Preload Dependence and Microcirculation Relationship: Reply

In Reply:

I would like to thank the authors of the letter for reminding us that the notion of preload dependence is not synonymous with hypovolemia. As mentioned in the article,[1] preload dependence is defined as a state in which increases in right ventricular and/or left ventricular end-diastolic volume result in an increase in stroke volume.[2] Changes in preload could be due to hypovolemia and/or a decrease in venous tone with increased venous capacity. Having a preload dependence does not give any indication of the state of the microcirculation. Indeed, microcirculation can be preserved up to a certain level of venous return decline, but can then be altered if the venous return decline is greater. For this reason, it is essential to have an assessment of microcirculation in order to titrate perioperative fluid and correctly administrate vasopressors.

With this in mind, our study highlights that the occurrence of preload dependence was associated with reduced sublingual microcirculation during major abdominal surgery. This shows that decreases in venous return during anesthesia for major abdominal surgery, regardless of cause, are sufficient to alter sublingual microcirculation. In these circumstances, sublingual microcirculation was not protected by self-regulatory mechanisms during venous return decreases. This should encourage us to correct the preload dependency episodes that may occur during surgery in order to avoid these microvascular alterations. As mentioned in the article,[1] the fact that fluid challenge was able to restore microcirculatory alterations pleads for hypovolemia. Fluid administration may have corrected an absolute hypovolemia due to a loss of blood volume or a relative hypovolemia due to a decrease in venous tone. In any case, correcting preload dependency remains a priority considering the risk of failure to treat an alteration of the microcirculation. Static (pulmonary artery occlusion pressure, central venous pressure, global end-diastolic volume, flow time of aortic flow) and dynamic (pulse pressure variation, stroke volume variations, vena cava diameter variations) hemodynamic variables have their own limits and their gray zone to guide fluid administration. Especially, pulse pressure variations cannot be used during arrhythmia, when tidal volumes are less than 8 ml/kg of ideal body weight, when spontaneous breathing occurs, or when pulse pressure variation value is in the gray zone (between 9 and 13%). Microvascular sublingual measurements could be an additional tool in the future to support the decision to administer fluids or vasopressors. It is clear that we must continue to develop techniques to analyze the behavior of microcirculation because the ultimate goal of hemodynamic optimization is the optimization of microcirculation and tissue oxygenation.

Competing Interests

The author declares no competing interests.

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IV Fluids for Major Surgery: Comment

To the Editor:

The review article of perioperative fluid therapy by Miller and Myles[1] provides new recommendations for fluid administration during major surgery. Many studies performed during the past 15 yr show that a restrictive strategy consisting of 3 to 5 $ml^{-1} \cdot kg^{-1} \cdot h^{-1}$ of crystalloid fluid during surgery provides a better outcome in comparison with 10 to 12 $ml^{-1} \cdot kg^{-1} \cdot h^{-1}$. The authors now swing the pendulum once again and recommend the larger amount. The basis for their recommendation consists of only two retrospective studies and their own prospective study, the RELIEF (Restrictive Versus Liberal Fluid Therapy in Major Abdominal Surgery) trial.[2]

We believe that the patient's preoperative fluid status should be considered when giving recommendations of this kind. Miller and Myles encourage unrestricted intake of

fluids until 2 h before elective surgery,[1] but in the RELIEF trial patients had fasted for a median of 9 h, and 25% of them even for 12 h or more, before surgery.[2] Moreover, 36% of their patients received bowel preparation, which causes fluid depletion. Therefore, many of the patients in the RELIEF trial were probably dehydrated, or even hypovolemic, when surgery started. Finally, the postoperative fluid administration in the restrictive group in the RELIEF trial amounted to only $0.8\,ml^{-1} \cdot kg^{-1} \cdot h^{-1}$, which is less than the recommended minimum water intake of 1.0 to $1.2\,ml^{-1} \cdot kg^{-1} \cdot h^{-1}$ in conscious healthy humans. Therefore, the higher incidence of postoperative creatinine elevation in the restrictive group might be an expected result of the trial.

The issues we mention may even explain the discrepancy between the RELIEF trial and previous studies in this area which, with few exceptions, favor a restrictive strategy. The new recommendations[1] are probably correct for patients with various degrees of preoperative dehydration attributable to lengthy preoperative fasting and bowel preparation, which have fallen out of practice in most parts of the world.[3,4] However, we question this liberal approach in patients who are euhydrated before surgery.

Competing Interests

The authors declare no competing interests.

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IV Fluids for Major Surgery: Reply

In Reply:

Drs. Bahlmann and Hahn mention the existence of some published studies supporting a restrictive approach to perioperative IV fluid therapy, but do not mention others (aside from the RELIEF [Restrictive Versus Liberal Fluid Therapy in Major Abdominal Surgery] trial[1]) that identified possible harms or at least no measurable benefit.[2–4] The RELIEF trial clearly identified an increased risk of acute kidney injury when a more restrictive zero-balance approach was used.

We agree with Drs. Bahlmann and Hahn that any unnecessary preoperative fasting should be avoided, and that clinicians should encourage unrestricted intake of fluids until 2 h before elective surgery as a standard of care. This was one of our recommendations.[5] Although unnecessarily lengthy preoperative fasting times will create a state of relative dehydration, it is quite usual for most people to not drink between the late evening hours and morning (8 to 10 h period of fasting), so this duration is very unlikely to induce dehydration. More importantly, the RELIEF trial investigators analyzed and reported their results for acute kidney injury according to fasting times and the adverse effect of the restrictive zero-balance approach remained. That is, the risk of acute kidney injury occurred in those with short, intermediate, and longer fasting times (*P* value for interaction equals 0.47; see fig. S8 in the supplementary material of Myles *et al.*[1]). A similarly consistent finding was observed in those who did or did not receive bowel preparation (*P* value for interaction equals 0.55).

Recent guidelines from others had recommended a zero-balance approach to perioperative IV fluid therapy.[6–8] This implies that fluid balance should be zero at the end of surgery and over the ensuing 24 h. This is what was tested in the RELIEF trial and the results not only failed to identify any meaningful reduction in complications or hospital length of stay, but there was a higher incidence of acute kidney injury and surgical site infections. It is for this reason

that we recommended a moderately liberal IV fluid strategy for major surgery. That is what the evidence is telling us.

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Competing Interests

Dr. Myles was the principal investigator of the RELIEF (Restrictive Versus Liberal Fluid Therapy in Major Abdominal Surgery) trial. Dr. Miller declares no competing interests.

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