Heart Rate Characteristics Index and Extubation Outcome in Neonates
A Retrospective Cohort Study

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Heart Rate Characteristics

Health

- many small decelerations
- many small accelerations

Disease

- many large decelerations
- few or no accelerations

Histogram of heart rates

Heart Rate Characteristics index (HRCi)

- Raw data from routine ECG monitoring
- Captures characteristics pattern of HR changes
- Numerical score derived from a mathematical model
- Signifies the fold rise in the risk of clinical deterioration in the following 6-24 hours
- HRCi display to clinicians - reduced mortality in VLBW infants

HRCi Display

5 Days HRC index

Current HRCi: 0.44

30 minutes heart rate
HRCi Spikes

- Sepsis / NEC
- Respiratory deterioration
- Surgery
- Drugs
- Intracranial haemorrhage
Hypothesis

HRCi can predict the outcome of a clinical decision to extubate a neonate from mechanical ventilation either before or shortly after the extubation.
Methods

• Pilot retrospective single centre cohort study
• All ventilated infants: June 2014 and January 2015
• Intubation-extubation episodes identified
• Cases (reintubation within 72 hours) compared with controls (successful extubation)
• Multinomial mixed regression analysis to test for independent confounding variables
Methods

Extubation

- Hourly HRCi scores
  - 6 hours or from intubation, if within 6 hours
  - Mean pre-extubation epoch - BASELINE

- Hourly HRCi scores
  - 72 hours or until re-intubation
  - Mean Epoch 1
  - Mean Epoch 2
  - Mean Epoch 3
## Demographics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cases</th>
<th>Controls</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of episodes</td>
<td>18</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>Gestation (median)</td>
<td>26</td>
<td>29</td>
<td>0.002</td>
</tr>
<tr>
<td>Birth weight in grams (median)</td>
<td>950</td>
<td>1330</td>
<td>0.008</td>
</tr>
<tr>
<td>Males</td>
<td>10 (56%)</td>
<td>49 (62%)</td>
<td>0.60</td>
</tr>
<tr>
<td>Positive blood cultures</td>
<td>6 (33.3%)</td>
<td>3 (3.8%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Maximum CRP</td>
<td>7</td>
<td>5</td>
<td>0.521</td>
</tr>
<tr>
<td>Maximum WCC</td>
<td>16.5</td>
<td>16</td>
<td>0.993</td>
</tr>
<tr>
<td>Antibiotic treatment duration in hours</td>
<td>48</td>
<td>48</td>
<td>0.244</td>
</tr>
<tr>
<td>Clinically suspected sepsis</td>
<td>9 (50%)</td>
<td>23 (29%)</td>
<td>0.102</td>
</tr>
<tr>
<td>Necrotising enterocolitis</td>
<td>1 (5.6%)</td>
<td>0</td>
<td>0.186</td>
</tr>
<tr>
<td>Grade III-IV intraventricular haemorrhage</td>
<td>0</td>
<td>2 (2.5%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Use of post-natal steroids</td>
<td>0</td>
<td>3 (3.8%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Use of inotropes</td>
<td>1 (5.6%)</td>
<td>5 (6.3%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Use of muscle relaxants (not peri-intubation drugs)</td>
<td>1 (5.6%)</td>
<td>1 (1.3%)</td>
<td>0.338</td>
</tr>
<tr>
<td>Ventilation duration in hours</td>
<td>65.29</td>
<td>38.42</td>
<td>0.046</td>
</tr>
</tbody>
</table>
HRCi Scores

HRCi absolute values

Fold Changes from baseline
Peri-extubation changes

Baseline HRCi scores

Epoch 1 - Fold Changes from baseline
## Usefulness

### Pre-extubation baseline HRCi

<table>
<thead>
<tr>
<th>Positive test threshold</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 1</td>
<td>89 (65 – 99)</td>
<td>53 (41 – 64)</td>
<td>30 (18 – 44)</td>
<td>95 (84 – 99)</td>
</tr>
<tr>
<td>≥ 2</td>
<td>39 (17 – 64)</td>
<td>78 (67 – 87)</td>
<td>29 (13 – 51)</td>
<td>85 (74 – 92)</td>
</tr>
<tr>
<td>≥ 3</td>
<td>11 (1 – 35 )</td>
<td>95 (87 – 99)</td>
<td>33 (4 – 78)</td>
<td>82 (73 – 89)</td>
</tr>
</tbody>
</table>

### Post-extubation Epoch 1 Fold Changes from baseline

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 1</td>
<td>72 (47 – 90)</td>
<td>59 (47 – 70)</td>
<td>29 (16 – 44)</td>
<td>90 (79 – 97)</td>
</tr>
<tr>
<td>≥ 2</td>
<td>97 (91 – 99)</td>
<td>81 (71 – 88)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Regression analysis

Independent risk factors:

- Baseline HRCi score
- Post-extubation epoch 1 fold-changes
- Culture positive sepsis
Limitations

• Small sample size
• Single centre
• Wide gestation range – high extubation success
• No blinding possible
Conclusions

• Baseline and post-extubation HRCi were significantly different between cases and controls
• HRCi had poor PPV for extubation failure
• Low baseline HRCi and minimal changes post-extubation can add to the confidence of the clinician
• Culture proven sepsis remains a risk for extubation failure
• Further studies at different gestation groups required to establish usefulness
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