[NM-172] Impact of fluid resuscitation on plethysmographic and arterial waveform parameters in children

[1]Saadat H, [2]Golembeski T, [2]Shelley K, [2]Alian A
[1]Nationwide Children's Hospital , Columbus , Ohio, USA; [2]Yale University , New Haven , CT, USA

Introduction: Assessment of intravascular volume is a particular challenge in critically ill infants and neonates as traditional indices, such as blood pressure and heart rate, may not reflect mild to moderate blood loss. 1 In conjunction with clinical assessment, central venous pressure (CVP) has been used to guide fluid therapy in infants and neonates 2. Investigations have progressed beyond static measurement of cardiac filling pressures to a more dynamic approach using variables such as pulse pressure variation (PPV) and stoke volume variability (SVV).4, 5 The performance of these dynamic indices in the pediatric literature has been disappointing due to low tidal volumes, higher arterial elastic properties and increased chest wall compliance which may dampen the transmission of transpulmonary pressure changes.6 Scoliosis surgery is a major operation that involve substantial fluid shift and fluid resuscitation. This study was done to assess the effect of fluid boluses on plethysmographic (PPG) and arterial waveforms during scoliosis repair with the utilization of frequency domain analysis.
Methods: With IRB approval, we studied 11 children scheduled for scoliosis repair. EKG, blood pressure, invasive arterial pressure, finger pulse oximeter (finger PPG) and airway pressure were recorded at 100 Hz with a data acquisition system (Collect 5/S, GE) and analyzed using Fourier analysis (spectrum, 8K, Hamming, Amplitude density) with LabChart 7, (ADInstruments) figure (1). Analysis consisted of measuring the height of amplitude density of PPG and arterial pressure direct current (DC) and alternate current (AC, amplitude modulation) at respiratory frequency at 2 points; after 400 cc of bleeding and after fluid resuscitation (whether blood, colloid or crystalloid). Hemodynamic data together with waveform data were analyzed before and after fluid resuscitation. Data are presented as median and inter-quartile range (IQR). Wilcoxon tests were used; $P < 0.05$ was statistically significant.
Results: we collected 24 paired data segments (before and after blood transfusion) from 10 patients who were scheduled for elective scoliosis repair. There were no significant changes in the hemodynamic data. On the other hand PPG DC, AC, DC% and AC% all showed statistical reduction ($\geq 40\%$) after fluid bolus .The arterial DC, AC, DC% and AC% also showed statistical significant reduction , but the magnitude of change is less than that of PPG waveforms parameters as shown in figure (2)
Discussion: Hypovolemia is a common cause of perioperative circulatory failure. Our study indicate that the dynamic parameters from the frequency analysis of the PPG and arterial blood pressure waveforms are useful in pediatric populations. These parameters may be of value in assessment of patient volume status and helping in decision making as regard volume expansion.
References:
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2. Tibby SM, Hatherill M, Murdoch IA. Use of trans-esophageal Doppler ultrasonography in ventilated pediatric patients: derivation of cardiac output. Critical Care Medicine 2000; 28:2045-50

