A capnodynamic method delivers continuous hemodynamic monitoring during abdominal surgery

Thorir Svavar Sigmundsson^{1,2}, Tomas Öhman^{1,2}, Magnus Hallbäck³, Anders Oldner^{1,2}, Caroline Hällsjö-Sander^{1,2}, Håkan Björne^{1,2}

¹Department of Perioperative Medicine and Intensive Care, Karolinska University Hospital, Solna, Sweden, ²Department of Physiology and Pharmacology, Karolinska Institutet, Stockholm, Sweden, ³Maquet Critical Care AB, Solna, Sweden,

Introduction

A capnodynamic method continuously calculates non-shunted pulmonary blood flow (CO_{EPBF}) using an automatic expiratory hold in three out of nine breaths during mechanical ventilation. In a porcine model, the method has performed well during different respiratory and circulatory challenges¹, although as expected, transiently affected during swift changes in mixed venous CO_2 and at high shunt levels². Concordance during large CO changes has been preserved throughout the animal studies. The aim of the current study was to evaluate CO_{EPBF} clinically for the first time during abdominal surgery.

Methods

Effective pulmonary blood flow was calculated and compared to trans-pulmonary thermodilution (TPTD) in 25 patients undergoing elective open abdominal surgery. Three measurements were performed at baseline (BL_{PEEP5}) at five minutes interval and subsequently before and after changes in PEEP (5-15-5 cmH_2O) and epidural activation with bolus mepivacaine. Events such as hypovolemia and low cardiac output were captured during surgery and values before and after installation of treatment were recorded.

Results

Mean CO was 4.4 (1.0) and 4.8 (1.1) L/min for EPBF and TPTD in patients with a mean age 68 (9) years and weight 76 (16) kg (see figure 1 for eventline). Bias (levels of agreement) for all 233 paired values was -0.3 L/min and improved after $\Delta PEEP$ 15 without affecting LoA (-2.1 to 1.4 L/min) and percentage error (37%) (See figure 2). Concordance with a 15% exclusion zone (0.75 L/min) was 81 and 95% after PEEP increase and decrease respectively, 86% after epidural activation and 100% after volume infusion (See figure 3).

Figure 1. Eventline showing CO measured with EPBF and TPTD during consecutive steps in the protocol

Conclusion

CO_{EPBF} performed acceptably during open abdominal surgery tracking small but recognizable hemodynamic changes starting at PEEP 5. Further clinical studies are warranted to establish its role as a continuous and simple alternative for monitoring and tracking changes in CO in the operating theatre.

Figure 2. Bland Altman plot for all 233 values

Figure 3. Concordance plot for all trending values with 15% exclusion zone