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Peri-operative fluid management

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The controversy over peri-operative fluid management

Peri-operative fluid management continues to be a daily challenge in anaesthetic practice [1, 2]. Recent studies that investigated the effects of different amounts of peri-operative fluids on outcome reported conflicting results depending on the patient population, the type of surgery and the regimen. Studies in minor or ambulatory surgery suggest that high-dose fluid regimens may improve early recovery measures such as dizziness, drowsiness, nausea and thirst, improve pulmonary function and exercise capacity and shorten hospital stay [3-7]. The results of these studies, however, cannot be extrapolated to major surgical procedures in which substantially larger third space loss, larger stress response and altered capillary permeability occur.

The widespread use of a 'dry' fluid regimen in pulmonary surgery with a resulting decrease in morbidity of pulmonary complications supports the safety of this regimen in high-risk patients undergoing major surgical procedures [8-10]. Nevertheless, at present, no widely accepted recommendations are available for the optimal peri-operative fluid regimen to be used in major non-thoracic surgery.

Fluid management in major intra-abdominal surgery

Abdominal surgical procedures, in particular, are associated with dehydration from pre-operative fasting, bowel preparation, underlying illness as well as intra- and postoperative fluid and electrolyte loss. The exact quantity of this fluid loss is difficult to ascertain and estimates for replacement with balanced salt solutions range from 0 to 67 ml.kg.hr of surgery [11]. According to textbook recommendations, intra-operative fluid administration in patients undergoing intra-abdominal procedures should be in the range of 10-15 ml.kg.hr [12]. This regimen, however, is not evidence-based and was recently challenged. Three studies in patients undergoing colectomy or colorectal resection or a variety of intra-abdominal operations found that restricted postoperative [13], peri-operative [14] or intra-operative [15] fluid administration resulted in reduced weight gain postoperatively, higher albumin concentrations, reduced hospital stays, faster return of gastrointestinal function, and reduced postoperative complications with no adverse effect on renal function. Recently, an association between positive fluid balance and adverse surgical outcomes has also been shown for oesophageal cancer and oesophagogastric junction cancer operations [16].

In liver transplantation, fluid overload has been shown to be a predictor of poor graft function and increased postoperative morbidity [17]. In liver resection it has been shown repeatedly that keeping the CVP low results in reduced blood loss and blood transfusion requirements [18-22].

Goal-directed fluid administration

Others workers have criticised the use of 'fixed volume regimens approach' and suggested that goal-directed fluid administration, in which cardiac output and stroke volume are monitored with an oesophageal Doppler monitor and optimised with colloid administration, is preferable. For example, Gan et al found that goal-directed fluid administration reduced the risk of nausea and vomiting, sped return of bowel function, and shortened hospitalisation without affecting the postoperative complication rate in patients undergoing major surgery with anticipated blood loss exceeding 500 ml [23]. Others have confirmed these results in patients undergoing colectomy [24-26]. In all these studies, however, patients received significantly more colloids in the Doppler/goal-directed group compared with the control group, suggesting that the differences between the groups in outcome could be attributed to the differences in the type of fluids administered and not to approach used. Indeed later studies by Gan et al [27] showed that intra-operative colloid administration reduced postoperative nausea and vomiting and improved postoperative outcomes compared with crystalloid administration.

In other types of operations Mythen et al [28] and Sinclair et al [29] found that Doppler-directed colloid administration improved gut mucosal perfusion (as determined by gastric tonometry), reduced the risk of complications, and shortened hospitalisation in cardiac surgery patients, and improved recovery characteristics and shortened hospitalisation in patients undergoing hip fracture repair.

