Use of Pulse Pressure Variation as Predictor of Fluid Responsiveness in Patients Ventilated With Low Tidal Volume: A Systematic Review and Meta-Analysis

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ABSTRACT

INTRODUCTION: Pulse pressure variation (PPV) has been shown to be useful to predict fluid responsiveness in patients ventilated at tidal volume (Vt) >8 mL kg^{-1}. Nevertheless, most conditions in critical care force to use lower Vt. Thus, we sought to evaluate the operative performance of PPV when a Vt ⩽8 mL kg^{-1} is used during mechanical ventilation support.

METHODS: We searched PubMed and Embase databases for articles evaluating the operative performance of PPV as a predictor of fluid responsiveness in critical care and perioperative adult patients ventilated with tidal volume ⩽8 mL kg^{-1} without respiratory effort and arrhythmias, between January 1990 and January 2019. We included cohort and cross-sectional studies. Two authors performed an Independently selection using predefined terms of search. The fitted data of sensitivity, specificity, and area under the curve (AUC) were assessed by bivariate and hierarchical analyses.

RESULTS: We retrieved 19 trials with a total of 777 patients and a total of 935 fluid challenges. The fitted sensitivity of PPV to predict fluid responsiveness during mechanical ventilation at Vt ⩽8 mL kg^{-1} was 0.65 (95% confidence interval [CI]: 0.57-0.73), the specificity was 0.79 (95% CI: 0.73-0.84), and the AUC was 0.75. The diagnostic odds ratio was 5.5 (95% CI: 3.08-10.01, $P < .001$) by the random-effects model.

CONCLUSIONS: Pulse pressure variation shows a fair operative performance as a predictor of fluid responsiveness in critical care and perioperative patients ventilated with a tidal volume ⩽8 mL kg^{-1} without respiratory effort and arrhythmias.

KEYWORDS: Critical care, hemodynamic, perioperative care, pulse pressure, sepsis, tidal volume

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Introduction

Intravenous fluid resuscitation is a key piece in the management of patients with circulatory shock.[1] Fluid loading aims to increase cardiac output (CO) to improve the convective transport of oxygen to the tissues. Nevertheless, fluids can be harmful when excessively administered.[2] Indeed, higher fluid balances have been related to adverse clinical outcomes in septic shock,[3] whereby strategies to prevent fluid overload are highly desirable and represent a priority in sepsis research.[4]

Prediction of fluid response could potentially avoid unnecessary volume load during resuscitation of circulatory shock. Several tools can be used to predict the increase in CO after a fluid load[5] and potentially, some of these might improve clinical outcomes when incorporated as a part of treatment algorithms of intravenous fluid management.[6-10] Pulse pressure variation (PPV) can predict fluid responsiveness in critically ill patients,[11-13] and although with some limitations, it might better predict fluid responsiveness than stroke volume and systolic pressure variations.[11]

Mechanical ventilation with low tidal volumes is widely recommended in patients with acute respiratory distress syndrome[14] and other many circumstances in critical care.[15] Nevertheless, the operative performance of PPV may be substantially reduced when mechanical ventilation is set at low tidal volumes[16] or when lung compliance is severely compromised[17] because, under such conditions, the effects of mechanical ventilation on the cardiac extramural and intramural pressures are limited. Besides, at higher respiratory rates (RR) and low heart to RR ratios, the usefulness of PPV could also be limited[18,19]

Although several meta-analyses and systematic reviews have described the operative performance of PPV as a predictor of fluid responsiveness, the particular usefulness of PPV under Vt ⩽8 mL kg^{-1} and high heart rate to RR ratio is controversial. Thus, we propose to perform a meta-analysis and