Esophageal Doppler ultrasound-based cardiac output monitoring for real-time therapeutic management of hospitalized patients: a review

ECRI Evidence-based Practice Center

CRD summary
This systematic review reported strong evidence to suggest that adding oesophageal Doppler monitoring for guided fluid replacement to a surgery treatment protocol that already includes central venous pressure monitoring (CVP) and standard monitoring would reduce major and total rates of complications. The conclusions of this review should be considered to be reliable.

Authors' objectives
To assess the extent to which oesophageal Doppler ultrasound-based cardiac monitoring during surgery or hospitalisation leads to reduced complications and shorter hospital stay duration or may be associated with adverse events. (The review addressed a number of key questions, but this abstract deals only with those relevant to DARE)

Searching

A number of journals, non-journal conference proceedings and publications were handsearched. Reference lists were scanned. Grey literature was accessed via reports/studies/articles or monographs that did not appear in the peer-reviewed literature. Only full journal articles in English were considered.

Study selection
Eligible studies included parallel controlled trials (minimum of 10 patients per group) which directly compared oesophageal ultrasound with any of pulmonary artery catheter-based measurement of cardiac output via thermodilution, catheter-based measurement of central venous pressure and usual clinical assessment. The study population was restricted to either surgical or non-surgical in each study. No mixed analyses were eligible, and comparable surgery or diagnoses should have been given to both groups.

For the key question about harm and adverse events, broader inclusion criteria were applied. Studies of any design were eligible (controlled trials, case series, case reports) and additional searches of adverse events databases were carried out.

The authors stated neither how the papers were selected for the review nor how many reviewers performed the assessment.

Assessment of study quality
Included studies were assessed according to the ECRI Quality Score (possible values of 0 to 10 based on a 25-item instrument). This included items on comparability of the groups at baseline, blinding, measurement of outcomes, treatment and investigator bias.

The authors did not state how the validity assessment was performed.
Data extraction

Effect sizes of the included studies were calculated from dichotomous data as log odds ratios (converted to odds ratios for final results and conclusions). Where one study group reported no events, Peto log odds and odds ratios were used. Effect sizes for continuous data were calculated from means (SDs) or where these were unavailable or inappropriate (skewed data) estimates were made based on the median (range) values. The authors stated neither how the data were extracted for the review nor how many reviewers performed the data extraction.

Methods of synthesis

Meta-analysis was used to calculate weighted mean differences (WMD) for continuous data and Peto odds ratios for dichotomous data. Heterogeneity was tested for using the $I^2$ statistic. Where $I^2$ was equal to or less than 50 per cent a fixed-effects model was used. Otherwise, a random-effects model was used. Random-effects models were also used if fewer than 80 per cent of the papers reported the relevant outcome in a usable format. Where only two studies were available and of high quality, meta-analysis was used to provide an indication of effect direction but without calculating an effect size. Sensitivity analyses were used to assess the robustness of the overall findings, examine the relative contribution of each study and explore the assumptions made when calculating the length of stay data.

Continuous data such as length of hospital stay was extracted and summarised as a weighted mean difference.

Results of the review

Seven randomised controlled trials (RCTs) addressed the impact of oesophageal ultrasound cardiac output monitoring during surgery in comparison to other monitoring options (total n = 583). All included studies were judged to be of a high quality.

Five trials (n=453) assessed the benefits of adding oesophageal Doppler monitoring to CVP plus conventional clinical assessment. No conclusions could be drawn regarding mortality due to the overall low number of deaths. Major complications were reported by three studies (n=220). Overall, there was a significant Peto odds ratio ($p=0.00002$) indicating a reduction in major complications when oesophageal Doppler monitoring was used. No significant heterogeneity was observed and the sensitivity analyses did not substantially alter the results.

Four trials (n=388) reported total complications of adding oesophageal Doppler monitoring to CVP plus conventional clinical assessment. A random-effects meta-analysis found a significant decrease in total complications when oesophageal Doppler ultrasound monitoring was used, but no summary estimate was presented. All five trials reported length of hospital stay; four found a statistically significant reduction in this outcome when oesophageal Doppler monitoring was used, but it was not possible to pool the studies (less than 80 per cent of papers reported usable data).

Two studies (n=130) compared oesophageal Doppler monitoring plus conventional assessment versus conventional assessment alone. Total mortality was not informative due to the small numbers involved. No data was available for major complications. One study reported on total complications and found significantly fewer complications in the Doppler-monitored group, but the percentage of patients with complications did not differ significantly between groups.

Length of hospital stay was assessed in a random-effects meta-analysis, indicating that patients receiving oesophageal Doppler monitoring had a significantly shorter hospital stay ($p=0.008$) compared to those receiving conventional assessment alone. No effect size was presented due to the low number of studies reporting usable data.

One RCT addressed the impact of oesophageal ultrasound cardiac output monitoring during hospitalisation in comparison to other monitoring options (n=174). The study was judged to be of a high quality and compared oesophageal Doppler monitoring plus CVP and conventional clinical assessment versus CVP plus conventional clinical assessment. No large treatment effects were observed on the outcomes of interest and no conclusions could be drawn.

No studies compared oesophageal Doppler monitoring versus thermodilution with a pulmonary artery catheter.

Adverse effects of monitoring (23 studies: four RCTs; 18 case studies; and one case report). No serious adverse events associated with oesophageal probes were reported in the literature or the MAUDE database. Minor events included...
incorrect probe placement, tube displacement and minimal trauma to the buccal cavity. Oesophageal Doppler probes can be considered to be relatively low-risk devices.

The original report details all analyses in full including numerous sensitivity analyses which have not been summarised here.

**Authors' conclusions**
There was strong evidence to suggest that adding oesophageal Doppler monitoring for guided fluid replacement to a surgery treatment protocol which already includes CVP and standard monitoring reduced major and total rates of complications. It was not possible to draw any conclusions on the effects of oesophageal Doppler monitoring versus any other monitoring either during surgery or hospitalisation on patient outcomes/length of hospital stay.

**CRD commentary**
This review addressed a clearly articulated research question that was supported by appropriate inclusion and exclusion criteria. The search strategies were comprehensive as was the range of databases. Language bias may have been present as only English-language papers were included, but the authors justified this exclusion criteria. Although grey literature was accessed only full journal articles were included, which may have resulted in some publication bias. The reporting of the methodological processes was poor, so it was difficult to judge the extent to which the reviewers avoided systematic errors in this review. Detailed and cautious meta-analyses were carried out taking into account heterogeneity, clinical significance and generalisability through sensitivity analyses. The conclusions of this review should be considered to be reliable.

**Implications of the review for practice and research**
The authors did not state any implications for practice or research.

**Funding**
Research conducted by the ECRI under contract to the AHRQ; contract number 290-02-0019

**Bibliographic details**

**Original Paper URL**

**Other publications of related interest**

**Indexing Status**
Subject indexing assigned by CRD

**MeSH**
Blood Flow Velocity /physiology; Cardiac Output /physiology; Echocardiography, Doppler /methods /standards; Echocardiography, Transesophageal /methods; Heart Diseases /ultrasonography; Hemodynamics /physiology; Monitoring, Physiologic /instrumentation /methods; Sensitivity and Specificity

**AccessionNumber**
12008008077

**Date bibliographic record published**
09/04/2008
Date abstract record published
02/03/2009

Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.