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Central venous pressure as an indicator of the need for infusion therapy: a systematic review and meta-analysis

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ADMINISTRATIVE INFORMATION

Support - Nil.

Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 30 October 2024 and was last updated on 30 October 2024.

INTRODUCTION

Review question / Objective The objective of our study was to assess the prognostic value of the CVP measurement as a fluid responsiveness predictor.
(i) population: adult patients.
(ii) intervention (index test or test method): CVP measurement
(iii) comparator ('gold standard' method): fluid challenge (FC) method for fluid responsiveness assessment.
(iv) outcomes: area under the receiver-operating characteristic (AUROC).
(v) study design: prospective cohort studies.

Rationale Arterial hypotension is a common complication in intensive care patients, occurring in over half of cases. Its etiology may include cardiac dysfunction, peripheral vascular abnormalities, or insufficient blood volume. Current guidelines recommend initiating treatment by assessing fluid responsiveness. Various assessment methods exist, ranging from complex techniques like transpulmonary thermodilution and transesophageal echocardiography to simpler methods like passive leg raising or fluid challenge tests. These tests help determine if fluid therapy will increase cardiac output and resolve hypotension.
Central venous pressure (CVP) assessment, long used to evaluate fluid status and responsiveness, has such advantages as simplicity and cost-effectiveness. However, the interpretation of CVP is contentious, with conflicting evidence on its diagnostic accuracy. Recent studies criticize CVP for its limited precision, though it remains widely used in practice due to accessibility and ease of use. Given these ambiguities, a meta-analysis was conducted to evaluate diagnostic accuracy of CVP in determining fluid responsiveness.

Condition being studied Fluid responsiveness is defined as the ability of the left ventricle to increase its stroke volume (SV) in response to fluid administration.

METHODS

Search strategy A systematic literature search of studies published until March, 2024 was conducted in PubMed (Medline) and the Cochrane Central Register of Controlled Trials (CENTRAL) by two independent investigators. Both backward and forward snowballing methods were also used for an exhaustive search (Litmaps service). Language restrictions were not applied.

Participant or population Adult patients (without restrictions on age, sex, race, or ethnicity).

Intervention Index test or test method was CVP measurement, a measure of pressure in the superior vena cava or right atrium, which can be used as an estimation of cardiac preload.

Comparator 'Gold standard' method: fluid challenge method for fluid responsiveness assessment. The FC is a diagnostic test consisting of the administration of a fixed volume of fluids in central venous catheter with the purpose of identifying fluid responsive patients.

Study designs to be included We included prospective cohort studies.

Eligibility criteria We focused on prospective cohort studies that explored diagnostic accuracy of CVP measurement for fluid responsiveness defined by FC method. Studies were excluded if they met one of the following criteria: 1) were retrospective studies; 2) didn't use FC as a 'gold standard' method; 3) the CVP wasn't measured; 4) the 'gold standard' parameters were not cardiac.

Information sources PubMed (Medline), Cochrane CENTRAL and databases from Litmaps service (Crossref, Semantic Scholar, OpenAlex).

Main outcome(s) The primary outcome for this meta-analysis was calculated area under receiver-operating characteristic (AUROC) for CVP measurement.

Additional outcome(s) Sensitivity and specificity for certain cut-offs of AUROC.

Quality assessment / Risk of bias analysis The internal validity and risk of bias of the included studies were assessed by two independent investigators using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) tool. Publication bias and small-study effects were assessed using Egger's test and funnel plot analysis. The certainty of evidence will be assessed with the GRADE systematic approach.

Strategy of data synthesis Data extraction was performed by three independent authors. The data extracted included: 1) general information and patient characteristics: first author, setting, sample size; mean age, sex, body mass index (BMI), APACHE II score, type of fluid used, baseline CVP; 2) information on index test and 'gold standard': type, method, parameter, and criterion (cut-off); 3) outcome data: reported AUROC, sensitivity and specificity.
The data was converted to the mean and 95% confidence interval format if needed.
STATA 17.0 (StataCorp LLC, Texas, US) was employed for both calculations and visualizations. The interstudy heterogeneity was assessed via the I-squared (I^2) statistics and the Cochrane Q test. We applied a random-effects model (restricted maximum likelihood [REML]) for the meta-analysis. Statistical significance was set at $p < 0.05$. We also performed univariate meta-regression using the REML model to assess whether the association between CVP measurement and fluid responsiveness might be affected by such covariates as age, sex and BMI.

Subgroup analysis The subgroup analyses were conducted to evaluate the AUROC in subgroups formed by: 1) the setting; 2) the type of 'gold standard' method; 3) the type of ventilation and 4) the year of publication.

Sensitivity analysis For the sensitivity analysis the leave-one-out method was applied.

Language restriction No language limitations.

Country(ies) involved Russian Federation.

Keywords Fluid responsiveness, central venous pressure, anesthesiology and intensive care, arterial hypotension.

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