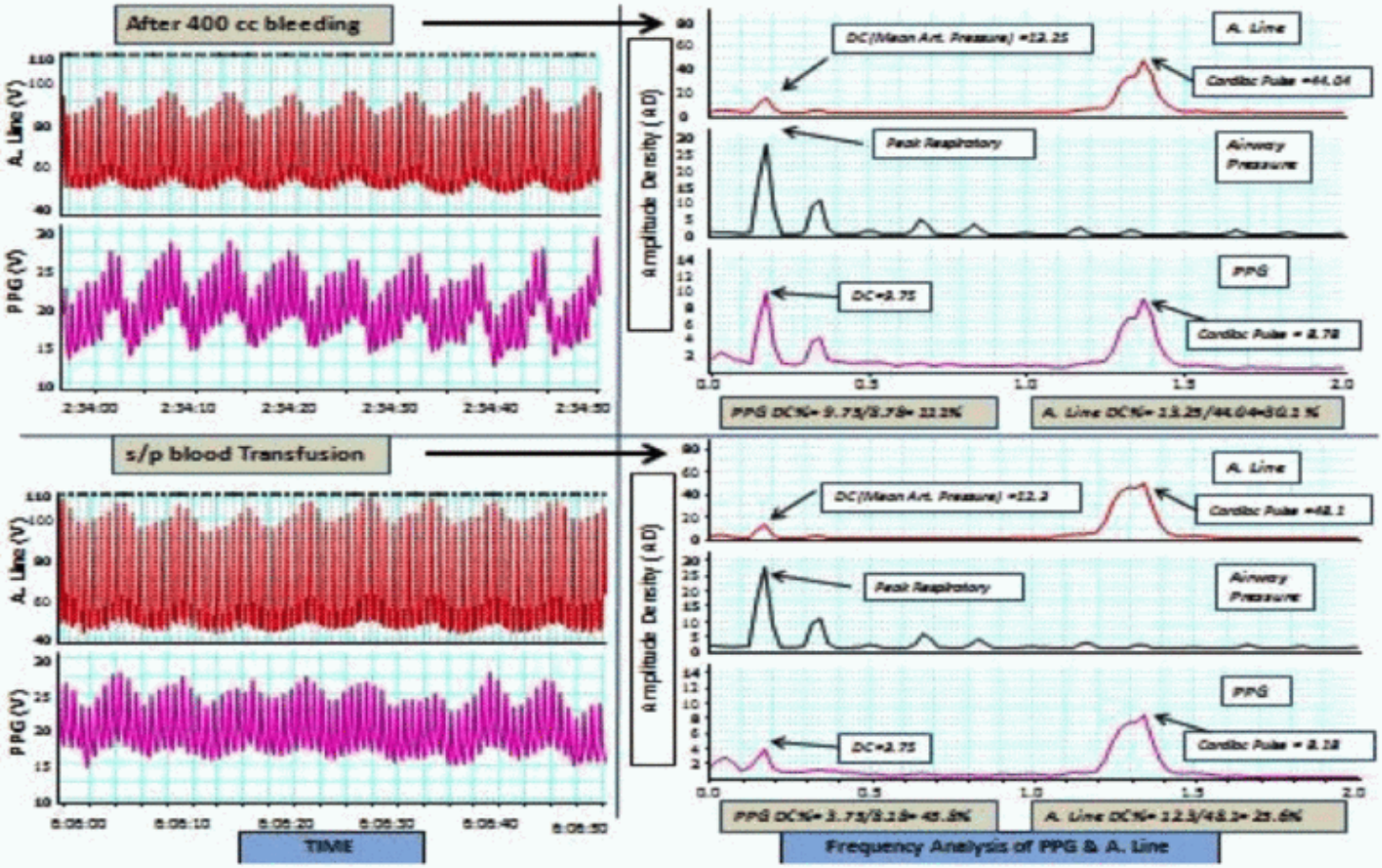
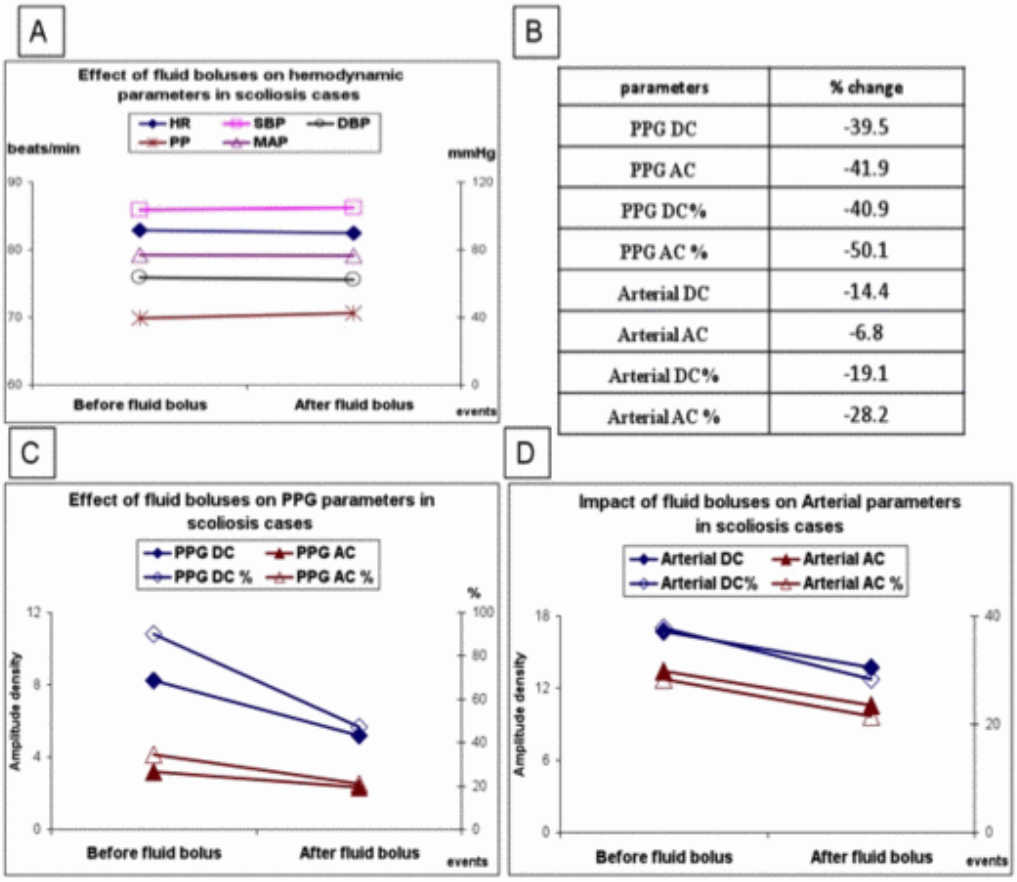


Figure (1): PPG and invasive arterial blood pressure (A-line) waveforms after 400 cc blood loss and after blood transfusion (left). PPG and Arterial blood pressure waveforms analysis for DC and DC% (right). Note that the peak of PPG and arterial DC peak in coincide with the airway pressure peak. The PPG DC% during bleeding was 95.9% while the arterial DC% was 33.8%, while after blood transfusion. It drops to 31.4% and 17.1% respectively. The percent change of PPG DC% reduction was 67.3%, while the Arterial Dc% reduction was 49.4%.



parameters	% change
PPG DC	-39.5
PPG AC	-41.9
PPG DC%	-40.9
PPG AC %	-50.1
Arterial DC	-14.4
Arterial AC	-6.8
Arterial DC%	-19.1
Arterial AC %	-28.2

Figure(2):impact of fluid bolus in scoliosis patients on A) hemodynamic data, B)summary of the % change in the PPG and arterial waveform parameters after fluid bolus C) impact of fluid bolus on the PPG waveform parameters and on the arterial waveforms in D).