Crossing the Threshold To Give a Fluid Bolus; Do We All Agree?

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Background

Fluid optimization therapies have shown improved outcomes and enhanced health care quality. These techniques, studied in high-risk surgical cases, are not widely utilized in daily practice. Barriers include the invasive nature of conventional monitoring techniques and the skill required to obtain accurate, reliable measurements. New automatic, noninvasive monitoring techniques are available, which could eliminate major obstacles to the practice of fluid optimization therapies. Several functional hemodynamic parameters, which are derived from blood pressure and plethysmographic wave forms, are good indicators of fluid responsiveness. We sought to determine if temporal threshold values on the same patient across monitors, maintain consistency and thus would recommend treatment (ie suggest a fluid bolus).

Methods

Consecutive patients (n=22) of ASA 2-4, scheduled for high-risk abdominal surgery (potential for at least 500 mL blood loss), without heart failure, a-fib, or hemodynamically significant valvular disease, were enrolled between 9/2009 and 1/2010. All patients received mechanical ventilation with 8-10 cc/kg TV and VC mode with PEEP = 5. The NICOM (Cheetah) device was attached to the patient using electrodes. The LIDCO Rapid (LR) was connected to the anesthesia machine (Datex Ohmeda), and obtained data from the radial arterial catheter. This arterial blood pressure was transduced to a Philips MP 50 monitor, measuring pulse pressure variation (PPV). Radical-7 (Masimo) finger probes were placed on the middle finger of each hand, and Pleth Variability Index (PVI) continuously measured and recorded. The A-line tracing was briefly frozen at a sweep speed of 12.5 mHz. By using the P1 Art cursor function embedded in the Datex monitor, highest and lowest SBP and DBP values were obtained from the frozen tracing. PPV and SPV were then calculated. Data points were compared to determine rates of agreement between each monitoring technique and its ability to determine when a patient has reached a predicted "threshold" of fluid responsiveness. A threshold of 13% was utilized as the value for Philips PPV and 14% for PVI. The SVV and SPV threshold values were 10%.

Results

The LR PPV demonstrated robust agreement (95%) in its determination of agreement with Philips PPV. Manual calculation techniques of PPV agree 62% with the reference monitors. PVI agreed 71% of the time with the reference monitor. Manual SPV calculations poorly agreed with the LR SPV reference monitor. And while it appeared the LR SVV and NICOM SVV monitors had high-level agreement (95%) this was actually due to false positive values with the current algorithm. Out of 154 NICOM SVV measurements only 13 were noted to be below threshold compared with 107 from the LR SVV.

Conclusions

The strongest inter-monitor agreement (ie. above threshold that may require treatment in the right clinical context) is noted in our study to be between the LR and the Philips PPV. PVI also had consistent agreement with Philips PPV. Manual measures (PPV and SPV) poorly agree with the reference monitor. Whether this data has clinical implications on patient outcomes cannot be determined from this study. Some values analyzed could differ simply because of monitor frameshift and recording error rather than their inability to determine appropriate physiologic thresholds.