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Post-surgery fluid therapy: the debate on tonicity is still open

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The administration of fluids to the post-surgical patient is a routinary practice that is usually dictated by practices learned during specialized training and, with the exception of children, it usually is the same irrespective of age, gender, and body size of the patient. Since the mortality secondary to fluid therapy is perceived by the clinician as being relatively low, concerns are not generated nor clinical studies on whether volume or composition of the fluids administered may be improved or not. For several years ago, the clinician has been put on alert about the risk for hyponatremia associated to the administration of hypotonic solutions, particularly at the post-surgical setting and in childbearing-aged women.[1] In a recent review[2] Dr. Moritz and Dr. Ayús question the use of hypotonic solutions at the hospital setting since hospitalized patients, especially post-surgical patients, receive several stimuli for non-osmotic release of vasopressin, so that the administration of fluids other than normal saline increases the risk for hyponatremia occurrence that may be fatal. In the review here commented, it is proposed to avoid any type of hypotonic solution in hospitalized patients. Although there are data suggesting the severe hyponatremia is less likely to occur in patients having not received hypotonic solutions, there are, however, no studies confirming that routinary administration of normal saline may be safer than hypotonic solutions.

In the work by Caramelo et al. published in this issue of NEFROLOGÍA,[3] the authors look deeper into this topic, analyzing the reposition of water and electrolytes and its consequences in the internal milieu in 112 patients submitted to elective surgeries under general anesthesia. In these patients, the average volume of fluids administered was 4.6 liters for the first 24 hours, with a mean proportion of isotonic fluids/water of approximately 2:1, that is to say, a hypotonic combination. Twenty-six cases of either hyponatremia (n = 12, $Na^+ < 135$) or Na^+ decrease > 6 mmol/L although without hyponatremic values (n = 14) were detected. These patients did not receive, however, higher amounts of free water than the remaining ones, three patients even only received normal saline during fluid reposition. The authors conclude that there is not a significant relationship between the type of fluids administered and hyponatremia occurrence, and that the latter would be more related to the existence of renal impairment in free water clearance.

These results suggest that the type of reposition used after surgery is neither the main nor the critical factor in the genesis of post-surgical hyponatremia. Besides, they highlight the arbitrariness with which fluids are administered in clinical practice. In fact, there still are important questions to which an appropriate answer cannot be found in the literature, such as how much volume? With what tonicity? In what type of surgeries?

Fluid reposition regimens currently used at post-surgery came up in the 1950s because of the need to maintain post-surgical fasting, and have not substantially being modified to date.[4,5] These regimens were calculated according to estimations on daily needs of water and electrolytes and reposition of losses through drainages or fistulae. They generally establish volumes of 2.5-6 liters of fluids for the first 24 hours with sodium concentrations of 30-100 mmol/L (normal saline has a sodium concentration of 154 mmol/L). One liter of Ringer lactate ([Na+]: 130 mmol/L) and 2.5 liters of 5% dextrose, that is to say an overtly hypotonic solution is established as proper intake in some textbooks on electrolytes and acid-base balance.[6] Other textbooks, such as the one by Kokko and Tannen,[7] also establish hypotonic reposition regimens, although they underline the need for close supervision for the first 24 hours after surgery, during which there is renal inability to eliminate free water due to non-osmotic release of vasopressin; this release may be sustained up to one week after surgery.

In the daily practice there exist high variability in fluids prescription, both in their volume and in their composition. A survey done among 200 surgeons from the United Kingdom[8] showed that education on fluid therapy was insufficient, the prescription being mainly done by training physicians, being highly variable, the most prescribed regimen being 1 liter of normal saline (0.9%) and 2 liters of 5% dextrose. In an analysis carried out by the Pharmacy Department of the «12 de Octubre» Hospital in Madrid,[9] the most used regimen was 1.5 liters of normal saline and 1.5 liters of dextrose. In spite of this striking diversity of regimens, as also reflected in the study by Caramelo et al., it seems that the mortality secondary to electrolytic impairments during post-surgery is low, or at least these impairments are not reported, which reflects that in most of the cases the kidney response to hypotonic solutions overload is adequate, and although there exists a net gain of free water it does not seem to have a clinical relevance.

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An important problem with post-surgery fluid therapy is that generic regimens are used in very different clinical conditions. So that a surgery needing prolonged gastric drainage will have increased reposition requirements as compared with a gynecologic surgery without paralytic ileus. During surgery itself, there are fluid losses that should be estimated and replaced. So, in those surgeries in which the peritoneal cavity or the thorax are exposed for a long time, it is estimated that 4.5 mL/kg of free water per hour of surgery are lost.[10]

