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Indications and management of mechanical fluid removal in critical illness

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Editor's key points

- The authors provide guidelines on the mechanical management of fluid overload based on a Delphi analysis.
- Further work is needed on the role and practice of mechanical fluid removal in critically ill patients not meeting fluid balance goals.

Background. The Acute Dialysis Quality Initiative (ADQI) dedicated its Twelfth Consensus Conference (2013) to all aspects of fluid therapy, including the management of fluid overload (FO). The aim of the working subgroup 'Mechanical fluid removal' was to review the indications, prescription, and management of mechanical fluid removal within the broad context of fluid management of critically ill patients.

Methods. The working group developed a list of preliminary questions and objectives and performed a modified Delphi analysis of the existing literature. Relevant studies were identified through a literature search using the MEDLINE database and bibliographies of relevant research and review articles.

Results. After review of the existing literature, the group agreed the following consensus statements: (i) in critically ill patients with FO and with failure of or inadequate response to pharmacological therapy, mechanical fluid removal should be considered as a therapy to optimize fluid balance. (ii) When using mechanical fluid removal or management, targets for rate of fluid removal and net fluid removal should be based upon the overall fluid balance of the patient and also physiological variables, individualized, and reassessed frequently. (iii) More research on the role and practice of mechanical fluid removal in critically ill patients not meeting fluid balance goals (including in children) is necessary.

Conclusion. Mechanical fluid removal should be considered as a therapy for FO, but more research is necessary to determine its exact role and clinical application.

Keywords: fluid balance; fluid therapy; kidney failure

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Volume overload or fluid overload (FO) (here defined as a positive value of the total input − total output/the initial body weight) is a common occurrence in critically ill adult and paediatric patients and is associated with deleterious consequences that worsen with increasing severity of FO.[1–6] For instance, a paediatric study found a 3% increase in mortality for every 1% increase in FO and children with more than 20% FO had an odds ratio for mortality of 8.5 compared with <20% FO.[4] In particular, there appears to be a significant interaction between FO and acute kidney injury (AKI) in determining the risk of adverse outcomes. Positive fluid balance has been associated with increased AKI incidence,[7] and non-recovery of renal function in AKI survivors.[5 8] A large number of observational studies have associated FO in patients with AKI and death in both adults[9 10] and children,[3 11] and FO remains independently associated with adverse outcomes in AKI after accounting for illness severity and haemodynamic instability in multivariate analyses.[2 3 9 10–13] However, without prospective data, it is difficult formally to separate the effect of FO as a marker of illness severity and its treatment, from a direct causative role in outcomes that might be modifiable by mechanical or pharmacological fluid removal.

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Broadly, FO occurs either secondary to increased fluid intake (such as i.v. fluid or blood product administration), decreased urinary output, or a combination of both (Table 1). In many cases, FO is iatrogenic, secondary to continuous i.v. fluid therapy over a period of days without adequate attention to daily fluid balance. In other cases, FO results from obligate daily fluid needs (such as for total parenteral nutrition and i.v. antibiotics) in the setting of poor urine output. The magnitude of FO can be staggering; in an analysis of the Vasopressin and Septic Shock trial, fluid accumulation over the first 12 h of care ranged from 8 to as high as 30 litres in patients presenting with sepsis.[14] In those patients who develop progressive FO, pharmacological, mechanical modes of therapy, or both may be utilized to restore an optimal volume status and improve outcomes (Fig. 1). This paper describes the indications and use of mechanical fluid removal techniques in the critically ill patient and represents the work of the Twelfth Acute Dialysis Quality Initiative (ADQI) workgroup on mechanical fluid therapy held in London, UK, in September 2013.

Table 1 Causes of FO

Excessive fluid intake
Early
Need for blood products
Aggressive fluid administration
Late
Continued fluid administration despite positive fluid balance
Obligate daily fluid therapy in excess of losses
Oliguria or anuria (inadequate fluid losses)
AKI (+/− chronic kidney disease)
'Third spacing' (sepsis, pancreatitis, burns)
Severe heart failure—poor cardiac output from any causes
Pre-existing severe chronic kidney disease

Methods

The 12th ADQI meeting on Fluid Therapy assembled experts in the area, including nephrologists, intensivists, paediatricians, emergency physicians, and physiologists and performed a modified Delphi analysis of the existing literature. The Delphi method is a structured and standardized process for collecting, summarizing, and disseminating knowledge from a group of experts focused on a specific problem or task. Further information is available at: www.adqi.net.

