Predicting Fluid Responsiveness in Children: A Systematic Review.
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Background
Administration of fluid to improve cardiac output is the mainstay of hemodynamic resuscitation. Not all patients respond to fluid therapy, and excessive fluid administration is harmful. Predicting fluid responsiveness can be challenging, particularly in children. Numerous hemodynamic variables have been proposed as predictors of fluid responsiveness. Dynamic variables based on the heart-lung interaction appear to be excellent predictors of fluid responsiveness in adults, but there is no consensus on their usefulness in children.

Methods
We systematically reviewed the current evidence for predictors of fluid responsiveness in children. A systematic search was performed using PubMed (1947-2013) and EMBASE (1974-2013). Search terms included fluid, volume, response, respond, challenge, bolus, load, predict, and guide. Results were limited to studies involving pediatric subjects (infant, child, and adolescent). Extraction of data was performed independently by 2 authors using predefined data fields, including study quality indicators. Any variable with an area under the receiver operating characteristic curve that was significantly above 0.5 was considered predictive.

Results
Twelve studies involving 501 fluid boluses in 438 pediatric patients (age range 1 day to 17.8 years) were included. Twenty-four variables were investigated. The only variable shown in multiple studies to be predictive was respiratory variation in aortic blood flow peak velocity (5 studies). Stroke volume index, stroke distance variation, and change in cardiac index (and stroke volume) induced by passive leg raising were found to be predictive in single studies only. Static variables based on heart rate, systolic arterial blood pressure, preload (central venous pressure, pulmonary artery occlusion pressure), thermodilution (global end diastolic volume index), ultrasound dilution (active circulation volume, central blood volume, total end diastolic volume, total ejection fraction), echocardiography (left ventricular end diastolic area), and Doppler (stroke volume index, corrected flow time) did not predict fluid responsiveness in children. Dynamic variables based on arterial blood pressure (systolic pressure variation, pulse pressure variation and stroke volume variation, difference between maximal or minimal systolic arterial blood pressure and systolic pressure at end-expiratory pause) and plethysmography (pulse oximeter plethysmograph amplitude variation) were also not predictive. There were contradicting results for plethymograph variation index and inferior vena cava diameter variation.

Conclusions
Respiratory variation in aortic blood flow peak velocity was the only variable shown to predict fluid responsiveness in children. Static variables did not predict fluid responsiveness in children, which was consistent with evidence in adults. Dynamic variables based on arterial blood pressure did not predict fluid responsiveness in children, but the evidence for dynamic variables based on plethysmography was inconclusive.