Intraoperative fluid management guided by esophageal Doppler monitoring in major abdominal surgery utilizing the enhanced recovery after surgery program: a systematic review protocol

Lindsay Wuellner • Lisa Sutton

The Texas Christian University for Center for Evidence-Based Practice and Research: a Collaborating Center of the Joanna Briggs Institute

**Review question/objective:** The objectives of this review are to identify the effectiveness of esophageal Doppler monitoring (EDM) for goal-directed fluid therapy on postoperative outcomes during abdominal surgery when an enhanced recovery after surgery (ERAS) program is implemented. The specific question of this review is: does the guidance of fluid management by EDM versus fluid management without EDM affect the length of hospital stay, occurrence of postoperative infection, hemodynamic stability and 30-day postoperative complication rate in adult patients undergoing major abdominal surgery with ERAS or similar programs?

**Keywords** Abdominal surgery; enhanced recovery fluid therapy; esophageal Doppler; esophageal Doppler enhanced recovery after surgery

**Background**

Optimization of perioperative fluid therapy has been a substantially analyzed aspect of anesthesia care. A direct correlation between patient outcomes and adequate perioperative fluid balance has been identified in relevant literature. Classic delivery of considerable volumes of intravenous fluid in the perioperative period may induce intravascular expansion, enhancing tissue oxygenation and organ perfusion, whereas fluid in excess can produce or amplify the occurrence of perioperative complications.

Balance is the key to optimal perioperative fluid management, yet the definitive method to effectively achieve this equilibrium remains controversial.

Pulmonary artery catheters are considered the standard technique for monitoring hemodynamics in critically ill patients. The hemodynamics most commonly measured include cardiac output, cardiac index and stroke volume. However, there are several risks involved with this invasive method, such as pneumothorax, arrhythmias and infection. Most often it is deemed unnecessary for routine surgical procedures and has not been proven to decrease morbidity and mortality. Heart rate, blood pressure and urine output are the physiological parameters which providers predominantly rely on to guide fluid management in the absence of invasive monitoring. Evidence has shown that relying solely on these factors in the perioperative period can lead to hypovolemia or hypervolemia along with accompanying complications. Several factors affect fluid resuscitation such as duration or complexity of surgery, patient comorbidities, nutritional status and age, and developing a necessity for an alternative method to achieve patient-specific fluid optimization.

Over the last decade, the esophageal Doppler monitor (EDM) has played a pivotal role in the tailoring of intraoperative fluid management. The reliability of the esophageal Doppler has been supported by extensive research and conveys hemodynamic measurements comparable with a pulmonary artery catheter. The noninvasive EDM consists of a small, flexible probe that incorporates ultrasound technology and is inserted orally into the distal esophagus of an anesthetized patient. An ultrasound transducer in the tip of the probe measures blood flow velocity in the descending aorta. These data are transduced and displayed on a separate monitor by
algorithmic calculations. Placement of the probe can be verified by finding the optimal waveform on the monitor. By following a protocol, anesthesia professionals are able to optimize stroke volume and cardiac output with fluid boluses of colloid and crystalloid, ideally leading to prevention of excessive fluid administration. Esophageal Doppler monitor has been incorporated into a protocol of combined perioperative interventions often referred to as enhanced recovery after surgery (ERAS). The goal is to decrease postoperative complications by maintaining optimal fluid balance and physiological stability. The majority of ERAS programs are implemented in patients undergoing colorectal surgeries. Because of positive outcomes, ERAS programs have been extended to abdominal, orthopedic and trauma surgeries. These multimodal techniques include decreased duration of fasting prior to surgery with consumption of clear carbohydrate drinks at least two hours preoperatively, restricted intraoperative crystalloid administration and avoidance of mechanical bowel preparation. This strategy enables patients to present for surgery in an optimized electrolyte balance and enhanced nutritional state. Esophageal Doppler monitor plays a substantial role in the ERAS pathway strives to maintain euvoolemia and present a hydrated, nutritionally optimized patient. The esophageal Doppler, although considered an accurate technique for fluid optimization, may be unwarranted and costly for implementation in this type of surgical program based on the most current evidence. Further, EDM requires hemodynamic stability and may be critically affected by probe positioning. Esophageal Doppler monitor may be inaccurate in patients with dysrhythmias and during the use of a surgical electrocautery. In addition, a learning curve may hinder provider acceptance of the EDM.

