Review Article

Proper volume management during anesthesia for esophageal resection

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Abstract: Esophagectomy is a high-risk surgical procedure with significant postoperative morbidity and mortality. Proper fluid management is essential to reduce postoperative pulmonary complications. Restrictive management is advocated in ERAS based protocols and recent guidelines for esophagectomy, however Goal Directed treatment may be useful. Perioperative fluid management must always be seen in light of a multi modal approach and must be balanced at the needs of the patient and the surgical approach chosen.

Keywords: Fluid management; esophagectomy; pulmonary complications

Submitted Dec 31, 2018. Accepted for publication Jan 09, 2019.

doi: 10.21037/jtd.2019.01.33

View this article at: http://dx.doi.org/10.21037/jtd.2019.01.33

Introduction

Esophagectomy is a high-risk surgical procedure with significant postoperative morbidity and mortality. The challenge of modern anesthesia is participation in a multidisciplinary team with contributes to postoperative recovery. The starting point for changing perceptions and standardizing approaches to perioperative management lies in improving communication within the multidisciplinary team. This implicates, for the anesthesiologist, an effort on patient's selection, ventilation strategies, postoperative pain management, early mobilization and peri-operative fluid management (1,2).

A multimodal approach may help to improve the infrastructure for the management of esophageal cancer patients in high-volume centers, by earlier recognition and better treatment of complications (3,4).

Thirty years ago, Brodner *et al.* described the first multi modal approach for esophagectomy (5). It was concluded that sufficient analgesia with blockade of the perioperative stress response, combined with other aspects of postoperative therapy, can improve recovery after surgery. The intensive care unit stay after esophageal resection was significantly reduced with the combination of thoracic epidural analgesia (TEA), early tracheal extubation and forced mobilization. In more recent studies the benefit of this strategy is supported by restrictive fluid management (6-8).

Here, fluid management in general is discussed and the effect of fluid management on postoperative complications following esophagostomy.

Liberal, restrictive, or goal directed fluid management

The debate between liberal, restrictive or goal directed fluid management (GDT) is long, intense and still ongoing. In 2009, Chappell *et al.* described that the discussion in liberal versus restrictive fluid management is limited by a lack of proper definitions: fluid volumes called restrictive by some are named liberal by others (9). This lack of definition leads to substantial heterogeneity between studies making a proper meta-analysis difficult. Recently, a combination of the Australian and New Zealand College of Anaesthetists Clinical Trials Network and the Australian and New Zealand Intensive Care Society Clinical Trials Group tried to create a breakthrough with a prospective randomized trial with well-defined endpoints for the restrictive or liberal fluid treatment group (10). In the first 24 hours after surgery, the restrictive fluid group received a median fluid intake of 3.7 L. The liberal group received 6.1 L. There was no difference in disability-free survival at 1 year.

Liberal fluid management

Liberal fluid management is based on conserving and maintaining adequate organ and tissue perfusion. Fluid loss is calculated as the effect of starvation, insensible loss, third spacing and blood loss, leading to highly positive fluid balances and tissue edema. Administration of fluid is guided by urine output, skin temperature, heart rate, and systemic blood pressure but is mostly based on the observations and experience of the anesthetist.

A perioperative fluid load as much as 7 L has been described in an open three hole esophagectomy (11). Surgeons traditionally tried to avoid the use of vasopressors (nor-epinephrine, vasopressin) in the perioperative phase of an esophagectomy because of the delicate gastro – esophageal anastomosis. The gastric conduit is constructed after resection of the specimen and the arterial supply solely depends on the right gastroepiploic arterial arcade (12). In a cervical anastomosis (McKeown), the top of the gastric conduit is dependent on the microcirculation and is at risk for ischemia. All studies towards tissue perfusion show a tremendous decrease in blood flow, tissue oxygenation or both in the gastric area of the anastomosis. Although the cause of these complications is still unknown, compromised microvascular blood flow and hypoxia of the gastric tube are thought to be important factors for failure of the gastro-esophageal junction. As vasopressors have long been considered to impair the gastric microvascular blood flow (13), esophagectomy is associated with a liberal fluid protocol, and strongly positive fluid balance, to maintain gastric microcirculatory blood flow.

