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Hemodynamic optimization during surgery

Maxime Cannesson*

* Department of Anesthesiology and Perioperative Care. UC Irvine California, USA.

Fluid management and optimization is a daily problematic in anesthesiology and in the critical care setting. The concept of hemodynamic optimization is related to the concept of oxygen delivery optimization to the tissues and has been shown to be able to improve postoperative outcome and to decrease the cost of surgery[1-7]. Schematically, in the operating room, the anesthesiologist and his or her patients have to deal with two distinct risks: hypovolemia on one side, and hypervolemia on the other side. Both risks, potentially leading to a decrease in oxygen delivery to the tissues and to an increased postoperative morbidity (Figure 1).

Most of previously published studies showing an impact of perioperative fluid optimization on postoperative outcome are based on cardiac output optimization using esophageal Doppler[2,3,5,6,8,9]. Several studies, conducted in various clinical settings, in various countries, have shown that this management was able to decrease postoperative morbidity and to decrease the cost of surgery (decrease in the length of stay in the hospital and decrease in the incidence of postoperative nausea and vomiting[10]). Consequently, monitoring and optimization of cardiac output would be able to improve postoperative outcome. These observations are of major importance since cardiac output monitoring using esophageal Doppler would be one of the only monitoring devices to be able to impact perioperative outcome. For example, pulse oximetry has not been shown to be able to impact outcome, even in studies conducted in more than 20,000 patients[11,12]. However, despite physiological evidences showing that organ perfusion requires two physiological objectives: 1) adequate perfusion pressure in order to force blood into the capillaries of all organs, and 2) adequate cardiac output to deliver oxygen and substrates, and to remove carbon dioxide and other metabolic products[13], and despite data provided by recent medical literature showing the impact of cardiac output optimization on postoperative outcome, cardiac output monitoring is rarely used in the daily anesthesiology practice.

Since 1980's, a significant portion of the medical literature focusing on perioperative hemodynamic has been related to the concept of fluid responsiveness[14-27]. It is now clear that dynamic parameters of fluid responsiveness, based on cardiopulmonary interactions in patients under general anesthesia and mechanical ventilation, are superior to static indicators (such as central venous pressure)[14]. The main advantage of these dynamic indicators is that they can be derived from a single arterial pressure waveform [systolic pressure variations (SPV), and pulse pressure variations (PPV)] or from the plethysmographic waveform (respiratory variations in the plethysmographic waveform amplitude (ΔPOP), and pleth variability index (PVI))[14,28]. Their aim is to predict an increase in cardiac output induced by volume expansion before volume expansion is actually performed. These indices have been described more than 20 years ago[29]. During the past two years, several new softwares and algorithms have been developed to automatically and continuously calculate these indices[21,23,30-34]. These new monitoring parameters open the door to the concept of optimization of these dynamic indicators of fluid responsiveness and to an alternative to cardiac output monitoring and optimization[28]. Recent studies suggest that this approach has the ability to improve postoperative outcome[35-37].

In the present conference we will describe and discuss the physiological and technological background necessary to the understanding of these dynamic parameters of fluid responsiveness and to the understanding of recent softwares and algorithms allowing for their monitoring. We will then discuss how these dynamic parameters may be used for hemodynamic optimization during high and/or moderate risk surgery. Finally, we will propose new methodological approaches to strengthen the clinical validation of these dynamic parameters in order to improve their utility in the daily clinical anesthesia practice.

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