The purpose of this review will be to focus on GDFT only in ERAS programs. It will examine new evidence and combine it with appropriate studies from previous reviews. Several new randomized controlled trials have shown decreased complications by using a restrictive fluid management technique within the ERAS program without the utilization of esophageal Doppler. Although these studies present similar outcomes to the 2013 systematic review focusing on colorectal surgery, it contradicts the standard practice implemented in most facilities regarding GDFT. This review will therefore strengthen the evidence regarding the esophageal Doppler’s role in decreasing complications in major abdominal cases when other strategies of the ERAS program have been implemented. With the growing popularity of ERAS programs, an updated review will exclusively analyze GDFT with...
and without EDM utilized in ERAS protocols among patients undergoing all major abdominal surgeries.

Inclusion criteria

Types of participants
The current review will consider studies with adult patients, aged 16 years and older. There are studies on adult and pediatric esophageal Doppler available; however, this review will only examine trials with adult patients. This decision was made due to the populations of previous systematic reviews and preliminary searches resulting in studies focussing on only adult populations. Inclusion criteria will include patients undergoing abdominal surgery using an ERAS program.

Types of intervention(s)
The current review will consider studies that evaluate the effectiveness of intraoperative fluid management based on cardiac output by EDM. Esophageal Doppler monitoring will be compared with fluid management based on the provider’s assessment of hemodynamic status, liberal fluid administration, or a restrictive fluid protocol. Each intervention and corresponding outcomes will be examined individually and then compared with the others so that trends may be identified and analyzed for significance.

Outcomes
The current review will consider studies that include the following outcome measures: length of stay, postoperative infection, hemodynamic stability and 30-day postoperative complications. Postoperative infection will be measured by elevated white blood cell count, febrile episodes or swelling/redness of incision site. Hemodynamic stability will be indicated by measures of heart rate and blood pressure. Thirty-day postoperative complications will be defined as any postoperative event that is not part of the normal recovery and requires additional medication or intervention. Complication events can be recorded by telephone call, outpatient appointments or readmission to hospital. The Clavien-Dindo will be used to grade and classify 30-day postoperative complications.9,10

Types of studies
The current review will consider any experimental study design including randomized controlled trials, nonrandomized controlled trials, quasi-experimental and prospective and retrospective cohort studies for inclusion. The target study type will be randomized controlled trials; however, if this primary study type is not available during the search, other types of studies will be utilized.

Search strategy
The search strategy aims at finding both published and unpublished studies. A three-step search strategy will be utilized in this review. An initial limited search of PubMed and EMBASE will be undertaken followed by an analysis of the text words contained in the title and abstract, and of the index terms used to describe the article. A second search using all identified keywords will be undertaken across all included databases. This search will be performed by both reviewers to ensure that all applicable studies are included in the review. Lastly, the reference list of all identified articles will be searched for additional studies pertinent to the review topic. Studies published or translated in English will be considered for this review. Esophageal Doppler monitor was first introduced in the 1970s, therefore, studies published from 1970 to present day will be considered. All studies identified during the search will be assessed for relevancy on the basis of the information in the title, abstract and MeSH terms. If the article meets the inclusion criteria, a full text will be obtained of that article. The authors will hand search the references of all articles relevant to the review.

