

# Fluid and Electrolyte Balance in the Intensive Care Unit – Trickle or Flood?



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## Introduction:

It is recognised that the ability of critically ill patients to handle excess fluid and sodium is impaired and is a major factor in the incidence of organ failure, length of stay in hospital and overall mortality<sup>1, 2</sup>. Errors in fluid and electrolyte management contribute to perioperative morbidity and mortality and may often be ascribed to inadequate knowledge and training.<sup>3</sup> Guidelines<sup>4</sup> have been written recently on the fluid management of patients in the perioperative period (Box 1). Good fluid and electrolyte management is essential to optimise cardiac output and tissue oxygen perfusion in critically ill patients and these guidelines are helpful to inform fluid prescription in the Intensive Care Unit (ICU) for all types of patient.

## Methods:

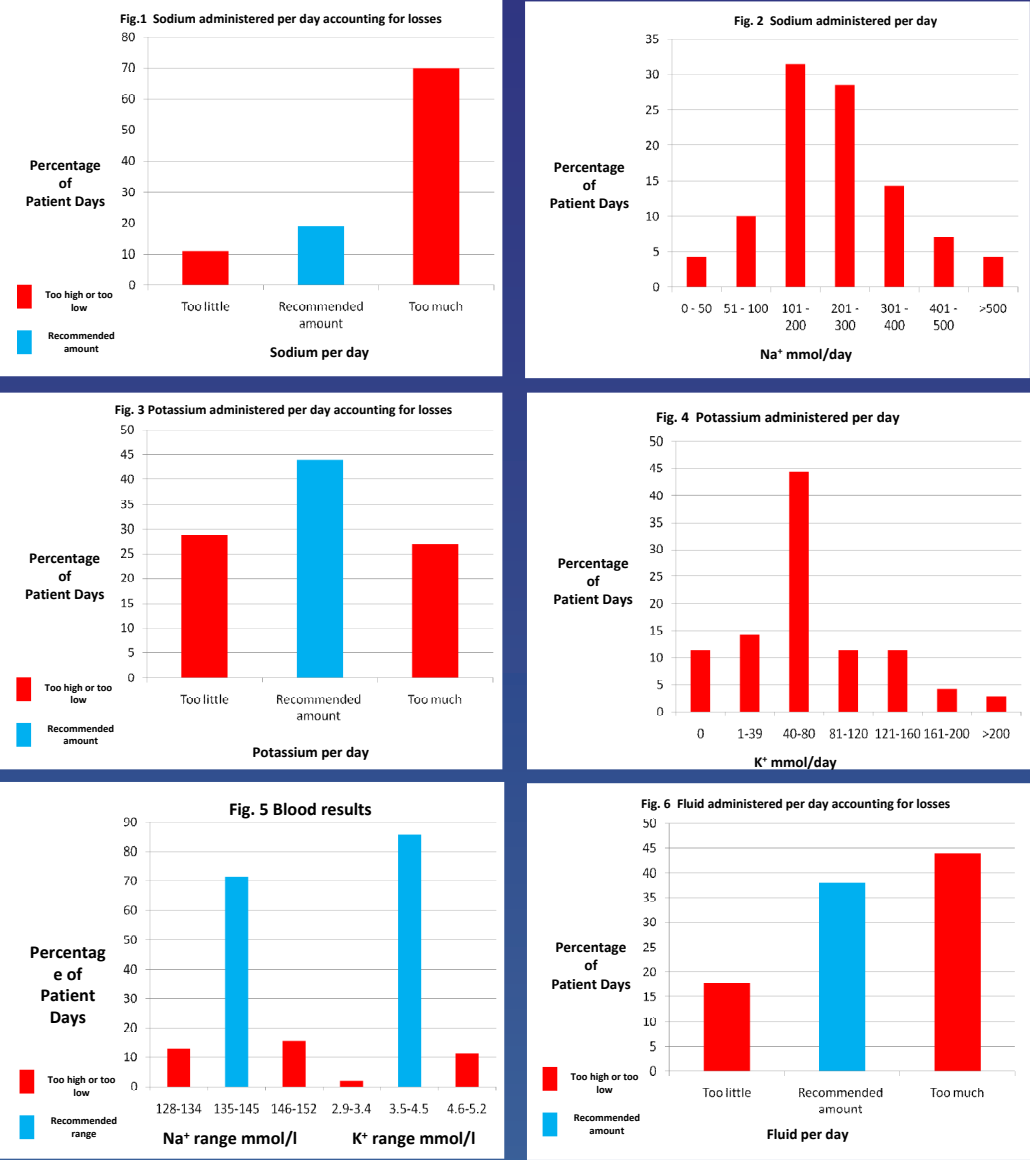
A retrospective analysis of fluid and electrolyte prescription for ten Level 3 patients admitted to the ICU between April and October 2009 was carried out. Each patient's results were recorded for a seven day period from admission, resulting in a sample size of 70 patient days. Weight, serum sodium and potassium levels and fluid balance were documented. All fluids given, including those prescribed, feed, enteral water and drug additives, were recorded. Fluid and electrolyte losses (excluding urinary losses), including those related to pyrexia, were estimated or measured and accounted for in presenting the results. Electrolytes in prescribed fluids and those present in feed and additive fluids were included, but not those in drug formulations. Patients requiring renal replacement therapy and patients requiring fewer than seven days of ICU management were excluded.

