Electrical Velocimetry - Clinical Validation of a New Noninvasive CO-Monitor in Postoperative Non Cardiac Surgical Patients

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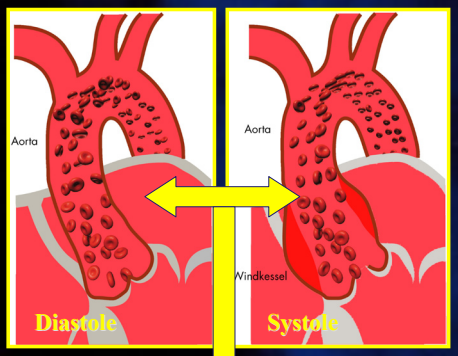
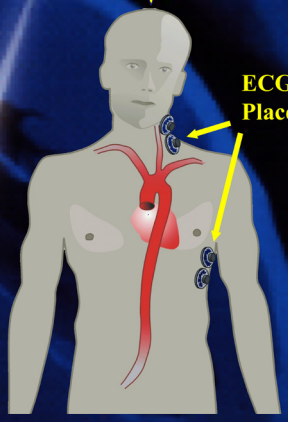
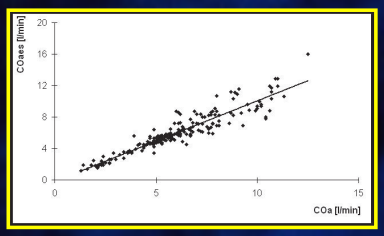
Background: All Methods measuring Cardiac Output (CO) currently established in clinical practice are of more or less invasive nature. We evaluated a new completely non-invasive technique for continuous CO monitoring.

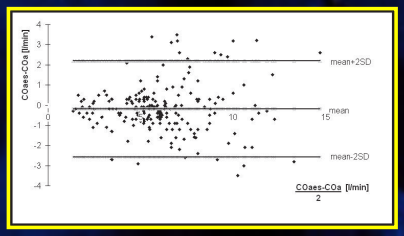
Method: Electrical Velocimetry (EV) measures transthoracically non-invasively the changes of conductivity of blood in the aorta during systole using four standard ECG-surface electrodes. An equivalent for peak aortic blood acceleration is determined. With the Bernstein-Osypka equation Stroke Volume (SV) and Cardiac Output (COaes) are calculated taking into account left ventricular ejection time and a factorial patient constant. The change of conductivity of aortic blood is caused by the change of erythrocyte orientation from random orientation prior to aortic valve opening towards alignment of their disc shaped area in parallel to the pulsatile blood flow - approximately 60 ms after aortic valve opening. A prospective clinical validation of COaes (Aesculon®, Osypka Medical Berlin, Germany) was performed using threefold transthoracic arterial thermodilution CO (COa) and pulse contour CO (PCCO, PiCCO®, Pulsion Medical Systems Munich, Germany) as a clinical reference method. With IRB approval and informed consent we incorporated 62 general surgical patients with indication for invasive monitoring.





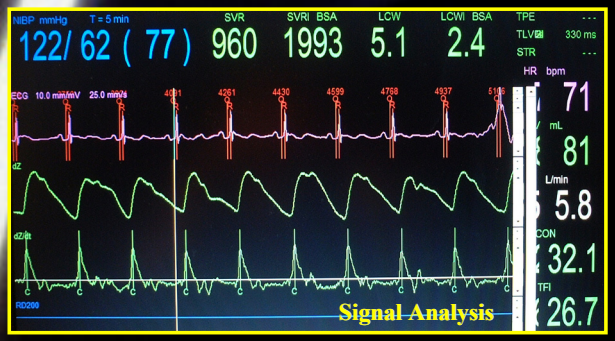
Results: A total of 298 measurements were obtained and analysed using linear regression and Bland Altman plots. CO measurements were ranging 1,9–12,7 l/min (mean 4,6±1,6 l/min).
Average observation time was 17,9 h (3,9 – 79,6 h).





COaes = 0,44*COa-0,59 r = 0,91 bias –0,34 l/min SD=1,3 l/min

Discussion: For a non calibrating continuous CO-monitor the EV-technique shows a surprisingly good correlation to the clinical reference COa. Whereas correlation is very good at low SV, there is a tendency of underestimation in SV exceeding an absolute value of 70 ml. Proof of possible causes of error in this method such as aortic valve disparities, low hematocrite values, morbid obesity or demographic factors could not be detected by multivariate analysis due to low statistical power of this data set in these subgroups.
EV is captivating because of its simplicity and short setup time of below 30 second. Independency from vascular access and physiologically stable measurement conditions are other advantages of this monitoring technique.



Literatur:
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2.) Osypka MJ, Bernstein DP: AACN Clinical Issues 1999; 10: 385-99
3.) Bernstein DP, Osypka MJ: U.S. Patent No. 6, 511, 438
4.) Kiefer H et al: EJA Suppl. 2004 Abstract