Comparison of Cardiac Output Measurements Between Electrical Cardiometry and Echocardiography

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Abstract

Background: The capability to continuously and non-invasively monitor cardiac output in absolute numbers would be a breakthrough in critically ill patients as the diagnosis of neonatal shock would be less complicated and treatment more effective. Electrical Cardiometry (EC) is a non-invasive method of continuous beat-to-beat left cardiac output monitoring based on measurement of thoracic electrical bioimpedance.
Purpose of the study: To investigate the correlation of cardiac output measurements obtained by the non-invasive continuous cardiac output monitor (electrical cardiometry, Aesculon®) and echocardiography in term and preterm infants.
Methodology: This is a prospective observational study. Left ventricular output (LVO) was measured by echocardiography and EC simultaneously. As EC estimates LVO by assessing blood flow in the ascending aorta, measurements were performed on term and preterm infants with a patent ductus arteriosus irrespective of the potential hemodynamic significance of ductal shunting. Measurements were obtained from day 1-72 of postnatal life.
Summary of results: There were 46, paired measurements performed on neonates with a gestational age of 23-41 and birth weight of 375-4330gms. LVO by ECHO and EC was 653±188, and 658±263 mL/min, respectively (r^2=0.55).
Conclusion: Despite the relative imprecision of LVO measurement by echocardiography, there is a good correlation between the cardiac output measurements obtained by EC and echocardiography in neonates. There is a potential for continuous monitoring of cardiac output with the use of EC in these infants but additional studies simultaneously investigating changes in CO in response to treatment are needed to confirm these findings.

Background

- The capability to continuously and non-invasively monitor CO would be a breakthrough in critically ill patients for cardiovascular assessment and hemodynamic management.

•Electrical Cardiometry (EC) is non- invasive continuous beat to beat cardiac output monitoring.

• EC measures the thoracic electrical bioimpedance and relates to changes in electrical conductivity of the aortic arch blood flow

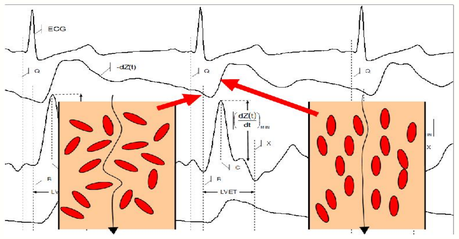


Figure 1: EC is based on the premise that erythrocytes rapidly change orientation from random to alignment in the direction of blood flow upon opening of the aortic valve

- Initial studies in adults provided clinically acceptable agreement between CO values measured by EC, transesphageal doppler technology and thermodilution by cardiac catherization[1]

•A study in the pediatric population showed a good correlation between the measurement of cardiac output by EC and CO by Fick on catheterization in infants and children with heart defects[2]

Objectives

To investigate the correlation of cardiac output measurements obtained by noninvasive continuous cardiac output monitor (electrical cardiometry, Aesculon®) and echocardiography in term and preterm infants

Methods

•Term and preterm infants had simultaneous measurement of cardiac output using Electrical Cardiometry (EC) and echocardiography

•Echocardiographic measurement of left ventricular stroke volume and calculated heart rate (stroke volume x heart rate) were used as the standard to validate the accuracy of electrical cardiometry.

•4 EKG leads were placed on the forehead, left neck, thorax and leg to measure cardiac output from the EC and continuous monitoring was done for 10 seconds


Sensor placement for small children and neonates

•Left ventricular output was measured by obtaining the velocity time integral (VTI) of the aortic valve and internal diameter of the aortic valve ring using 2 dimensional Echo and 5 highest were averaged

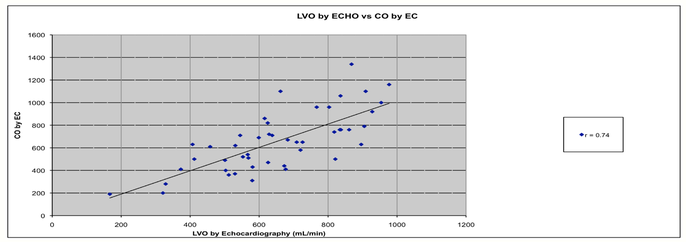
•CO was calculated for echo from cross-sectional area of the aortic valve, VTI and HR

•CO from EC was obtained from the monitor

Results

There were 46, paired measurements performed on neonates with a gestational age of 23-41 and birth weight of 375-4330gms.

	Electrical Cardiometry	Echocardio-graphy
N	46	46
BW (grams)	375-4330	375-4330
GA (weeks)	23-41	23-41
LVO (mL/min)	658±263	653±188



Conclusion

Our study demonstrated there is an acceptable correlation between the cardiac output measurements obtained by EC and echocardiography in these neonates.

There is a potential for continuous monitoring of cardiac output with the use of EC in these infants.
Additional studies simultaneously investigating changes in CO in response to treatment are needed to confirm these findings.

References

1. Zoremba et al. Acta Anaesth Scand, 2007.

2. Norozi et al. Brit Jnl Anes, 2008.