Before the meeting, the working subgroup 'Mechanical fluid removal' developed a list of preliminary questions and objectives with particular focus on indications, prescription, and monitoring of fluid removal using mechanical devices. It was recognized that the work was a continuation from the work of other groups, in particular the work of the subgroup 'pharmacological management of fluid overload'.[15]

The group performed a literature search using the MEDLINE database (via the PubMED interface) and the following search terms: 'fluid balance', 'fluid overload', 'fluid accumulation', 'extracorporeal', 'ultrafiltration', and 'mechanical'. The bibliographies of relevant review articles or editorials and personal records of participating members were searched for any additional potentially relevant studies. After review of the literature, the group summarized the existing evidence. In the case of lack of evidence on specific key areas, the working subgroup formulated consensus statements and questions for future research.

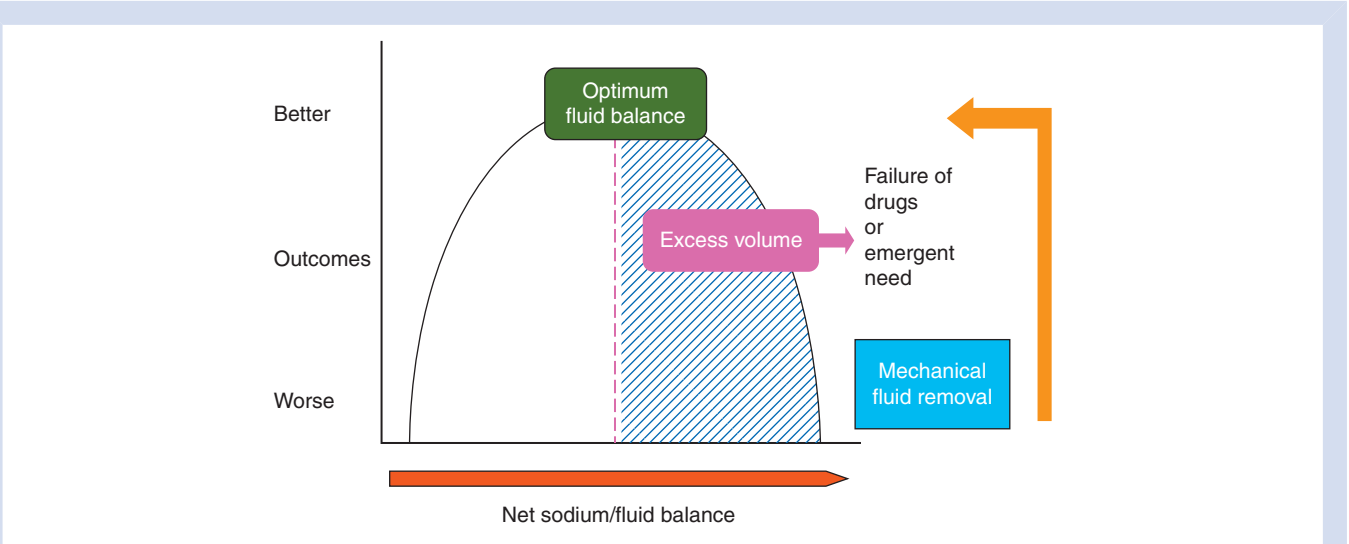

Fig 1 Pathways in fluid management. Each patient has an optimal fluid balance that can be disturbed in critical illness. In some cases, patients may become fluid overloaded as a consequence of aggressive fluid resuscitation. In other situations, patients may present with FO, such as in acute decompensated heart failure. In any event, therapies to reverse the FO are required to restore optimum fluid balance. Mechanical fluid removal should be considered when emergent and rapid fluid removal is needed or when pharmacological therapies have failed. Figure reproduced with permission from ADQI 12 (Acute Dialysis Quality Initiative. http://www.adqi.org/).