Fluid Management in Abdominal Surgery

What, When, and When Not to Administer

Karthik Raghunathan, MD, MPH[a,*], Mandeep Singh, MD[b], Dileep N. Lobo, MS, DM, FRCS, FACS, FRCPE[c]

KEYWORDS

• Intravenous fluids • Crystalloids • Colloids • Balanced fluids • Fluid responsiveness • Noninvasive monitoring

KEY POINTS

- Intravenous fluids are drugs with predominantly cardiovascular and renal effects, potentially significant gastrointestinal effects, and possible immune effects.
- Distribution of administered fluid volume across compartments (such as the intravascular, interstitial, and intracellular spaces) depends on several factors, including the integrity of the endothelial glycocalyx and intravascular volume context.
- Before the administration of fluid therapy, determination of volume responsiveness and volume status is recommended.
- Balanced crystalloids, with a physiologic strong ion difference and chloride content, may avoid the potentially deleterious effects of chloride-rich isotonic fluids like normal (0.9%) saline.
- Intravascular volume status may be assessed with variable accuracy using minimally invasive or noninvasive technologies.

INTRODUCTION

Intravenous fluid therapy is a key part of perioperative care, and surgical outcomes have been shown to be affected by the type and volume of fluid used. This review

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[a] Anesthesiology Service, Durham VA Medical Center, Duke University Medical Center, Box 3094, Durham, NC 27710, USA; [b] Division of Anesthesiology and Critical Care Medicine, Duke University Medical Center, 2301 Erwin Road, Durham, NC 27710, USA; [c] Division of Gastrointestinal Surgery, Nottingham Digestive Diseases Centre National Institute for Health Research Biomedical Research Unit, Nottingham University Hospitals, Queen's Medical Centre, Nottingham NG7 2UH, UK
* Corresponding author.
E-mail address: Karthik.Raghunathan@duke.edu

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presents an overview of the basic principles that underlie fluid management in the perioperative setting, includes evidence-based recommendations (where tenable), and suggests a rational approach to the timing and choice of fluids for administration.

TYPE OF FLUID

A variety of fluid types are available, including different types of crystalloids, colloids, blood products, and even hemoglobin-based oxygen-carrying solutions. The use of normal or isotonic (0.9%) saline solution dates to the work of a Dutch chemist named Hartog Hamburger in 1896.[1] In an in vitro study of red blood cell (RBC) lysis in response to changes in tonicity, human RBCs were found to be most stable in a preparation of 0.92% saline. More recently, studies have reported an association between resuscitation with isotonic saline and several undesirable effects when compared with resuscitation with physiologically balanced crystalloids (eg, lactated Ringer solution, Plasma-Lyte, Hartmann solution).[2] Administration of 0.9% saline results in hyperchloremia and a decrease in the plasma strong ion difference with consequent metabolic acidosis.[3] This condition, in turn, has been associated with reduced cardiac contractility, decreased renal perfusion, reduced gastric blood flow, and impaired gastric motility.[4–7] Elevated serum chloride concentrations have been associated with renal vasoconstriction and renal parenchymal swelling in animal studies[8,9] and an increase in postoperative 30-day mortality in large database analyses.[10] The deleterious effects of administration of large volumes of 0.9% saline on the kidney have also been shown in a human study that demonstrated decreased renal blood flow velocity and cortical tissue perfusion.[11] Acknowledging potential clinical implications, the British Consensus Guidelines on Intravenous Fluid Therapy for Adult Surgical Patients recommended the use of balanced crystalloids rather than isotonic saline in most routine clinical settings.[12] The case for balanced crystalloids has also been presented comprehensively in a review.[13] Populations for whom isotonic saline remains a reasonable choice include patients with nausea/vomiting or gastric suction (and thus hypochloremic alkalosis) and neurosurgical patients for whom avoiding other hypotonic crystalloids may be reasonable.

Hadimioglu and colleagues[14] conducted a double-blind study randomizing kidney transplant recipients to receive isotonic saline, lactated Ringer solution, or Plasma-Lyte and compared subsequent changes in acid-base balance and potassium and lactate levels. No significant changes in pH or acid-base measures were seen in patients receiving lactated Ringer solution or Plasma-Lyte as opposed to those who received saline (7.44 ± 0.50 vs 7.36 ± 0.05, and 0.4 ± 3.1 vs -4.3 ± 2.1, respectively). However, there were no subsequent significant differences in postoperative renal function. The best metabolic profile was seen in patients receiving Plasma-Lyte. Shaw and colleagues[15] conducted an observational study evaluating the use of normal saline versus a calcium-free isotonic balanced crystalloid solution in adult patients undergoing major abdominal surgery using the Premier Perspective Comparative Database. A total of 926 patients who received Plasma-Lyte on the day of surgery were propensity-matched (in a 3:1 ratio) with 2778 patients who received saline. Hemodialysis occurred approximately 5 times more often in the matched saline group (1.0% [95% confidence interval (CI) 0.05–1.8] vs 4.8% [95% CI 4.1–5.7], $P<.001$); the matched saline group also had significantly increased odds of postoperative infection, blood transfusion, and electrolyte disturbance (sodium, potassium, and/or magnesium). In addition, in-hospital mortality was higher for the saline group (5.6%) than for the balanced crystalloid–Plasma-Lyte group (2.9%), although the difference was not significant after correcting for confounders. Further literature has