

## Non-invasive cardiac assessment in neonatal mobile ICU: echocardiography versus electrical cardiometry during ride.

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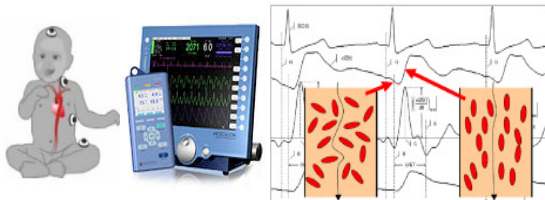
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**Background:** Haemodynamic assessment is an important topic in neonatology. Non-invasive techniques as echocardiography (US) and electrical cardiometry (EC) are useful in NICU. EC is a new continuous stroke volume (SV) measurement device based on bioimpedance: SV measurement presumes that the ejection of blood into the thorax would lower its resistance to current due to vessel volume changes. Models correlate impedance and erythrocytes orientation changes with peak flow velocity in aorta (Fig.1) using Bernstein-Osypka equation incorporating patients physical characteristics.

Fig.1

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



In France, mobile pediatric ICU (dedicated teams) perform transfers of newborns and children requiring emergency cares with various monitoring. But US and mainly EC are not common used and there are few studies on these devices in ambulances.

We studied reliability of US and EC in a pediatric mobile ICU (Fig.2) and the effect of transportation on SV.



Fig.2: Neonatal transportation module in a clinic and in team ambulance

**Methods:** We enrolled prospectively neonates transported for any medical reason, except malformations. SV and cardiac output (CO) were measured at the same time with EC (ICON™, Cardiotronc Osypka Medical©) and US (M-Turbo®, FUJIFILM SonoSite, Inc), by the same operator before, during and after transfer. US relies on Doppler principle: velocity time integral (VTI) of blood flow through aortic valve is multiplied by its surface (CSA) to calculate SV. Ductus Arteriosus status is noted (Patent or closed CDA).

$$SV \text{ (mL)} = VTI \times CSA$$

$$CO \text{ (mL/h)} = SV \text{ (mL)} \times HR \text{ (bpm)}$$

Tabl.1	SV US (mL)	CO US (L/kg/min)	SV EC (mL)	CO EC (L/kg/min)	Pearson	Variability coefficient
Before	2.62 ± 1.4	0.414 ± 0.25	5.61 ± 2.23	0.868 ± 0.34	0.514	US:0.54 EC:0.4
	1	7		7		
During	2.85 ± 1.8	0.448 ± 0.32	6.59 ± 2.38	1.04 ± 0.4	0.755	US:0.66 EC:0.36
	5	1				
After	2.97 ± 1.8	0.478 ± 0.32	5.54 ± 1.99	0.876 ± 0.33	0.677	US:0.62 EC:0.36
	4	3		7		
Total	2.79 ± 1.7	0.446 ± 0.31	6.31 ± 2.36	0.996 ± 0.39	0.697	US:0.64 EC:0.37
	8	1		0		
CDA during	3.11 ± 1.9	0.499 ± 0.34	6.98 ± 2.39	1.11 ± 0.4	0.750	US:0.63 EC:0.34
	6	2				

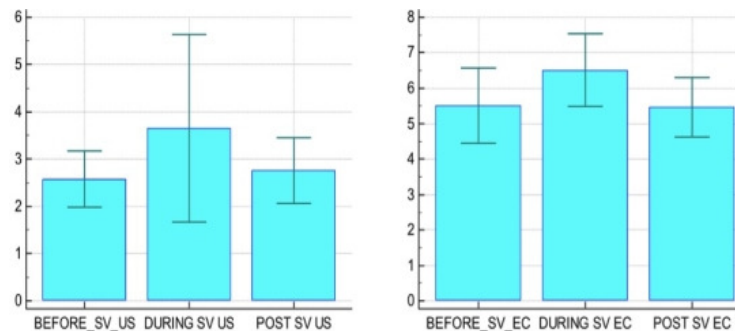


Fig.3: Repeated measures ANOVA for SV with US and EC

**Results:** We included 30 infants (GA 36.4 ± 7.4, 2.41kg ± 1.25) and performed 577 paired measurements (100 before, 414 during and 63 after ride). Supported time was 93 ± 35min and travel time 31 ± 19min.

There is a difference between SV and CO measures respectively with US and EC (Tabl.1) with an overestimate of EC on US especially during travel period (Bland Altman test bias: 3.74 mL [95%CI:0.7;6.8] in ambulance versus 2.68mL [95%CI:-0.8;6.2]).

There is strong correlation between EC and US (Pearson). Coefficient of variation is better and more stable for EC. SV and CO are not affected by transfer, neither if measured by US, nor by EC (Fig.3).

**Discussion:** Non-invasive techniques are more sensitive to interferences than invasive ones: signal may be altered when electrodes are not perfectly fitted or not functional. All methods, invasive and non-invasive, measure either CO or SV indirectly.

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

EC is not validated yet but results in NICU highlight good accuracy and correlation with US.

Great advantages of EC are:

- Continuous measure
- Early detection of haemodynamic alterations
- No need of training

**Conclusion:** EC is a reliable and continuous technique during neonatal transportation as it has less variability than US, even if it tends to overestimate SV and CO.