CIR ESP. 2016;94(7):369–371

CIRUGÍA ESPAÑOLA

www.elsevier.es/cirugia

Editorial

# Intravenous Fluids: Concepts and Rationality of Use☆

## *Fluidoterapia: conceptos y racionalidad en su aplicación*

In stable surgical patients, physiological alterations related with fluid exchange are minimal, and, consequently, so are the needs for replacement. However, there is evident variability in the preoperative administration of fluids among hospitals, as well as between anesthesiologists and surgeons within the same hospital. This is usually determined by routine habits and not actual patient needs.

The type and characteristics of the fluids should be adapted to the Frank–Starling law and the role of the endothelium in the balance of the pressures exerted in the vascular space. The *circulatory filling pressure* is the pressure that causes tension in the vasculature and is responsible for the venous return. With the administration of large quantities of fluids, the *ventricular filling pressure* surpasses the circulatory filling pressure, causing a discrepancy between the two pressures and lower venous return. Therefore, the administration of fluids would only increase the ventricular ejection fraction if the circulatory filling pressure increases above the ventricular filling pressure and both ventricles function in the ascending area of the cardiac function curve according to the preload.[1] Furthermore, the vascular endothelium is covered by a glycoprotein/proteoglycan layer known as the glycocalyx, which functions as a barrier that avoids endothelial edema and the adherence of thrombogenic substances. The massive administration of fluids releases natriuretic peptides that combine with and transform the glycocalyx (damaging it in extreme cases), thereby modifying permeability and facilitating the passage of water, solutes, proteins and other substances.[2]

Balanced crystalloid or lactated Ringer's solutions offer advantages over 0.9% saline solution in terms of risk for hyperchloremia and hypernatremia. The demonstrated capacity for expansion of colloids, especially hydroxyethyl starch130/0.4, has not led to improved symptoms in unbalanced patients, and it has even been associated with renal failure, so the current consensus is to not administer colloids in situations of risk for multiple organ failure.[3] Nevertheless, in a meta-analysis of non-cardiac surgery[4] with 1500 published articles, only 13 studies (741 patients) match the basic methodology criteria. Although the results of this meta-analysis should be considered preliminary, no differences were found in 90-day mortality or in post-operative renal failure in patients treated with crystalloids (mostly lactated Ringer's) or starches (mostly 130/0.4).[4]

## Goal-directed Fluid Therapy in Stable Surgical Patients

With the aim of improving organ perfusion, the concept of goal-directed fluid therapy (GDFT) has been created in order to optimize cardiac output, which is the parameter that determines tissue oxygenation and perfusion. By administering small volumes (250 mL) of crystalloids or colloids for 5–10 min and measuring the ejection fraction (EF) and its variation, we determine the need for fluid therapy. An increase in EF greater than 10% (*responsive*) indicates good response, therefore another bolus should be added. Likewise, a spontaneous reduction in EF of more than 10% is also indicative of fluid requirement. Contrarily, spontaneous variation or variation after a fluid bolus of less than 10% of the EF (*non-responsive*) indicates the lack of need for fluids. This methodology is a general algorithm and is independent from the monitors for EF and cardiac output used.

The National Institute for Health and Clinical Excellence (NICE) in the United Kingdom recommends GDFT in abdominal surgery patients, especially in colorectal surgery. Even so, GDFT has important limitations[5]: (*a*) in most studies, minimally invasive or non-invasive cardiac output and ejection fraction measurements are used, which have limitations in precision (reproducibility of the different measurements over time) and in the variability or discrepancy with regards to the reference method (usually echocardiogram or pulmonary artery catheter); and (*b*) the predictability of the response to fluid therapy is less than 70%, improving slightly during

☆ Please cite this article as: Sabate A, Koo M. Fluidoterapia: conceptos y racionalidad en su aplicación. Cir Esp. 2016;94:369–371.

mechanical ventilation and worsening in situations of intraabdominal pressure, such as in laparoscopy.

Recently, the introduction of enhanced recovery after surgery (ERAS) protocols and the restrictive therapy of perioperative fluids have been seen to be equally effective, regardless of the application of a GDFT protocol. In a meta-analysis of 23 randomized studies in patients with elective abdominal surgery,[6] patients in the ERAS program showed no differences in overall morbidity or mortality between those managed with GDFT and those with conventional fluid management. In the OPTIMISE study,[7] which randomized patients to standard treatment or GDFT using the administration of colloids and the additional continuous administration of dopexamine, no differences were observed in the complications, but there was a suggested tendency toward a higher mortality attributed to the administration of dopexamine. In this same study, an analysis of myocardial markers (troponin I) revealed a high frequency (>45%) of myocardial ischemia, with no differences between standard management or goal-directed therapy.[8]

## Goal-directed Fluid Therapy in Unstable Surgical Patients

The benefits of fluid therapy in patients with symptomatic hypotension and/or in acute renal failure are evident. The uncertainty lies in determining the type of fluid, volume and time of administration. The experimental model has proven the hypothesis that reestablishing perfusion with *physiological levels* is superior to obtaining *supranormal levels* of tissue perfusion, as this would cause lower tension over the vascular endothelium due to a lower fluid supply.[9] On the one hand, only 50% of *critical patients* have a positive response (*responsive*) to fluid therapy, so the current consensus is to not guide the supply of fluids exclusively based on hemodynamic parameters.[10] On the other hand, the use of diuresis as a renal function parameter is confusing, and it would be necessary to differentiate between oliguria caused by renal function failure and oliguria caused by hypervolemia and associated dysfunction in terms of increased abdominal pressure, lung and cardiac dysfunction.

