1: Intensive Care Med. 2006 Dec;32(12):2053-8. Epub 2006 Oct 13. SpringerLink FULL-TEXT ARTICLE Links

Noninvasive assessment of cardiac output using thoracic electrical bioimpedance in hemodynamically stable and unstable patients after cardiac surgery: a comparison with pulmonary artery thermodilution.

Suttner S, **Schöllhorn T**, **Boldt J**, **Mayer J**, **Röhm KD**, **Lang K**, **Piper SN**.

Department of Anesthesiology and Intensive Care Medicine, Klinikum der Stadt Ludwigshafen, Bremser Strasse 79, Ludwigshafen, Germany. suttner@gmx.de

OBJECTIVE: To compare noninvasive cardiac output (CO)measurement obtained with a new thoracic electrical bioimpedance (TEB) device, using a proprietary modification of the impedance equation, with invasive measurement obtained via pulmonary artery thermodilution. DESIGN: Prospective, observational study. SETTING: Surgical intensive care unit (ICU) of a university-affiliated community hospital. PATIENTS AND PARTICIPANTS: Seventy-four adult patients undergoing elective cardiac surgery with routine pulmonary artery catheter placement. INTERVENTIONS: None. MEASUREMENTS AND RESULTS: Simultaneous paired CO and cardiac index (CI) measurements by TEB and thermodilution were obtained in mechanically ventilated patients upon admission to the ICU. For analysis of CI data the patients were subdivided into a hemodynamically stable group and a hemodynamically unstable group. The groups were analyzed using linear regression and tests of bias and precision. We found a significant correlation between thermodilution and TEB ($r = 0.83$; $n < 0.001$), accompanied by a bias of -0.01 l/min/m(2) and a precision of +/-0.57 l/min/m(2) for all CI data pairs. Correlation, bias, and precision were not influenced by stratification of the data. The correlation coefficient, bias, and precision for CI were 0.86 ($n< 0.001$), 0.03 l/min/m(2), and +/-0.47 l/min/m(2) in hemodynamically stable patients and 0.79 ($n< 0.001$), 0.06 l/min/m(2), and +/-0.68 l/min/m(2) in hemodynamically unstable patients. CONCLUSIONS: Our results demonstrate a close correlation and clinically acceptable agreement and precision between CO measurements obtained with impedance cardiography using a new algorithm to calculate CO from variations in TEB, and those obtained with the clinical standard of care, pulmonary artery thermodilution, in hemodynamically stable and unstable patients after cardiac surgery.

PMID: 17039348 [PubMed - indexed for MEDLINE]

1: Br J Anaesth. 2005 Nov;95(5):603-10. Epub 2005 Sep 9.

Comparison of electrical velocimetry and transoesophageal Doppler echocardiography for measuring stroke volume and cardiac output.

Schmidt C, **Theilmeier G**, **Van Aken H**, **Korsmeier P**, **Wirtz SP**, **Berendes E**, **Hoffmeier A**, **Meissner A**.

Department of Anaesthesiology and Surgical Intensive Care Medicine, University of Münster Hospital, Albert-Schweitzer-Strasse 33, D-48149 Münster, Germany. schmch@uni-muenster.de

BACKGROUND: Impedance cardiography (ICG) has been used extensively to estimate stroke volume (SV) and cardiac output (CO) from changes of thoracic electrical bioimpedance (TEB). However, studies comparing ICG with reference methods have questioned the reliability of this approach. Electrical velocimetry (EV) provides a new algorithm to calculate CO from variations in TEB. As the transoesophageal Doppler echocardiographic quantification of CO (TOE-CO) has emerged as a reliable method, the purpose of this study was to determine the limits of agreement between CO estimations using EV (EV-CO) and TOE-CO. METHODS: Standard ECG electrodes were used for non-invasive EV-CO measurements. These were placed on 37 patients scheduled for coronary artery surgery necessitating transoesophageal echocardiography monitoring. Simultaneous EV-CO and TOE-CO measurements were recorded after induction of anaesthesia. EV-CO was calculated using the Bernstein-Osypka equation. TOE-CO was measured across the aortic valve using continuous-wave Doppler echocardiography and a triangular orifice model. RESULTS: A significant high correlation was found between the TOE-CO and the EV-CO measurements (r2=0.86). Data were related linearly. The slope of the line (1.10 (se 0.07)) was not significantly different from unity, and the point at which it intersected the ordinate (-0.46 (0.32) litre min(-1)) was not significantly different from zero. Bland-Altman analysis revealed a bias of 0.18 litre min(-1) with narrow limits of agreement (-0.99 to 1.36 litre min(-1)). CONCLUSIONS: The agreement between EV-CO and TOE-CO is clinically acceptable, and these two techniques can be used interchangeably.

PMID: 16155037 [PubMed - indexed for MEDLINE]

1: Acta Anaesthesiol Scand. 2007 Nov;51(10):1314-9.  Links

Comparison of electrical velocimetry and thermodilution techniques for the measurement of cardiac output.

Zoremba N, **Bickenbach J**, **Krauss B**, **Rossaint R**, **Kuhlen R**, **Schälte G**.

Department of Intensive Care Medicine, University Hospital RWTH Aachen, Aaschen, Germany.

Aim: To compare a new method of non-invasive determination of cardiac output based on electrical velocimetry (EV-CO) with invasive thermodilution methods. Methods: Fifty critically ill patients were enrolled into the study. EV-CO was compared with cardiac output measured by a pulmonary artery catheter (PA-CO) in one group (n= 25) and by a femoral artery catheter (PiCCO-CO) in a second group (n= 25), by simultaneous measurements. Standard electrocardiography electrodes were used for non-invasive measurements, and EV-CO was calculated using the Bernstein-Osypka equation. The invasive measurements of PA-CO and PiCCO-CO were made by the injection of iced 0.9% saline and the recording of thermodilution curves. Results: The precision values of EV-CO, PA-CO and PiCCO-CO measurements were +/- 0.46 [95% confidence interval (95% CI), +/- 0.06], +/- 0.57 (95% CI, +/- 0.09) and +/- 0.48 l/min (95% CI, +/- 0.08 l/min), respectively. The mean differences between EV-CO and PA-CO or PiCCO-CO were -0.05 +/- 0.71 and 0.22 +/- 0.78 l/min, respectively. The lower and upper limits of agreement for the comparison of EV-CO with PA-CO were -1.47 and 1.37 l/min (95% CI, +/- 0.25 l/min), respectively. In the comparison of EV-CO and PiCCO-CO, lower and upper limits of -1.34 and 1.78 l/min (95% CI, +/- 0.27 l/min) were found. The percentage errors between EV-CO and PA-CO or PiCCO-CO were 26.5% and 26.4%, respectively. Conclusions: The values of cardiac output were statistically comparable between the groups. Therefore, electrical velocimetry is a suitable method to evaluate haemodynamic variables with clinically acceptable accuracy.

PMID: 17944633 [PubMed - in process]