Controlled studies allowing reaching any conclusion only exist in particular groups of patients. Several controlled studies and one meta-analysis in minor ambulatory surgery and in laparoscopic surgery have shown that the administration of 20-40 mL/kg of normal saline vs. 1-15 mL/kg before the surgery decrease dizziness, thirst, and vomiting after surgery.[11-14] There are fewer data in major surgery to reach conclusions. In a Cochrane review from the year 2000, in surgery of the abdominal aortic artery,[15] no significant differences were found between different fluid therapy regimens. The authors conclude that more studies are required in order to establish additional conclusions. In a controlled study on parenteral fluids regimens in patients submitted to hemicolectomy,[16] the administration of a restricted regimen of 2 liters/day (0.5 liters of normal saline + 1.5 L of 5% dextrose vs. 3 liters (1 liter of normal saline and 2 L of 5% dextrose) decreased perioperative complications and hospitalization days. Surprisingly, the group with a restricted regimen presented less hyponatremia episodes in spite of receiving lower sodium concentration (37.5 *vs* 51 mmol/L), which again reflects that the issue of post-surgical hyponatremia is probably more related with the volume of fluid administered and renal retention of free water than with the concentration of sodium administered. In children, the data available are in favor of administering normal saline as the reposition fluid, for both surgeries and other circumstances requiring fluid therapy such as dehydration due to gastroenteritis. A systematic review from the year 2006[17] concludes that the experimental evidence in childhood is limited, the studies having a heterogeneous design and low power, although a higher risk for hyponatremia episodes is detected in children receiving hypotonic solutions, which may be anticipated and prevented by the administration of isotonic solutions.

Given the lack of robust evidence, at least in adult patients, about the type of fluid therapy to be administered during the post-surgical period and given the description of severe hyponatremia episodes, some of them fatal, the question to be answered is whether or not the use of only isotonic solutions is justified. Until controlled studies analyzing this issue will not be available, observational studies as the one published in this issue of NEFROLOGÍA deserve great interest. Caramelo et al. show how free water gain is not correlated with the tonicity of the fluids administered. Other observational studies show how post-surgical complications are related with the volume of fluids and the amount of sodium administered and not with the fluids tonicity. So, in an analysis of 100 surgeries of the colon and rectum,[18] there were 44 complications, of which 11 were cardiopulmonary. The group having complications received higher amount of Na (149 *vs* 115 mmol/day) and more volume (2000 *vs* 1700 mL/day). In a similar prospective study on 106 patients submitted to laparotomy,[19] there were 55% complications, including 4 hypernatremia episodes, 17 hyponatremia episodes, and 19 episodes of cardiac failure. The risk for complications was very much higher (67 *vs* 45%) in the group receiving more than 200 mmol of Na per day. The importance of Na intake is essential in the elderly due to his/her decreased cardiopulmonar capacity. In an analysis from the year 1999 about hospital mortality in the elderly population from the United Kingdom[20] it was concluded that errors in parenteral fluids prescription (usually due to an excess) represent the main preventable perioperative morbimortality cause in the elderly.

Within this context, the debate on tonicity still goes on. To assume the recommendations proposed by Ayús et al. to prevent post-surgical hyponatremia and giving only normal saline without controlling the volume and amount of sodium administered may generate higher morbidity due to volume overload than to hyponatremia itself, which usually has little clinical relevance. Besides, and according to the results by Caramelo et al., this is not a regimen allowing for the prevention of hyponatremia occurrence since some patients develop the phenomenon known as «desalination» or inappropriate natriuresis.[21]

Until more information is available on the risks derived from the tonicity and fluid volume to be prescribed in the post-surgical setting, it is judicious to establish strategies allowing preventing the complications, which are as simple as: regularly assessing the patient, from both a clinical and laboratory perspective (electrolytes in blood and urine during all the time that fluid therapy remains in order to adequate the tonicity of the reposition regimen), and keeping a careful water balance, with estimates of intakes and losses, and avoiding unnecessary overhydration, specially in children and the elderly.

Note to the editor: The topic discussed in the article by Dr. Caramelo,[3] being the object of this editorial, is of great interest. Despite the continuous use, post-surgical fluid therapy constitutes a very little studied intervention, sometimes with controversial opinions. NEFROLOGÍA considers that it may be extremely useful to promote the debate on this issue, so the Journal will try to get the opinion from experts on this topic. From here we invite Spanish nephrologists having an opinion on the topic, based on their own work or analysis of the literature, to send us their opinions as a «Letter to the Editor».

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KEY CONCEPTS

1. Fluid therapy in the post-surgical patient is based on classical regimens that have not been revised for several decades ago. There is a great variability in fluids prescription after surgery.

2. In children there exists reasonable evidence supporting the use of isotonic solutions, since they decreased hyponatremia-associated morbidity.

3. In adult patients, the risk for clinically relevant hyponatremia is small, a priori unpredictable, and secondary to renal free water retention.

4. The main morbidity related to fluids administration after surgery derives from excessive volume and sodium intake, particularly in elderly patients.

5. There is no evidence supporting that the administration of isotonic vs. hypotonic solutions decreases morbimortality in the adult patient.

6. Frequent clinical and analytical (ions in blood and urine) monitoring of patients on parenteral fluid therapy is a good clinical practice aimed at decreasing the risk for complications.

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