In septic patients with intraabdominal problems who require surgical intervention, continuous monitoring of hemodynamic parameters and intraabdominal pressure would be justified to assess the initial administration of a fluid mini-dose (100 mL/1 min), or rather elevation of the extremities. If the response is positive (increase in EF >15%), resuscitation would be maintained with fluids together with the administration of noradrenaline. This evidence of response to fluid therapy has limitations in patients with spontaneous ventilation and in those with an intraabdominal pressure above 16 mmHg.

In summary, the volume of fluids administered during the intraoperative period and in the initial postoperative days is directly related with operative complications, so the liberal administration of fluids is not justified. It seems reasonable to utilize balanced solutions to substitute saline in surgical patients. Fluid therapy should be individualized and include the concepts of *stabilization* (maintaining fluid in a zero balance once hemodynamics are stabilized) and *scaled restriction* (reducing the supply of fluids to mobilize the accumulated interstitial fluid).[11] The final objective would be to maintain a zero balance of fluids during the surgical period (including days following surgery).

## Funding

The authors have received no funding related with this manuscript.

## Conflict of Interests

The authors have no conflict of interests to declare.

REFERENCES


1. Cecconi M, Aya HD, Geisen M, Ebm C, Fletcher N, Grounds R, et al. Changes in the mean systemic filling pressure during a fluid challenge in postsurgical intensive care patients. Intensive Care Med. 2013;39:1299–305.
2. Woodcock TE, Woodcock TM. Revised Starling equation and the glycocalyx model of transvascular fluid exchange: an improved paradigm for prescribing intravenous fluid therapy. Br J Anaesth. 2012;108:384–94.
3. Raghunathan K, Murray PT, Beattie WS, Lobo DN, Myburgh J, Sladen R, et al. Choice of fluid in acute illness: what should be given? An international consensus. Br J Anaesth. 2014;113:772–83.
4. Raiman M, Mitchell CG, Biccard BM, Rodseth RN. Comparison of hydroxyethyl starch colloids with crystalloids for surgical patients. A systematic review and meta-analysis. Eur J Anaesthesiol. 2016;33:42–8.
5. Biais M, Berthezène R, Petit L, Cottenceau V, Sztark F. Ability of esCCO to track changes in cardiac output. Br J Anaesth. 2015;115:403–10.
6. Rollins KE, Lobo DN. Intraoperative goal-directed fluid therapy in elective major abdominal surgery: a meta-analysis of randomized controlled trials. Ann Surg. 2016;263:465–76.
7. Pearse RM, Harrison DA, MacDonald N, Gillies MA, Blunt M, Ackland G, et al. Effect of a peri-operative, cardiac output-guided hemodynamic therapy algorithm on outcomes following major gastrointestinal surgery: a randomized clinical trial and systematic review. JAMA. 2014;311:2181–90.
8. Gillies MA, Shah ASV, Mullenheim J, Tricklebank S, Owen T, Antonelli J, et al. Perioperative myocardial injury in patients receiving cardiac output-guided haemodynamic therapy: a substudy of the OPTIMISE Trial. Br J Anaesth. 2015;115:227–33.
9. Wodack KH, Poppe AM, Lena T, Bachmann KA, Strobel CM, Bonk S, et al. Individualized early goal-directed therapy in systemic inflammation: is full utilization of preload reserve the optimal strategy? Crit Care Med. 2014;42:e741–51.
10. Cecconi M, DeBacker D, Antonelli M, Beale R, Bakker J, Hofer C, et al. Consensus on circulatory shock and hemodynamic monitoring. Task force of the European Society of Intensive Care Medicine. Intensive Care Med. 2014;40:1795–815.
11. Hoste EA, Maitland K, Brundey CS, Metha R, Vincent JL, Yates D, et al. Four phases of intravenous fluid therapy: a conceptual model. Br J Anaesth. 2014;113:740–7.

Antoni Sabate[a,b,*], Maylin Koo[a,b]
[a]*Servicio de Anestesiología y Reanimación, Hospital Universitari de Bellvitge, L'Hospitalet de Llobregat, Barcelona, Spain*
[b]*Universidad de Barcelona Health Campus, L'Hospitalet de Llobregat, Barcelona, Spain*

*Corresponding author.
E-mail address: asabatep@bellvitgehospital.cat (A. Sabate).

2173-5077/
© 2016 Published by Elsevier España, S.L.U. on behalf of AEC.