Stroke Volume Evaluation With Electrical Cardiometry in Term and Preterm Infants: Comparison With Functional Echocardiography

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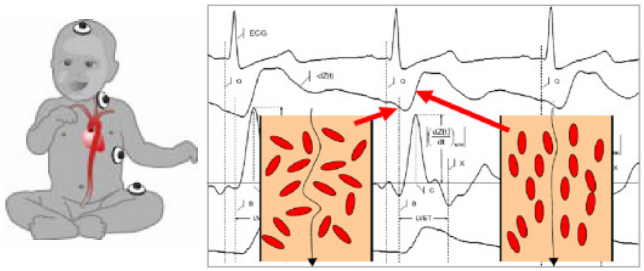
Background: Cardiac Output (CO) is essential to guarantee organ perfusion. Invasive reference methods are Fick's method and thermodilution, not referring to physiological output definition based on Stroke Volume (SV), being technically demanding and likely to cause complications. There is a need for non-invasive alternatives especially in neonates like echocardiography (EC) and bioimpedance.

We investigated if electrical velocimetry (EV) and EC are interchangeable for SV measurement.



Osypka Medical, Berlin, Germany and La Jolla, California, USA

Bioimpedance measurement of CO was developed in the 1960s by Kubicek. It presumes that the ejection of blood into the thorax would lower its resistance to a current emitted through it by electrodes due to intrathoracic vessel volume changes. Models were refined using algorithms such as the Osypka–Bernstein equation with EV development : it correlates impedance and erythrocytes orientation changes with peak flow velocity in the ascending aorta.

Methods: We measured SV with EV and EC, within 10 min. Measurements were also repeated 6 times by the same operator before and after EC.

EC relies on the Doppler principle: velocity time integral (VTI) of the blood flow through aortic valve is multiplied by its surface (CSA) to calculate SV. Ductus arteriosus is studied (close : CDA, patent : PDA).

SV = VTI x CSA
CO (ml/h) = SV (ml) x HR (bm)

Results: We included 32 patients permitting 53 measures. Reapetability was 50% for EV and 35% for EC. There was no difference in SV measured by EV after 10 minutes (3.43 vs 3.36;p=0.13, Wilcoxon test). Bland Altman results and correlation between two methods are pointed out below.

	Population
n	32/ 53 measures
Birth Weight	1.265± 786 g
Gestational age GA	29.6±4.4 wks

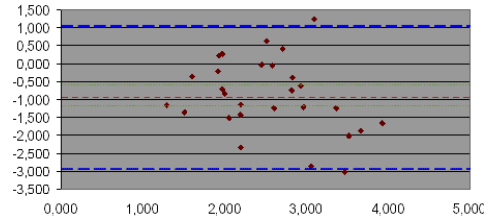
BA plot	PDA : ml	CDA : %
D bias	-0.903 ml (27%)	0.859 (14% = 0,5ml)
Limits of agreement	-2.954ml / 1.148ml	0.249/ 1.470

	SV EV	SV EC	p	Correlation	p
Total ml	3.268	4.643	0.0001	0.499 GA : 0.499	<0.001
PDA ml	3.001	2.098	0.003	0.292	0.131
CDA ml	2.248	1.737	0.08	0.491	0.001

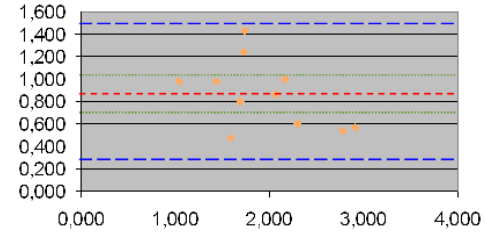
Discussion: Non-invasive techniques are more sensitive to interferences than invasive ones : signal may be altered when electrodes are not perfectly placed or not functional.

Bland–Altman plot

PDA



CDA



For EC : errors are possible, especially in small infants.

All methods, invasive and non-invasive, measure either CO or SV indirectly.

EV technique is not validated yet but results are correlated to EC and not influenced by AG but are better without cardiac shunt (PDA).

Conclusion: Results are encouraging: EV may be a valuable tool in the hands of neonatologists for SV measurement and has the advantages of easy handling and allows continuous measurement.