The ‘left’ ventricle during pulsatile mechanical assistance: reliability of cardiac output monitoring with an uncalibrated pulse contour method

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The determination of cardiac output (CO) during mechanical circulatory support (MCS) is crucial since low-output syndrome is the main cause of death in such patients.

A new uncalibrated pulse contour method (PCM) named PRAM (pressure recording analytical method) has recently been introduced in the clinical practice and validated in animals, humans, and patients assisted with axial flow pumps.

The figure illustrates CO monitoring by PRAM in a patient during pulsatile left ventricular assist device assistance (HeartMate-I Thoratec Corporation, Pleasanton, CA, USA) (Panel A). The discrepancy between pump (operating in fixed-rate mode at 50 b.p.m.) and patient heart rate (paced at 85 b.p.m.) shows that some spontaneous ventricular contraction still occurred and resulted in a residual ventricular ejection (Panel B).

A good agreement between PRAM-CO and ThD-CO estimations was found in all the determinations whereas an apparent bias (about 10% overestimation) with respect to values of pump console (device calculated output) was observed (Panel C).

A retrospective analysis by PRAM (Panel D) demonstrated that, depending on loading conditions, each residual systolic-arterial wave resulted from an adjunctive ventricular stroke volume of about 5–8 mL. Although this is relatively small, with a heart rate of 85 b.p.m., left ventricle actually contributed to ‘total’ CO with 400–600 mL/min (about 10% of ‘total’ PRAM estimated CO).

PRAM technique overcomes the limitations inherent to thermodilution (ThD)-based devices (unreliable during right or biventricular support because of the ‘indicator loss’ occurring in right heart sections) and other PCMs based on ‘cold bolus’ trans-pulmonary thermodilution calibration which are not applicable during any type of MCS. It allows a less-invasive, beat-by-beat monitoring, deriving CO values from peripheral arterial pressure waves (radial artery), and seems to provide an actual estimation of the ‘total’ systemic blood flow (device derived plus residual ventricular ejection) in patients assisted with pulsatile VADs.