

Are Respiratory Induced Changes in Pulse Pressure and Pulse Oximeter Plethysmography Wave Amplitude Related in Ventilated Children?

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Introduction

The variations induced by mechanical ventilation in the arterial pulse pressure and plethysmographic waveforms have been investigated in adults as surrogates of changes in stroke volume.¹ Pulse pressure variation (PPV) measured from the arterial waveform was shown to correlate significantly with manually calculated plethysmograph variation (PlethV) and an automated plethysmograph variability index (PVI).^{2,3} The aim of our study was to investigate the relationship between PPV, PlethV and PVI in mechanically ventilated children in two age groups (< 2 years and 2-10years).

Methods

Following institutional review board approval, a prospective study was performed. We studied mechanically ventilated children less than 11 years of age, with arterial catheters placed as part of planned medical management in the intensive care unit (ICU) or in the operating room (OR). Exclusion criteria included: rhythm other than sinus, presence of spontaneous breaths, known intracardiac shunts, ventilation at tidal volumes <8ml/kg and unstable blood pressure or heart rate. Two additional oxygen saturation probes were placed on the fingers of one hand and connected to separate monitors (Novamatrix Oxypleth® 520a and Masimo Radical-7). A laptop computer was used to collect real time waveforms (arterial pressure, endtidal CO₂, ECG, plethysmograph), PVI values were downloaded from the Masimo oximeter following completion of the study. Patient characteristics, ventilator tidal volume, medical diagnoses and administration of vasoconstrictor medications were recorded. PPV and PlethV were manually calculated for three consecutive breaths and compared using Bland-Altman analysis and Pearson correlation. PPV and PlethV were individually compared to PVI using Pearson correlations.

Results

38 children were recruited (19 subjects in each group); three were excluded for poor quality plethysmograph waveforms. Median age was 5.25 years (range: 2 days - 10.5 years) and median weight was 22.25 kg (range: 1.2 - 43 kg). PPV and PlethV were strongly correlated ($r=0.8$, $p<0.01$) and showed good agreement (bias = 0.58± 6.8%) (figures 1&2). PVI was found to correlate significantly with PPV ($r=0.66$, $p<0.01$) and PlethV ($r = 0.71$, $p<0.01$). In comparison with the younger age group there was a reduced correlation between PVI with both PPV and PlethV in the older age group. The relationship between PPV and PlethV was unchanged across the two groups.

Discussion

This study demonstrates that in children as has been shown in adults, there is good agreement between ventilation-induced changes in arterial pressure and pulse oximeter plethysmograph amplitude.

References :1. Anesthesiology;106:1105-11 2007.; 2. Crit Care;9:R562-8 2005.; 3. Anesth Analg;106:1189-94 2008.

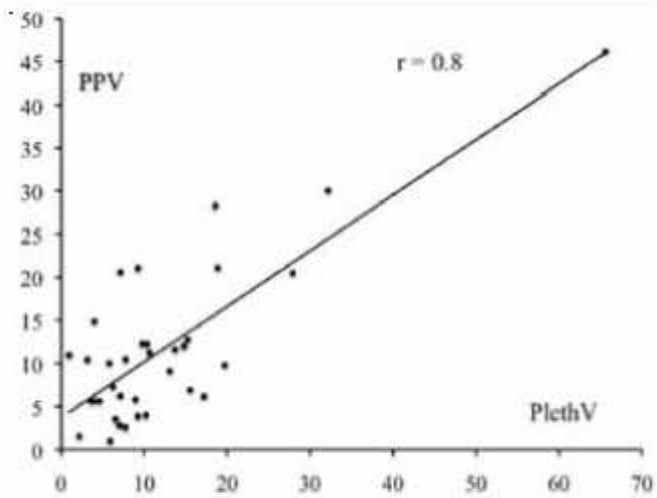


Figure 1: PPV % vs PlethV %

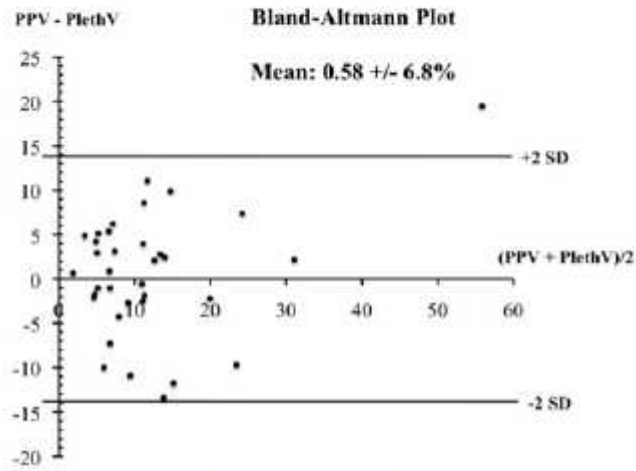


Figure 2: Bland-Altman plot of PPV % and PlethV %