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MONITORING INTRA-CARDIAC SHUNTS CORRECTION WITH TRANSPULMONARY THERMODILUTION CURVE: THE BEST IS YET TO COME!

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In this issue of Journal of Clinical Monitoring and Computing, Dr Keller and colleagues highlight the importance of transpulmonary thermodilution (TPTD) monitoring during paediatric cardiac surgery [1]. The present report may lead to support this monitoring tool during intra-cardiac shunts correction.

TPTD measurements of cardiac output (CO) by means of PICCO catheters (Pulsiocath; PiCCO™, Pulsion Medical Systems, Munich, Germany), in a strict sense, represent both pulmonary and systemic arterial blood flows. However, in principle, this is not true in the presence of intra-cardiac left-to-right shunts due to atrial or ventricular septal defects as early recirculation of indicator may give rise to serious methodological problems in these cases [2]. Indeed, under varying levels of left-to-right shunt, the algorithms for calculation of flow considerably influence the validity of thermodilution measurements [3]. The data of the present report highlight that intracardiac left-to-right shunt generates early recirculation of thermal indicator with an obvious overestimation of EVLW and confirm the Giraud and colleagues finding in adult patients [2].

The reason for this overestimation of EVLW, in absence of gas exchanges abnormality, is an overestimation of the area under curve as the indicator curve decay is more prolonged without possibility to adequately eliminate the pathophysiological recirculation by a standard mathematical truncation method [3]. In this setting, left-to-right shunt induces an extra circuit with a delayed delivery of indicator to the systemic circulation which increases the down slope time (DSt) and, to a lesser extent, the mean transit time (MTt) [4]. This phenomenon should not be confused with a real physiological recirculation [3] or an increment of the DSt and, to a lesser extent, of the MTt observed in the presence of a large volume of lung water. Indeed, in this setting, the entrapment of the indicator in the pulmonary tissue is a loss of indicator but not a recirculation. Nevertheless, in the forthcoming, we can presume that a modified extrapolation algorithm could be illustrated during TPTD measurements in patients with cardiac defects [5]. The use of computer-based regression analyses to define the optimal segment for monoexponential extrapolation could effectively eliminate indicator recirculation from the initial portion of the declining thermodilution curve. The clinical applicability of this kind of innovation could be the development of commercially implemented software with curve-alert messages.

A pubMed search identified 250 articles that were published on TPTD monitoring for a variety of critically

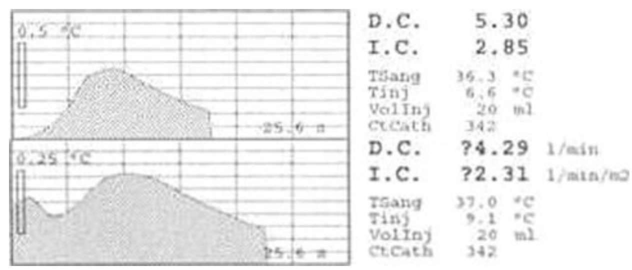

Fig. 1. Trans-pulmonary thermodilution curves in a normal subject (upper panel) and in a patient with a shunt across a patent foramen ovale (lower panel). Note in the lower panel the shorter appearance time and initial hump caused by passage of a portion of the thermal indicator from right to left through the defect.

ill patients during the last decade. The present report adds something new: a look back over the Swan finding [3, 6]. Indeed, a right-to-left intracardiac shunt related to an atrial septal defect (patent foramen ovale) can also be diagnosed by using TPTD curve [3]. In this setting, the appearance time is usually short with a secondary hump on the build-up slope of the dilution curve and a reduced peak deflection [3] (Figure 1). This abnormal curve can be explained by the passage of a portion of the thermal indicator from the right atrium into the systemic circulation [3]. As the passage of this portion of the thermal indicator is not delayed by traversing the pulmonary circuit, it arrives at the femoral catheter earlier than the remainder of thermal indicator which passes classically by the more tortuous route through the lungs [3] (Figure 1).

The main lesson from the elegant report of Keller and colleagues is the demonstration that TPTD monitoring could be a very useful method to evaluate, per-operatively, the intrac-cardiac shunts closure [1]. Indeed, we can expect that the TPTD curve could be a useful monitoring tool to guide intra-cardiac shunt correction as a significant relationship was demonstrated between TPTD curve and blood gas methods to measure shunt fractions [3, 7]. The present finding reminds us that despite gaining an increasely detailed understanding during the last sixty years, indicator dilution curves monitoring knowledge could be described as an ''endless frontier''.

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