Editorial Commentary

Importance of intraoperative fluid management

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Intraoperative fluid management and postoperative adverse effects

Intraoperative fluid management is an important issue for postoperative outcomes. A hospital registry study by Shin *et al.* (1) found an association between liberal fluid administration and the development of respiratory complications. Further, both restrictive and liberal fluid administrations displayed correlations with the development of acute kidney injury (AKI).

In pulmonary resection, single-lung ventilation as well as the reduction of the pulmonary vascular bed by lung resection results in stress on the right heart circulation (2). Intraoperative fluid management is thus a more important issue for postoperative surgical outcomes following lung resection. In the case of lung resection, particularly in patients with chronic obstructive pulmonary disease, the burden on the heart is even greater, so postoperative complications are increased in both frequency and severity among these patients (3). Alam *et al.* (4) investigated postoperative lung injury in 1,428 patients with lung resection for lung cancer. Postoperative lung injury developed in 76 cases (5.3%), including acute lung injury (ALI) or acute respiratory distress syndrome (ARDS) in 44 (3.1%). They compared 76 cases with postoperative lung injury and 76 propensity-matched controls. Median perioperative fluid volume was higher in the group with postoperative lung injury (2,775 mL; range, 1,350–5,000 mL) than in controls [2,500 mL; range, 1,400–4,500 mL; odds ratio (OR), 1.20; P=0.05]. Both uni- and multivariate analyses identified perioperative fluid administration and a decrease in postoperative predicted lung function as factors significantly associated for postoperative lung injury.

In a review by Evans *et al.* (5), intra- and postoperative administration of fluids at 1–2 mL/kg/h was recommended, but not exceeding a positive fluid balance of 1,500 mL. The intent of this was to reduce the postoperative risk of multifactorial ALI or ARDS. However, those recommendations appear rather too stringent. Ahn *et al.* (6) analyzed 74 of 1,442 patients (5.1%) who developed AKI after thoracic surgery. Crystalloid administration less than 3 mL/kg/h showed no relationship with AKI. They also demonstrated that hydroxyethyl starches increase the risk of AKI in patients with lower renal function defined by preoperative serum creatine or estimate glomerular filtration rate. Matot *et al.* (7) designed a randomized, controlled trial to clarify whether intraoperative fluid management affected urinary output and postoperative renal function in 102 patients undergoing video-assisted thoracoscopic surgery. They demonstrated that neither high (8 mL/kg/h) nor low (2 mL/kg/h) crystalloid administration affected intraoperative urinary output, postoperative creatinine serum level or postoperative complication rate.

The Enhanced Recovery After Surgery Society (ERAS) and the European Society of Thoracic Surgeons (ESTS) strongly recommended, in a joint guideline (8), euvolemic fluid management, balanced crystalloids, and early enteral route for perioperative fluid management following lung resection. Both restrictive and liberal fluid administration should thus be avoided, and intraoperative use of vasopressors and a limited volume of fluid, particularly balanced crystalloids, prevents hypoperfusion.

Wu *et al.* (9) examined correlations between intraoperative fluid management and outcomes following minimally invasive lobectomy. They investigated 446 patients under 70 years old who underwent minimally invasive lobectomy using video- or robotic-assisted thoracoscopic surgery. Notably, their analysis was designed to focus purely on the relationship between lung resection and intraoperative fluid administration by excluding those patients with relatively lower preoperative condition. They classified total intraoperative fluids into four groups: restrictive, ≤9.4 mL/kg/h; moderate, 9.4 to ≤11.8 mL/kg/h; moderately liberal, 11.8 to ≤14.2 mL/kg/h; and liberal, >14.2 mL/kg/h. They also classified total intraoperative fluids by colloid administration into three groups: no administration; restrictive, >0 to ≤3.8 mL/kg/h; and moderate, >3.8 mL/kg/h. The aim in that study was to clarify the relationship between intraoperative total fluids or colloid administration and risk of postoperative pulmonary complications (PPCs). The PPCs examined were ARDS, a requirement for intubation, pneumonia, need for bronchoscopic airway cleaning, atelectasis, prolonged air leak, and expansion failure. Significant increases in the risk of PPCs were identified for each of the restrictive (OR =2.202, P=0.012), moderately liberal (OR =2.743, P=0.002), and liberal (OR =2.609, P=0.008) groups. Compared with the moderate group in terms of the intraoperative colloid infusion rate, risk of PCs was significantly increased for both no-colloid (OR =2.095, P=0.010) and restrictive (OR =2.911, P=0.003) groups. Wu *et al.* therefore concluded that both restrictive and liberal intraoperative fluid administrations were associated with adverse impacts on postoperative outcomes. Fluid management may thus achieve optimal postoperative outcomes when conducted in a moderate manner.

Arslantas *et al.* (10) likewise reported that intraoperative fluid administration affects PPCs. They investigated 139 patients, comprising 69 with segmentectomy or lobectomy, 19 with video-assisted thoracoscopic segmentectomy or lobectomy, 37 with extended lobectomy, 9 with pneumonectomy, and 5 with extended pneumonectomy. A total of 161 PPCs were observed in 76 patients. Univariate analyses identified smoking, total intraoperative volume of fluids, crystalloids, and blood products, and infusion rate as well as total amount of crystalloids and infusion rate during the first 48 h postoperatively as significantly associated with risk of PPCs. Intraoperative infusion rate and smoking were subsequently identified as significant predictors of PPCs from multivariate logistic regression analysis. PPCs were concluded to occur more frequently for intraoperative infusion rates exceeding 6 mL/kg/h.

Our previous study (11) examined perioperative risk factors associated with postoperative acute exacerbation (PAE) of idiopathic pulmonary fibrosis (IPF), including fluid management. Participants in that retrospective investigation comprised 52 patients with primary lung cancer and clinical IPF. Seven of those 52 patients (13.5%) developed PAE of IPF, and 6 of those 7 patients (85.7%) died of respiratory failure due to uncontrollable PAE. Mean intraoperative fluid administration and intraoperative fluid balance were 10.3±3.66 and 8.00±4.21 mL/kg/h, respectively. By way of comparison, these values in patients without PAE were 7.71±3.11 and 4.99±2.86 mL/kg/h, respectively. Intraoperative fluid balance and preoperative concentration of C-reactive protein were revealed as prognostic factors for PAE of IPF by multivariate logistic regression analysis (OR =1.312, P=0.026 and OR =1.280 P=0.048, respectively). We therefore concluded that intraoperative management minimizing intravenous fluid administration is essential for preventing PAE.

Conclusions

Appropriate levels of intraoperative transfusion volume have differed between several reports, and a definitive determination is difficult. However, as Wu *et al.* (9) showed, proper care to minimize postoperative adverse effects requires avoidance of both restrictive and liberal fluid administration.

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Footnote

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Ethical Statement: The author is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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