TAKE-HOME MESSAGE

Transthoracic echocardiography and passive leg-raise maneuvers can be used to assess preload responsiveness in the critically ill.

DATA SOURCES

Two authors independently performed a search in MEDLINE, EMBASE, and the Cochrane Database of Systematic Reviews to identify all studies that met the inclusion criteria. The search was performed with the key words "fluid OR preload OR volume responsiveness," "cardiovascular monitoring," "fluid challenge," "functional hemodynamic monitoring," "dynamic indices OR indexes," and "passive leg raising" to identify all published studies that met the inclusion criteria. References of included articles were examined to identify other studies of interest.

STUDY SELECTION

Study inclusion was considered for all clinical trials investigating the ability of hemodynamic response after passive leg raise (the index) to predict the increase in cardiac output after subsequent fluid infusion (the outcome). No language restriction was imposed, and only studies published or accepted for publication as full-text articles in indexed journals were included. Included studies had to have the predictive value of the index assessed by calculating at least 1 of the following: sensitivity and specificity of the index in identifying fluid responders, the difference between the mean value of the index in responders versus nonresponders, and the correlation coefficient between the hemodynamic response after passive leg raise and the increase in cardiac output after fluid load.

Is Passive Leg Raise an Accurate Diagnostic Method for Assessing Fluid Responsiveness in Adults?

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Results

Characteristics and results of select studies on passive leg-raised induced changes in cardiac output and its surrogates.

Reference	Index	Device	% Responders	*r*	AUC (SEM)	Sens	Spec
Lamia et al[1], 2007	cVTIAo	TTE	54	0.83	0.96 (0.040)	77	100
	cCO	TTE	54	0.79			
Maizel et al[2], 2007	cSV%	TTE	50	0.56	0.89 (0.059)	88	83
	cCO%	TTE	50	0.75			
Biais et al[3], 2009	cSV% (TTE)	TTE	67	—	0.96 (0.030)	100	80
Preau et al[4], 2010	cSV%	TTE	41	—	0.94 (0.040)	86	90
Overall (95% CIs)	—	—	52.9	0.81 (0.75–0.86)	0.95 (0.92–0.97)	89.4	91.4

—, Not available; *Sens*, sensitivity; *Spec*, specificity; *cVTIAo*, passive leg raise–induced changes in aortic velocity-time integral; *cCO*, passive leg raise–induced changes in cardiac output; *TTE*, transthoracic echocardiography; *cSV*, passive leg raise–induced changes in stroke volume; *CI*, confidence interval.

Commentary

The passive leg raise maneuver is a dynamic assessment of a patient's preload responsiveness through augmentation of the Frank-Starling curve, inducing a shift of venous blood from the lower extremities to the intrathoracic compartment.[5] Hemodynamic optimization is a priority in the management of critically ill patients, but there are no clear guidelines to assess fluid responsiveness.[6] Furthermore, recent changes in quality measures and standards of care for sepsis care have made the discussion of fluid responsiveness increasingly relevant. Passive leg raise maneuvers in the meta-analysis by Cavallaro et al[7] show how noninvasive hemodynamic indices may be a reasonable approach in emergency department (ED) and ICU assessments of fluid responsiveness and cardiac output.[8]

The high correlation between passive leg raise–induced cardiac output changes and fluid load–induced cardiac output changes (overall r=0.81) observed in pooled

Quality Assessment Tool of Diagnostic Accuracy Studies scale to assess the quality of studies on diagnostic accuracy was used, scoring each included study from 0 to 14. Sensitivity analysis was not needed because overall quality of included studies was satisfactory, with a median QUADAS score of 13 (range 12 to 14). Heterogeneity was evaluated with Q and I^2 tests and regarded as significant when $P<.1$ and I^2 was greater than 50%.

DATA EXTRACTION AND SYNTHESIS

Using a standardized form, 2 authors independently extracted the following: study setting, patient population, use of inotropes or vasopressors, ejection fraction, ventilation mode, cardiac rhythm (sinus versus arrhythmias), type and amount of fluid infused, definition of responders, instrument(s) used for measuring index and cardiac output, number of patients included, number of fluid boluses administered, number and percentage of responders, mean value (with SD) of the index in responders and in nonresponders, correlation coefficient (Spearman's or Pearson's), sensitivity, specificity, best threshold, and area under the receiver operating characteristic curve (AUC). First authors were contacted to obtain additional information when reported data were not sufficient to perform the planned statistical analysis.

results suggests that passive leg raise may be a feasible method of "autotransfusion," safely and reversibly testing Frank-Starling relationships in a manner similar to that with intravenous fluids. Specific to emergency physicians, a number of studies evaluated transthoracic echocardiography indices (ie, changes in stroke volume or cardiac output) as a method for assessing hemodynamic response to passive leg raise.

The correlation coefficients for studies using ultrasonographic assessments of hemodynamics were closely tied with actual fluid bolus effects on cardiac output, obtaining r values exceeding 0.75 and AUC values often greater than 0.94. Furthermore, the studies were shown to have consistent results despite inclusion of patients with arrhythmias or those with a respiratory status of spontaneous breathing. Although the meta-analysis examined a number of hemodynamic indices, those listed in the Table show how passive leg raise may be applicable to the ED.

Editor's Note: This is a clinical synopsis, a regular feature of the *Annals*' Systematic Review Snapshot (SRS) series. The source for this systematic review snapshot is: **Cavallaro F, Sandroni C, Marano C, et al. Diagnostic accuracy of passive leg raising for prediction of fluid responsiveness in adults: systematic review and meta-analysis of clinical studies. *Intensive Care Med.* 2010;36:1475-1483.**

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Michael Brown, MD, MSc, and Alan Jones, MD, serve as editors of the SRS series.