The databases to be searched include:
American Search Complete
EMBASE
PubMed
Cochrane CENTRAL

The search for unpublished studies will include:
Index to Theses
ProQuest Dissertations and Theses
Initial keywords to be used will be:
esophageal Doppler OR oesophageal Doppler
Enhanced Recovery after Surgery OR Enhanced Recovery
fluid therapy OR goal-directed fluid therapy
postoperative complications
colorectal surgery OR abdominal surgery OR gynecological surgery

Assessment of methodological quality

Studies selected for the retrieval will be assessed by two independent reviewers for methodological
validity prior to inclusion in the review. The studies will be reviewed using standardized critical appraisal instruments from the Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument (JBI-MAStARI) (Appendix I). Any disagreements between reviewers will be resolved through discussion or a third reviewer.

Data extraction
The data for this review will be extracted from the studies using the standardized extraction tool from JBI-MAStARI (Appendix II). The data extracted will include specific details about the interventions, populations, study methods and outcomes of significance to the review question and specific objectives. Revision of the data extraction tool may be made after the final searches have been completed. The attempt to contact authors will be made if data is missing from any studies.

Data synthesis
Quantitative data will, where possible, be pooled in statistical meta-analysis using JBI-MAStARI. Effect sizes expressed as odds ratios (for categorical data) and weighted mean differences (for continuous data), and their 95% confidence interval will be calculated for analysis. Heterogeneity will be assessed statistically with the standard chi-square test. If there are differences between subgroups, clinical and methodological heterogeneity, as possible reasons for statistical heterogeneity, will be explored. Where statistical pooling is not possible, the findings will be presented in narrative form including tables and figures to aid in data presentation where appropriate.

Acknowledgements
We would like to acknowledge the support of the Harris College of Nursing and Health Science Center for Evidence-Based Practice and Research.

References
Appendix I: Appraisal instruments

MASTARI appraisal instrument

**JBI Critical Appraisal Checklist for Randomised Control / Pseudo-randomised Trial**

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Unclear</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Was the assignment to treatment groups truly random?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Were participants blinded to treatment allocation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Was allocation to treatment groups concealed from the allocator?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Were the outcomes of people who withdrew described and included in the analysis?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Were those assessing outcomes blind to the treatment allocation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Were the control and treatment groups comparable at entry?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Were groups treated identically other than for the named interventions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Were outcomes measured in the same way for all groups?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Were outcomes measured in a reliable way?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Was appropriate statistical analysis used?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Overall appraisal: Include □ Exclude □ Seek further info. □

Comments (Including reason for exclusion)

________________________________________________________________________

________________________________________________________________________
# JBI Critical Appraisal Checklist for Comparable Cohort/Case Control

Reviewer: 
Date: 

Author: 
Year: 
Record Number: 

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Unclear</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is sample representative of patients in the population as a whole?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2. Are the patients at a similar point in the course of their condition/illness?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>3. Has bias been minimised in relation to selection of cases and of controls?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>4. Are confounding factors identified and strategies to deal with them stated?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>5. Are outcomes assessed using objective criteria?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>6. Was follow up carried out over a sufficient time period?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>7. Were the outcomes of people who withdrew described and included in the analysis?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>8. Were outcomes measured in a reliable way?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>9. Was appropriate statistical analysis used?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Overall appraisal: Include ☐ Exclude ☐ Seek further info. ☐

Comments (Including reason for exclusion)

________________________________________________________________________

©2016 Joanna Briggs Institute. Unauthorized reproduction of this article is prohibited.
Appendix II: Data extraction instruments

MAStARI data extraction instrument

**JBI Data Extraction Form for Experimental / Observational Studies**

Reviewer ........................ Date ........................
Author ........................ Year ........................
Journal ........................ Record Number ........................

**Study Method**

- [ ] RCT
- [ ] Quasi-RCT
- [ ] Longitudinal
- [ ] Retrospective
- [ ] Observational
- [ ] Other

**Participants**

Setting

Population

**Sample size**

Group A ........................ Group B ........................

**Interventions**

- Intervention A
- Intervention B

**Authors Conclusions:**

**Reviewers Conclusions:**
**Study results**

**Dichotomous data**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Intervention ( ) number / total number</th>
<th>Intervention ( ) number / total number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Continuous data**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Intervention ( ) number / total number</th>
<th>Intervention ( ) number / total number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>