

Carotid Doppler ultrasonography: A novel method to predict fluid responsiveness in mechanically ventilated children

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Objective: The aim of this study was to investigate whether respiratory variations in carotid and aortic blood flows measured by Doppler ultrasonography could accurately predict fluid responsiveness in critically ill children.

Methods: This was a prospective single-center study including mechanically ventilated children who underwent fluid replacement at the discretion of the attending physician. A response to fluid load was defined by an stroke volume increase of more than 15%. Doppler ultrasonographic measurements of velocity peaks (V_{peak}) in carotid and aortic blood flows were performed before and after volume expansion. Maximum and minimum values of V_{peak} were determined over one controlled respiratory cycle. Respiratory changes in V_{peak} of the carotid (ΔV_{peakCa}) and aortic (ΔV_{peakAo}) blood flows were calculated as the difference between maximum and minimum values divided by the mean of the two values and were expressed as a percentage.

Results: A total of 24 patients were included with median age and weight of 28 months (IQR 9.5 – 68.5) and 10 kg (IQR 5.7 – 20.0). The volume expansion-induced increase in stroke volume was $> 15\%$ in 9 patients (responders) and $< 15\%$ in 15 patients (nonresponders). Before volume expansion, both ΔV_{peakCa} and ΔV_{peakAo} were higher in responders than in nonresponders (17.7% vs 4.6%; $p < 0.001$ and 23.8% vs 4.7%; $p < 0.001$, respectively). ΔV_{peakCa} could effectively predict fluid responsiveness (area under the ROC curve [AUC] 1.00, 95%CI 0.86-1.00), as well as ΔV_{peakAo} (AUC 0.96, 95%CI 0.78-0.99). The best cut-off values were 10.6% for ΔV_{peakCa} (sensitivity, specificity, positive predictive value and negative predictive value of 100%) and 18.2% for ΔV_{peakAo} (sensitivity, 88.9%; specificity, 93.3%; positive predictive value, 88.9%; negative predictive value, 93.3%). Volume expansion-induced changes in stroke volume correlated with the ΔV_{peakCa} and ΔV_{peakAo} before volume expansion (Pearson correlation coefficient of 0.68 and 0.64, respectively; $p < 0.001$ for both).

Conclusion: Analysis of respiratory changes in carotid and aortic blood flows are accurate methods for predicting the hemodynamic effects of volume expansion in children under invasive mechanical ventilation.