Restrictive fluid management

Pulmonary complications are prevalent following esophagectomy, with a reported incidence of postoperative pneumonia up to 60%. One of the underlying mechanisms is interstitial, pulmonary, edema. In restrictive fluid management, the aim is to avoid interstitial edema by maintaining a zero-fluid balance. Starvation, sensible loss and third spacing are considered to be less important and not corrected with extra fluid boluses. Beside postoperative pulmonary complications, interstitial edema, might lead to impaired wound healing and anastomotic failure. The term "restrictive" has been considered by some anesthetists as frightening, because of the believe that restrictive fluid management leads to dehydration, intravascular hypovolemia and microcirculatory disturbance. Especially the effect of hypoperfusion on kidney perfusion and the potential occurrence of acute kidney injury (AKI) is worrisome. However, a closer look at the study protocols supporting restrictive fluid management, show that the fluid regimens used were mostly not restrictive in the true sense of the word, but represented an adequate substitution of fluid needs (14). Restrictive fluid management has become one of the key points of ERAS protocols in several types of abdominal surgery and in esophagectomy. The beneficial effect of restrictive fluid management on post-operative pulmonary recovery after esophagectomy was described by several authors (15-17).

To our knowledge there is no effect of liberal versus restrictive fluid management on gastro-esophageal anastomotic leakage. Recently, a restrictive fluid protocol was proposed as part of the ERAS guidelines in esophagostomy (18). This guideline advised optimal fluid balance and to avoid a weight gain of 2 kg/day.

Goal directed therapy (GDT)

A balanced fluid management may be achieved by GDT, GDT describes an algorithm of care primarily used perioperatively in high-risk surgical patients, or septic shock patients. The goal is to optimize total blood flow and tissue oxygen delivery by supplemental fluids and vasoactive drugs (inotropes, vasopressors, and vasodilators). GDT is nowadays used in general surgery, orthopedic, cardiothoracic, and vascular surgery. The first trial evaluating GDT in high-risk surgical patients was by Shoemaker and colleagues in 1988 (19). In this study, a pulmonary artery catheter (Swann and Ganz catheter) was used to guide supportive treatment to achieve optimal cardiac output and oxygen delivery. Due to its invasiveness and complexity the pulmonary artery catheter has lost its popularity and is replaced by various, less invasive, techniques (Pulse contour analysis, pulse pressure variation). However, all protocols aim to improve oxygen delivery by fluid replacement and vasoactive medication (inotropics, vasopressors, blood transfusion). Despite the physiological theory a recent Cochrane review by Grocott *et al.* showed that GDT did not significantly improve mortality (20).

For esophagostomy, there is only one prospective RCT, by Veelo and co-workers (21), looking at the effect of GDT on outcome from. The study compared a GDT protocol to a historical, normal treatment (liberal) group. Patients in the GDT group received overall less fluid than those in the control group, but more colloids were used to achieve the goal. Unfortunately, in this study a decrease in overall morbidity, hospital-stay or mortality was not observed, but a reduction in pneumonia, mediastinal abscesses and prolonged ICU stay was found. There was no difference in anastomotic leakage between the two groups.

What kind of fluid?

Besides the amount of fluid, the kind of fluid to be used: crystalloids or colloids has also been debated for decades. Crystalloid fluids consist of isotonic saline or balanced electrolyte solutions (Ringer's lactate solution). Crystalloids are rapidly and widely shifting towards the interstitium, leading to tissue edema. Colloids (e.g., albumin, hydroxyethyl starch, gelatins) are crystalloid solutions containing suspended large-molecular-weight molecules, which have traditionally been thought to remain in the intravascular fluid compartment for a prolonged period after administration. Colloids are therefore thought to preserve colloid oncotic pressure. Colloid oncotic pressure is essential in avoiding tissue edema. Thus, colloids have been used as volume-sparing agents with the proposed benefits of less overall volume required for resuscitation and restoration of intravascular volume and therefore less interstitial edema. From the introduction in the late 1960's Colloids are associated with impaired blood clotting and kidney failure (22,23).

In a recent Cochrane review, there was no difference in mortality between colloids compared to crystalloids in the critically ill. Furthermore, starches probably increase the need for blood transfusion (hemodilution) and renal replacement therapy (24). This Cochrane review supports the finding found by Myburg *et al.*, on behalf of the Australian and New Zealand Intensive Care Society Clinical Trials group who also reported a higher incidence of renal replacement therapy (25,26). Although the results of this study performed in critical ill, and results cannot be translated directly to the "healthy" surgical patient, this study has led a reduction in the use of Starch. The European Society of Anesthesiology is now planning an international, multicenter trial on the use of starch in peri-operative care and trauma management (27).

