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**Abnormal saline:  
redressing the balance** **M2**

*John M Findlay, Sarah Spencer, Kerry  
Bosworth, Michael J Keogh*

**Dizziness in the elderly** **M4**

*Shankar Rangan, Anita Ayyar,  
Saumya Sundar Das*

**Paediatric supracondylar  
fractures of the humerus: acute  
assessment and management** **M8**

*Breck Lord, Khaled M Sarraf*

**Imaging the small bowel** **M12**

*Joanna Kasznia-Brown, Paul Burn*

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MMC SUPPLEMENT**

**Management of hyponatraemia**

**Imaging of small bowel:  
a pictorial review**

**Making referrals: a guide for  
foundation doctors**

# Abnormal saline: redressing the balance

Intravenous 0.9% saline is widely prescribed for emergency surgical admissions, despite mounting evidence demonstrating that, physiologically and clinically, saline is more abnormal than normal. The move to routine surgical use of balanced crystalloids is due.

## Introduction

Fluid therapy remains a contentious aspect of modern perioperative practice. The crystalloid *vs* colloid debate is one of which junior doctors are usually keenly aware, in part because of its discussion in a number of undergraduate and postgraduate acute medical courses. Less prominent – at least for most junior doctors outside anaesthetics and critical care – is the issue of which crystalloid to use. The lack of awareness of this issue belies its importance and the mounting evidence base legislating against

the default prescription of normal saline, on account of its deleterious physiological effects and subsequent implications for patient outcome. Despite this, prescription of (so-called ‘normal’) 0.9% saline remains largely the surgical default.

## Crystalloids

Crystalloids are aqueous solutions containing variable concentrations of electrolytes and other soluble substances. ‘Balanced crystalloids’, in the guise of Ringer’s solution, have been evolving for over a century (Wilkes et al, 2001). In the 1930s Hartmann added lactate to constitute his eponymous solution, and more recently ‘balanced colloids’ such as Hextend (Hospira Inc., Lake Forest, USA) have been developed in balanced carrier solutions (Wilkes et al, 2001).

The term ‘balanced’ implies a solution with more physiologically appropriate characteristics, constituents and concentrations than unbalanced solutions such as 0.9% saline (Table 1). As is demonstrated, for example by Hartmann’s sub-physiological pH, such characteristics are not perfect. However, they are a significant improvement upon those of 0.9% saline, thus have interesting and important clinical advantages.

## Surgical stress and saline

It has been understood since the 1950s that under physiological stress (such as surgical insult or acute disease) the body enters a phase of volume and sodium

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**Table 1. Characteristics of crystalloids**

Parameter	0.9% saline	Hartmann’s solution	Serum reference range
pH	5.4	6.0	7.35–7.45
Osmolality (mOsm/kg)	308	276	275–295
Na+ (mmol/litre)	154	131	135–145
Cl- (mmol/litre)	154	111	95–105
K+ (mmol/litre)	–	5	3.5–5.3
Ca2+ (mmol/litre)	–	2	2.2–2.6
HCO3- (mmol/litre)	–	29 (as lactate)	24–32

*adapted from Reid et al (2003)*

retention (Moore, 1959). This aberrant state of sodium, chloride and water handling makes the surgical patient exquisitely vulnerable to iatrogenic electrolyte and fluid disequilibrium. The body is slow to redress sodium and chloride overload even in normal healthy volunteers, let alone under these conditions of physiological sodium retention (Reid et al, 2003).

Concurrent saline therapy (with its supra-physiological concentrations of sodium and chloride) may therefore easily cause sodium and chloride excess, and an ensuing hyperchloraemic metabolic acidosis (Reid et al, 2003). Furthermore, chloride excess results in renal vasoconstriction, a reduction in glomerular filtration rate and therefore a reduced ability to offload excessive sodium, chloride and volume (Wilcox, 1983). This may be compounded by nitrogenous compounds mobilized by catabolism competing with chloride for excretion, and also by a potassium deficit (Gosling, 2003).

These effects are well proven, yet surgical patients often receive excessive and inappropriate crystalloid therapy, causing significant water, sodium and chloride excesses (Lobo et al, 2001).

## Surgical stress and balanced crystalloids

By contrast, balanced crystalloid solutions have been demonstrated to be significantly superior to 0.9% saline in a range of surgical circumstances. They significantly reduce adverse outcome, enacted via a reduction in sodium and chloride load and acidosis, and preservation of parameters such as renal function, urine output, splanchnic perfusion, and serum electrolyte and osmolality homeostasis (Wilkes et al, 2001; Reid et al, 2003). While saline administration is indicated in certain circumstances (hypochloraemia, for example secondary to vomiting) (Powell-Tuck et al, 2008), in general balanced crystalloids are demonstrably preferable to saline in surgical patients.

## Fluid prescription

Given their ready availability and supportive evidence base, why does 0.9% saline persist as the commonest crystalloid in use in surgical practice (Lobo et al, 2001)? The answer lies ultimately in education. While conducted almost a decade ago, two surveys have elucidated the issues underpinning the prevalence of saline.

In 2001, Lobo et al surveyed 150 surgical pre-registration house officers and senior house officers. As expected, responsibility for prescribing fluids fell to this group of junior doctors, predominantly the former. However, the study demonstrated that this cohort was often woefully ill-equipped to prescribe fluids, with over half ignorant of both the electrolyte compositions of fluids and the requirements of their patients (Lobo et al, 2001). This ignorance was attributed to a lack of education at university and on joining their surgical firms.

The following year, the same authors canvassed the opinions of over 1000 UK consultant surgeons (Lobo et al, 2002). Their findings of the previous year were iterated, and interestingly the respondents felt that fluid prescription was too important to be left to the most junior and ill-prepared members of their team. This issue was also highlighted by the 1999 report of the National Confidential Enquiry into Perioperative Deaths (Callum et al, 1999).

While these studies have not been repeated, it is fair to speculate that little has changed in the last decade, while evidence as to the important clinical advantages of balanced crystalloids continues to increase. In 2008 the *British Consensus Guidelines on Intravenous Fluid Therapy for Adult Surgical Patients* were published (Powell-Tuck et al, 2008). This joint venture of a number of bodies (including the Association of Surgeons of Great Britain and Ireland, the Intensive Care Society, the British Renal Association and the Association for Clinical Biochemistry) for the first time provided explicit guidelines as to the use of crystalloids, their rationale and a useful framework for fluid prescription in surgical patients. The impact of these guidelines has yet to be assessed, but their use by junior doctors should help optimize fluid prescription in the surgical patient.

## The future

Saline has been the historical lynchpin of intravenous fluid therapy, since its potential was illustrated by the ability to prevent cholera deaths in the early 19th century. While it certainly still has a role to play, the physiologically superior balanced solutions subsequently developed have unequivocally earned the right to be the default surgical crystalloids. However, the move to depose 'normal' saline has a long way to go. A concerted effort from those involved in perioperative practice is required, with senior surgeons taking a proactive role in both prescription and education, allocating the resources and efforts which are proportional to the importance of this topic. **BJHM**

*Conflict of interest: none.*

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## KEY POINTS

- Intravenous fluid prescription is a crucial aspect of perioperative care, and must be understood within the context of the surgical stress response; the administration of inappropriate volumes and solutions may have significant detrimental consequences.
- 0.9% 'normal' saline remains very much the surgical crystalloid of default, yet is associated with a number of unwanted clinical consequences.
- Mounting evidence demonstrates that the use of balanced crystalloids is associated with fewer physiological complications and better patient outcomes.