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Cardiac output and intrathoracic volumetric parameters obtained by ultrasound dilution and transpulmonary thermodilution methods in a pediatric animal model

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Introduction: Especially after cardiac surgery monitoring of cardiovascular function is essential in critically ill children. A novel minimal invasive indicator technique using ultrasound dilution (UDT) was recently introduced to measure cardiac output and intrathoracic blood volumes. Therefore, we compared cardiac output measurements and derived volumes using UDT (Transonic Systems Inc., NY, USA) with another indicator technique, the well-established transpulmonary thermodilution (TPTD) method (Pulsion medical systems, PiCCO plus, Germany) in a juvenile animal model.

Methods: Experiments were performed in 20 ventilated, anaesthetized piglets during isovolemic haemodilution. In each of the animals a 4-F Pulsiocath (Pulsion medical systems, PiCCO plus, Germany) catheter was surgically placed into the carotid artery and a central venous catheter introduced into the jugular vein. Piglets were randomly assigned into 4 groups and underwent four steps of isovolemic haemodilution by exchanging blood either with a colloid osmotic or crystalloid solution. Haemodynamically stable conditions provided ten minutes after each step of isovolemic haemodilution cardiac output and intrathoracic volumes were measured with TPTD followed by UDT. For each method, three injections were averaged. Cardiac output and intrathoracic volumes were compared by using bias and limits of agreement calculated as per the Bland-Altman approach and the linear regression analysis.

Results: A good agreement for measured cardiac output (Mean 1.98; range 1.1 − 2.9 l/min) with a percentage error of 17.3% with r=0.92, mean bias=0.28 L/min was observed. Global end-diastolic volume (GEDV) and intrathoracic blood volume (ITBV) measured by TPTD were almost 2 times larger than corresponding volumes quantified by UDT (ITBV(UDT) = 0.58 x ITBV(TPTD) + 27.1; GEDV(UDT)= 0.48 x GEDV(TPTD) + 23.1).

Conclusion: Cardiac output measured by UDT was found to be equivalent and hence interchangeable with TPTD in a paediatric animal model. The lack of agreement in the intrathoracic volumes recorded by two indicator methods could be due to either the different types of indicators (diffusible versus non-diffusible) or the underlying algorithm. Future studies are necessary to assign these results to critically ill paediatric patients and to determine the exact intrathoracic blood volume with reference techniques.