Fluid, esophagectomy and outcome

Evaluating the effect of fluid on the two major complications after esophagectomy: gastroesophageal anastomotic leakage and respiratory morbidity is difficult (28). To define best practice and to compare the results of studies, standardization of definitions of postoperative is of great importance. In a review on reported complications, Blencowe *et al.* (29) describes 22 different definitions were used out for anastomotic failure and 16 different descriptions for postoperative pneumonia. This is why in 2015 the Esophagectomy Complication Consensus Group (ECCG) came with proposed definitions for the post-operative morbidity (30).

Anastomotic failure

The choice of position of the anastomosis is dependent of the location of the tumor and by the insights of the surgeon. Some surgeons accept a possible higher leak rate associated with a cervical anastomosis (McKeown), because a wider oncological resection margin can be achieved. Others advocate that an intrathoracic anastomosis (Ivor-Lewis) is associated with a lower leak rate because the gastric tube is shorter and better vascularized (31). In Ivor-Lewis, the anastomosis is created in the watershed area of the right gastric epiploic artery and the microcirculation is considered to be less diminished in that region (32). In the Netherlands, intrathoracic anastomosis is gaining popularity. In 2017, according to the Dutch Upper GI Cancer Audit (DUCA), 57% of all esophagectomies were performed as Ivor Lewis, compared with 51% in 2016 and 43% in 2015 (33).

To our knowledge there is no literature that favors liberal, restrictive or GDT to avoid failure of the gastric-esophageal anastomosis. The condition of the anastomosis is probably more dependent on the patient's tissue quality (previous chemo-radiation), intra-operative events and surgical skills (learning curve).

Pulmonary complications

In the Dutch registry for esophageal cancer, the incidence of postoperative pneumonia was 21% (pneumonia was defined according to the ECCG definition).

In open esophagectomy, several studies actually favor fluid restriction (7,8,34). An increased perioperative fluid balance has been reported to increase pneumonia, respiratory failure and delayed extubation (15-17).

It is an illusion to consider one item in the total perioperative care process such as fluid management to be measurable in outcome, since all steps of within the process are directly connected to each other. For example, both thoracic epidural anesthesia and early extubation, directly affect fluid management. TEA leads to sympaticolysis and hence to vasodilatation. The decrease in blood pressure is often compensated by extra fluid load. A lot of centres are now searching for alternatives of TEA; multimodal pain regimens, regional blocks (paravertebral, erector spinae) to avoid extra fluid and to stimulate early mobilisation. Several older studies have shown that a short interval between surgery and extubation are associated with lower morbidity rates (6,35). It can be hypothesized that early extubation actually contributed to less postoperative pulmonary morbidity because it led to a significantly smaller positive fluid balance due to less sedation-related hypotensive episodes.

Minimal invasive esophagectomy (MIE)

The last years MIE has been implemented and widely performed. According to DUCA 98% of the procedures started with the intention for a minimal invasive procedure. Eleven percent of this group ended with an open esophagectomy. MIE requires a well-equipped surgical environment and a relative long learning curve (36).

After MIE, the incidence of the pulmonary complications is lower compared to open esophagectomy (23).

There is no specific literature on peri-operative (fluid) management for MIE. All literature and guidelines are based on open esophagostomy or the combination of open and MIE. With an increasing number of MIE's data on peri-operative care should be published and shared. Definitions on complications, proposed by the ECCG must be used to come to evidence based best practice and to help us to deliver optimum patient care.

Conclusions

Despite all discussions there is no final conclusion for fluid management in esophagectomy. However, restrictive management is advocated in ERAS based protocols and recent guidelines. GDT has not yet proved to be better than restrictive fluid management. Fluid management must always be seen in the light of a multi modal approach and must be balanced to the needs of the patient. Perioperative experience in Minimal Invasive Esophagectomy must be shared in the near future to come to evidence-based protocols.

Acknowledgements

None.

Footnote

Conflicts of Interest: The author has no conflicts of interest to declare.

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Cite this article as: Buise MP. Proper volume management during anesthesia for esophageal resection. J Thorac Dis 2019;11(Suppl 5):S702-S706. doi: 10.21037/jtd.2019.01.33