Morbidity that may be associated with liberal fluid administration

Liberal fluid administration in the peri-operative period is associated with increases in body weight in the range of 3-10 kg which reflects a positive fluid balance. The increase in weight has been reported to be associated with greater postoperative morbidity, longer length of ICU stay and greater mortality [30]. In healthy volunteers, infusion of 40ml.kg of Ringer's lactate solution over 3 h caused significant increases in body weight and reductions in pulmonary function compared with infusions of 5ml.kg [31]. Arieff presented 13 fatal cases of postoperative pulmonary oedema in healthy individuals in whom the oedema was secondary to excessive fluid administration [32]. The hypothesis that liberal use of fluid should significantly increase tissue oxygenation and, therefore, decrease the incidence of postoperative wound infection was recently disproved in a group of patients undergoing elective colonic resection [33]. Others have shown that massive fluid resuscitation during extensive surgery resulted in median nerve injury [34]. Positive postoperative fluid balance can also result in gut oedema, which may contribute to intestinal dysfunction [35, 36]. In the 1930's, Mecray et al [37] found that modest positive salt and water balance caused weight gain after elective colectomy and was associated with delayed recovery of gastrointestinal function (time to flatus and faeces passage), increased complication rate and extended hospital stays. Similar findings were demonstrated recently [14-15]. Hypoproteinemia has also been associated with extended gastric emptying, delayed small bowel transit and postoperative ileus [13, 37, 38]. Whether the effect is due to the hypoalbuminemia itself or the result of a positive fluid balance is unknown, as it is difficult to separate these two conditions.

Potential benefits of 'dry' fluid regimens

Significant healthcare resources are used to provide care to patients with prolonged postoperative hospitalisation. Clinicians, hospitals, and healthcare payers are increasingly focusing on reducing 'unnecessary' days of hospitalisation after surgery. Gastro-intestinal dysfunction has a substantial effect on resource utilisation [39]. In two large studies [40, 41] that included patients undergoing major non-cardiac surgery, Bennett-Guerrero et al demonstrated that gastro-intestinal dysfunction was the most common event that was associated with prolongation of hospital stay. Intra-operative use of a 'restrictive' fluid regimen, as discussed above, shortens the return of gastro-intestinal function and reduces the number of patients suffering from postoperative complications. Therefore, it is not surprising that it has also been shown to shorten hospital stay.

Conclusions

In summary, it has been previously demonstrated that excessive fluid administration increases peri-operative morbidity and mortality in patients undergoing pneumonectomy. There are increasing reports of improved outcome in patients undergoing major elective gastro-intestinal surgery who were managed with fluid restriction. Moreover, in a recent report [42] Tatara et al used a mathematical model which was validated in 30 patients undergoing elective abdominal surgery to show that increasing overall fluid replacement above 10 ml.kg.hr does not increase intra-vascular volume but instead increases only interstitial volume. Accordingly, replacement of fluids in the peri-operative period should be undertaken cautiously. Fluid overload may affect both the injured (surgical) area (with anastomotic leak, wound infection etc) and the non-operated organs (cardiopulmonary system, gastro-intestinal tract). Elimination of preloading fluids (prior to administration of epidural anaesthesia) and replacement fluids for 'third spacing', is suggested, together with monitoring of the patient's body weight so as to avoid significant increases. With the ongoing changes in surgical practice such as fast-track protocols that avoid pre-operative bowel preparation, early oral feeding and laparoscopic procedures, more studies are needed to define the amount of fluid to be administered intra-operatively. For further reading the readers are referred to a comprehensive review which was recently published that summarises the topic of peri-operative fluid management [43].

Key Learning Points

- The goal of peri-operative fluid application is to keep an adequate blood flow in vital organs.
- In contrast to previous beliefs, the extracellular deficit after normal fasting is low, a classic third space does not exist, and the insensible loss in major surgery is relatively small (~ 1 ml.kg.h).
- Excessive fluid administration increases peri-operative morbidity in patients undergoing pneumonectomy, liver transplantation and liver resection. There are increasing reports of improved outcome in patients undergoing major elective gastro-intestinal surgery and oesophagectomy who were managed with relative fluid restriction.
- Consequently, pre-operative volume loading in non-hypovolaemic patients and routine replacement of high insensible and third space losses should be abolished in favor of demand-related fluid regimens.

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