SUPRA-HIGH PHYSIOLOGIC CARDIAC OUTPUT MEASUREMENT AND MEANING

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Introduction: End-stage liver disease is associated with significant circulatory changes. Patients have a hyper dynamic state that includes high cardiac output with low systemic vascular resistance and high heart rate, resulting in normal to decreased systemic blood pressure. Liver failure patients having liver transplantation (who frequently have supernormal cardiac outputs) are monitored at our institution with indwelling Edwards continuous cardiac output pulmonary catheters.

The pulmonary artery catheter facilitates measurement of pulmonary artery pressure, central venous pressure, and mixed venous oxygen saturation. Indwelling intra-arterial catheters also provide beat-to-beat measurement of arterial blood pressure. This device is used in fluid management. Fluid management endpoints that are used include urine output, cardiac output, blood pressure, central venous pressure, and pulmonary artery pressure.

Alternatives to the pulmonary artery catheter have been developed in an effort to use less invasive monitors to measure cardiac output. One such alternative device is the Endotracheal Cardiac Output Monitor (ECOM, ConMed, NY). Since this new technology is starting to gain access into the clinical setting, it is important to determine whether this non-invasive cardiac output monitor is accurate and predictive in liver failure patients with hyper-dynamic circulatory changes. This is particularly important for those patients in whom appropriate vascular access for inserting pulmonary artery (PA) catheters is not available.

Methods: We compared hemodynamic parameters obtained from PA catheters and ECOM. ECOM technology is FDA approved (Regulation number 21 CFR870.2770, approved August 12, 2003). We collected multiple hemodynamic parameters (invasive blood pressure from the indwelling arterial catheter, noninvasive cardiac output via ECOM) and compared these to the hemodynamic parameters obtained from the PA catheter.

Results: The cardiac output as measured from the PA catheter increased during the surgical procedure; this finding was consistent in all 15 patients. This increase is expected as patients’ systemic vascular resistance (SVR) decreases after reperfusion of the new graft due to release of vasodilator substances from the preserved liver.
The ECOM-derived cardiac output did not vary much during this procedure. There was little agreement between PA catheter-derived and ECOM-derived cardiac output. This information was shared with the manufacturer who will be working on an improved algorithm for calculating the higher cardiac outputs. See chart below.

**Conclusion:** Our data raises the question of the validity of any of the measuring devices of parameters in the supra-physiologic high range, as there has not been much testing of devices in these ranges. Our data questions not only the accuracy and validity of measuring technologies that are based on normal-physiology algorithms, but they also raise the question of the physiologic significance of these measurements. Much work has yet to be done to fully describe and define physiologic changes at the extremes of normal physiology.