Predicting fluid responsiveness in children following congenital heart surgery: what about electrical cardiometry?

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Background

• Hot topic:
  – Haemodynamic evaluation
    • Fluid/load management
      – Infants: IVC and SVV

• Non invasive
  – Echocardiography (US)

• Non invasive AND continuous
  – Electrical cardiometry
    • As accurate as US

Noori 2012
Grollmuss 2014
Electrical cardiometry

• Bio-impedance
  – Alternating electric current through thorax
  – High frequency, low intensity
  – Non invasive and continuous
• Bernstein-Osypka equation

\[ SV = \frac{V_{tmv}}{\xi^2} \cdot \sqrt{\frac{(dz/dr)_{max}}{Z_0}} \cdot ET_\alpha \]
What about SVV?

Lee 2014

- SVV NICOM vs θ Peak Ao echo
- 26 children post VSD: 10ml/kg (=↑15% SV)
- AUC responders:
  - 0.956 θ peak Ao echo (19 vs 9%)
  - 0.888 SVV (13 vs 8%)
- Younger (23 vs 33 months)

Vergnaud, 2014

- SVV et Svi
- NICOM vs echo
- 30 post neuro surgery: 20 ml/kg Plasmion
  - 15 R/15NR

<table>
<thead>
<tr>
<th></th>
<th>AUC</th>
<th>Cut off</th>
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<tbody>
<tr>
<td>SVV</td>
<td>0.81</td>
<td>&gt;10%</td>
</tr>
<tr>
<td>SVi</td>
<td>0.88</td>
<td>&lt;29mL/m²</td>
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Cut off 10% SVV et 14% echo
Goal

- Predict fluid responsiveness
  - New device
  - Non invasive
    - Critical period
  - Continuous
    - Fluid goal/ response to volume expansion (VE)
      - Who?
      - Efficiency?
      - Cut-off values?
Design and Methods

- Prospective, observational
  - Post operative patients
    - Open / closed heart surgery
    - Invasive and non invasive devices

- Parameters:
  - Electrical cardiometry: SV, CO, SVV, ICON
  - Echocardiography
  - Invasive blood pressure
  - CVP
  - Left auricular pressure
  - Pulse oxymetry curve respiratory variations

- Responders to volume expansion had an increase in SV of at least 15%

- Results are median (interquartile).

  Teboul 2004
Results (1)

- 37 patients
- 20 volume expansion

<table>
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<tr>
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<th>N=37</th>
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<tr>
<td>Open heart</td>
<td>23</td>
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<tr>
<td>Age (months)</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>2-150</td>
</tr>
<tr>
<td>Weight (kilograms)</td>
<td>7.3</td>
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<tr>
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<td>4.2-43</td>
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<tr>
<td>Size</td>
<td>75</td>
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<td>55-157</td>
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<tr>
<td>Responders</td>
<td>11</td>
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Results (2)

• Before VE:
  – SV weight index: 1.48(0.26) vs 1.03(0.28) p=0.04
    • AUC: 0.778
  – SVV: 14(2.4) vs 18(3.9) p=0.05
    • AUC 0.767

Figure 1: ROC curves

All others: not significant, low AUC
Results (3)
Larger cohort

- 90 patients
  - 6.5 months (44), 6.4 kg (9.8)
  - 46 had VE
    - patients younger (3 vs 15.5 months) and low weight (5.2 vs 8.2 kg, p=0.0099) in VE group

- VE vs no VE:
  - SVV: 18% (9) vs 10% (5) p<0.0001
  - AUC 0.809 and cutoff 13% (p<0.0001)

- Responders vs non responders:
  - SVV: 20%(8) vs 15.5% (7) p=0.009
  - AUC 0.696 and cutoff 19% (p=0.015)
Discussion

• Similar accuracy US
  – Non-invasive
  – Operator-independent
  – Easy handling
  – Continuous
    • Without moving patient!

• Better / as accurate as invasive devices for fluid management?
• Population needing VE: younger patients?

• Study limitations
  – Population
    • One center
    • Relatively small
      – Heterogeneous
      – First one with this device on this population!
Conclusion

• EC is an interesting technique
• Overestimation
• Early detection of changes

• Noninvasive SVV and SV on ICON®:
  – Reliable data to guide fluid management
  – Preliminaries data

• Larger cohort
• Neonatology
• SMUR

Squara 2007