Non-Invasive Cardiac Output Monitor Validation Study in Pediatric Cardiac Surgery Patients

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Background

The continuous measurement of cardiac output (CO) can be helpful to clinicians in the intensive care unit during the administration of vasoactive drugs and fluids. There are multiple modalities available for measuring cardiac output. Impedance cardiography is a non-invasive modality of securing continuous cardiac output values. The Aesculon (Cardiotronic, La Jolla, California, USA) non-invasive cardiac output monitor (NICOM) utilizes impedance cardiography technology to measure CO and has been validated in adults and pediatric patients. We conducted a further validation study with this monitor in a pediatric cardiac operating room.

Results

There is a positive/direct significant relationship between Fick CO and NICOM CO measurements. More dispersion is detected when the magnitude of the measure increases.

Conclusions

There is a strong correlation between the cardiac output values derived from the Fick equation and the Aesculon NICOM.

Methods

Twenty pediatric cardiac patients scheduled to undergo elective cardiac surgery in the Cardiac Operating Room were studied. Eight patients were less than 10 kg, six patients were between 10 kg and 30 kg, and at six patients were be greater than 30 kg. After induction of general anesthesia and tracheal intubation, the Treymed Metaphor metabolic monitoring system was connected to the anesthetic breathing circuit to measure oxygen consumption (VO2). Once median sternotomy had been performed and the aortic and venous purse strings were in place, but before commencing cardiopulmonary bypass (CPB), blood samples were drawn.

To determine the cardiac output (CO) via the Fick equation, 0.5 cc blood samples were simultaneously obtained from the inferior vena cava (IVC), the superior vena cava (SVC) and the arterial line. Oxygen consumption and the cardiac output determined by the Aesculon (COEV) were noted at the same time. Blood samples were analyzed by the iStat blood gas machine. Mixed venous oxygen saturation (SvO2) was calculated by the equation SvO2 = 2/3*SVC saturation + 1/3*IVC saturation. The Fick principle for measuring CO was determined by dividing the VO2 by the arterio-venous oxygen content difference via the following equation:

\[ COF \text{ (l/min)} = \frac{\text{VO2} \text{ (l/min)}}{\text{Hb} \text{ (g/dl)} \times 1.36 \times (\text{SaO2} - \text{SvO2})} \]

Hb - hemoglobin   SaO2 - arterial oxygen saturation

Statistical Analysis

The Statistical Package for Social Sciences (SPSS 22®) was used to organize, validate and analyze the collected data. Data are expressed as means and standard deviations; 95% confidence intervals were constructed. Pearson correlation, linear regression and Bland–Altman analyses were performed to compare values obtained by both methods; p values < 0.05 were considered statistically significant.

References