## Results:

With reference to the GIFTASUP guidelines, excess sodium had been given on 70% of patient days (Fig. 1) with some very high doses being given (Fig. 2). Insufficient potassium had been prescribed on 30% of patient days (Figs. 3,4). However, serum levels of these electrolytes were mostly in the normal range (Fig. 5). Commenting upon fluid prescription is less straightforward, as many patients appropriately receive diuretics to achieve a negative fluid balance after the acute phase of illness. When the 25 days on which diuretics were given were excluded, patients received maintenance and replacement fluid in line with the GIFTASUP recommendations (1.5-2.5 litres) on 38% of days (Fig. 6). On 44% of days, patients received more fluid than required, taking into account resuscitation, and on 18% of days less fluid than required.

## Discussion:

Patients in this study received too much fluid and sodium and too little potassium. The serum levels suggest that a normal potassium level does not mean that the patient has adequate potassium stores, and that large doses of sodium do not cause high serum sodium. In post-operative and critically ill patients the stress response causes anti-diuresis and oliguria, mediated by vasopressin, catecholamines and the renin-angiotensin system (RAS). The capacity of the kidney to dilute, as well as to concentrate the urine, is impaired. Potassium depletion, due both to RAS activity and the cellular loss of potassium associated with protein catabolism, reduces the ability to excrete sodium and also causes arrhythmias and ileus. Hyperchloraemia due to excess normal saline infusion leads to renal vasoconstriction and reduced glomerular filtration rate, further compromising the ability of the kidney to excrete sodium and water.



## Recommendations:

1. Guidelines should be introduced into the ICU for electrolyte and fluid prescribing.
2. The education of junior doctors about fluid management should form part of induction training in ICU and throughout acute hospitals.
3. This audit should be repeated when these measures have been introduced.

## References:

1. Krishna GG, Chusid P, Hoeldtke RD. Mild potassium depletion provokes renal sodium retention. J Lab Clin Med 1987; 109: 724-730.  
2. Lobo DN, Macafee DA, Allison SP. How perioperative fluid balance influences post-operative outcomes. Best Pract Res Anaesthesiol 2006; 20: 439-455.  
3. Powell-Tuck J (chair), Gosling P, Lobo DN, Allison, SP, Carlson GL, Gore M, Lewington AJ, Pearse RM, Mythen MG. British Consensus Guidelines on Intravenous Fluid Therapy for Adult Surgical Patients. GIFTASUP  
4. Callum KG, Gray AJG, Hoile RW et al. Extremes of Age: The 1999 Report of the National Confidential Enquiry into Perioperative Deaths.

### Box 1: British Consensus Guidelines on Intravenous Fluid Therapy for Adult Surgical Patients (GIFTASUP) 3 Recommendation 9:6

Maintenance Requirements:  
Sodium 50-100mmol/day  
Potassium 40-80mmol/day  
in 1.5-2.5 litres water. Give additional amounts only to correct deficits or continuing losses. Administer sufficient balanced crystalloid and colloid to normalize haemodynamic parameters and minimise overload. Monitor: clinical examination, fluid balance charts and regular weighing when possible.