Youth anesthesiologists have long been taught that the replacement of losses is the key target in the management of IV fluid therapy. During surgery, a fluid deficit is undoubtedly created by preoperative fasting, surgical blood loss, evaporation, and urinary excretion. The vasodilatation induced by many forms of anesthesia allows the vascular space to contain more plasma, and this additional volume should probably be provided as IV fluid. Many of us feel encouraged to infuse even more volume due to a perceived transfer of fluid into the “third space.” Others believe that inflammatory mediators create a need to compensate for fluid extravasation due to increased transcapillary leak of albumin. All these factors may add up to many liters of fluid during a standard operation.

A more modern approach is to ask which fluid regimen is associated with the best outcome. Surprisingly, only a few such studies were published before this millennium. Their appearance goes hand-in-hand with a broader definition of surgical complications as registered prospectively by using sensitive scales. When studied in this way, the incidence of complications is approximately 25% for healthy patients undergoing moderate-length surgery, and 50% in elderly patients, smokers, and patients with cardiovascular disease (1–6). These high figures have made it possible to demonstrate statistically significant differences in outcome between fairly small groups of patients depending on the fluid program used. Multicenter studies are hardly needed, since the total number required for making such a comparison, between 75 and 200, is tractable for a single hospital.

New methods have also been developed. Quantification of the distribution and elimination of infusion fluids by kinetic analysis can provide mechanistic explanations to why and when patients are sensitive to large volumes of fluid. Such studies show that the clearance of crystalloid fluid during anesthesia and surgery is only 10–20% of that measured in awake volunteers (7–10). Other findings include the 25–30 min lag time for crystalloid to equilibrate between plasma and the interstitial fluid space (8) and influence of adrenergic drugs on fluid balance, at least in sheep (11).

Goal-directed fluid therapy is a method for correction of fluid status in the individual patient before surgery starts. Boluses consisting of 200 mL of colloid fluid are infused until there is no further increase in cardiac output. This approach, which is based on the Frank-Starling mechanism, has similarities to the optimization of oxygen transport that decreases morbidity after major surgery and sepsis (12). Hospital time has been the primary end-point in the studies based on goal-directed fluid therapy.

The study by Holte et al. in this issue of *Anesthesia & Analgesia* (13) is yet another approach to evaluate the effects of a fluid program. Here, the main focus is on physical fitness, recovery, and well-being after surgery. The assessment bridged multiple body systems and included spirometry, pulse oximetry, thromboelastography, time to restoration of bowel function, and questionnaires. The authors found only modest differences between patients randomized to a liberal fluid program and those given a restrictive regimen, although (not surprisingly) hypercoagulation was induced by the liberal fluid administration. The study was performed well,
other than the nonsequitur of using a walking test to assess exercise capacity after knee surgery.

The present report is number 3 in a series conducted by this group of Danish surgeons, after studies in volunteers (14) and patients undergoing laparoscopic cholecystectomy (15). The value of Holte et al.’s approach lies in the assessment of a broad set of variables that are of concern to all patients who undergo surgery and to every doctor who helps them along. Their studies are not powered to compare surgical complications, but to assess patient recovery. The measures appear robust and valid. Hopefully others will adopt their approach.

For many years, research in fluid therapy was hampered by the lack of methods to assess important outcomes. This has changed. Current assessment tools make fluid therapy a likely area for clinically significant advances. Among the recent results, we find that a restrictive program is superior to liberal administration of crystalloid fluid during colon surgery (5,6), and that fluid with a low sodium content is better than isotonic saline (4). The powerful inhibition of the elimination of crystalloid explains why edema easily occurs during prolonged surgery (9,10). Goal-directed fluid therapy helps to maintain pH in the gut during cardiac surgery (16), and reduces hospital time after hip surgery (17,18) and unselected general surgery (19). The studies performed by Holte’s group show that large volumes of crystalloid impair ventilatory capacity in volunteers (14), but have the opposite effect after laparoscopic cholecystectomy (15). Their most recent report shows that it does not matter much whether the fluid administration is liberal or restrictive during knee arthroplasty (13).

What is the “take-home” messages from this literature? Why does a liberal fluid program cause complications after colon surgery, when a similar program promotes fitness after laparoscopic cholecystectomy? A simple explanation could be that tissue edema causes problems for surgical wound healing, which might be particularly problematic in the bowel where crystalloid fluid tends to accumulate. The contradictions inherent in the present body of knowledge warn us from generalizing results among different types of operations.

None of the new studies has noted differences in arterial blood pressure and heart rate between liberal and restrictive fluid programs. This is highly significant, since anaesthesiologists often titrate fluid based on arterial blood pressure. The practice of doing so is borrowed from the treatment of hypovolemic shock. However, a more logical strategy would be to only give fluid as long as the arterial blood pressure responds accordingly. If it does not, an alternative strategy should be rapidly sought, as hypotension induced by anesthetic drugs reacts poorly, if at all, to fluid therapy.

We have a lot to learn about scientific titration of the drug most widely used in the operating room: IV fluid. This knowledge is likely to improve outcome in ways that are meaningful for our patients.

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