Pre-operative risk assessment, CPET update

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Consultant Teaching, March 2015
Summary

- Pre-operative risk assessment – vascular
- Evidence for CPET in pre-operative risk assessment – vascular
- CPET – info beyond the AT
Pre-operative risk assessment - vascular

- Risk of doing nothing; rupture risk and a mortality risk

- Risk of doing something; open repair V endovascular repair

- [https://sites.google.com/site/informrisk/](https://sites.google.com/site/informrisk/)
Evidence for CPET in pre-operative assessment - vascular

- Can CPET predict morbidity and length of stay after AAA repair in a group of unselected patients?
- Can CPET predict early post operative death following elective AAA repair?
- Can the introduction of a CPET-based risk-stratification strategy improve patient outcomes after elective AAA repair?
Can CPET predict morbidity and length of stay after AAA repair in a group of unselected patients?

- Submaximal exercise testing predicts perioperative hospitalization after aortic aneurysm repair.


- James M. Prentis, Michael I. Trenell, Dave J. Jones, Tim Lees, Mike Clarke, and Chris P. Snowden
## EVAR v OPEN

<table>
<thead>
<tr>
<th></th>
<th>EVAR (n=101)</th>
<th>OPEN (n=84)</th>
<th>(P&lt;.0001)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major post-op complications</td>
<td>10%</td>
<td>32%</td>
<td></td>
</tr>
<tr>
<td>Mean hospital LoS (SD)</td>
<td>5.7 (9.3)</td>
<td>14.4 (10.9)</td>
<td></td>
</tr>
<tr>
<td>Complications</td>
<td>None</td>
<td>Some</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28.1 [24]</td>
</tr>
</tbody>
</table>
OPEN repair

• AT was a significant independent predictor variable for the presence or absence of postoperative complications

• ROC analysis showing $10.0\text{ml/min/kg}$ to be the optimal AT for predicting those at risk of an increased rate of post operative complications

• Area under the curve of $0.75$
OPEN: Unfit v Fit; length of stay

Critical care

- Unfit population: median 4.1 days (CI 1.6 - 6.5); mean 6.4 days
- Fit population: median 1.2 days (CI 1.0 - 1.4); mean 2.4 days

Chi squared 9.44; $p=0.002$

Total hospital

- Unfit population: median 16 days (CI 8.5 - 23.5); mean 23.1 days
- Fit population: median 8 days (CI 7.1 - 8.9); mean 11.0 days

Chi squared 9.44; $p<0.0001$
# Outcomes after OPEN

<table>
<thead>
<tr>
<th>Complications No. (%)</th>
<th>All</th>
<th>Unfit n=27</th>
<th>Fit n=57</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory</td>
<td>13</td>
<td>8 (30)</td>
<td>5 (9)</td>
<td>.02</td>
</tr>
<tr>
<td>Renal</td>
<td>10</td>
<td>8 (30)</td>
<td>2 (3.5)</td>
<td>.001</td>
</tr>
<tr>
<td>Cardiac</td>
<td>7</td>
<td>5 (18.5)</td>
<td>2 (3.4)</td>
<td>.03</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>4</td>
<td>3 (11)</td>
<td>1 (2)</td>
<td>.09</td>
</tr>
<tr>
<td>Graft</td>
<td>3</td>
<td>2 (7)</td>
<td>1 (2)</td>
<td>.6</td>
</tr>
<tr>
<td>Wound</td>
<td>2</td>
<td>2 (7)</td>
<td>0</td>
<td>.1</td>
</tr>
<tr>
<td>Neurological</td>
<td>2</td>
<td>1 (4)</td>
<td>1 (2)</td>
<td>5</td>
</tr>
</tbody>
</table>
Can CPET predict early death following elective AAA repair? 2012

- Preoperative cardiopulmonary exercise testing and risk of early mortality following abdominal aortic aneurysm repair.

- British Journal of Surgery 2012

Can CPET predict early death following elective AAA repair? 2014

- Cardiopulmonary exercise testing and survival after elective abdominal aortic aneurysm repair.

- British Journal of Anaesthesia 2014

High risk patients:

- AT <10.2ml/min/kg
  - Snowden et al. *Ann Surg* 2010; 251:535-541

- Peak VO2 <15ml/min/kg

- VE/VCO2 >42
## EVAR v OPEN

<table>
<thead>
<tr>
<th></th>
<th>EVAR</th>
<th>(%)</th>
<th>OPEN</th>
<th>(%)</th>
<th>(P) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=329)</td>
<td></td>
<td>(n=179)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>75</td>
<td></td>
<td>70.5</td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td>171 (52.3)</td>
<td></td>
<td>56 (31.3)</td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Supra/juxtarenal AAA</td>
<td>13 (4.0)</td>
<td></td>
<td>46 (25.7)</td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>AT (&lt;10.2\text{ml/min/kg})</td>
<td>186 (56.9)</td>
<td></td>
<td>55 (30.7)</td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Peak VO2 (&lt;15\text{ml/min/kg})</td>
<td>189 (57.8)</td>
<td></td>
<td>66 (36.9)</td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>&gt;2 subthreshold CPET values</td>
<td>164 (50.2)</td>
<td></td>
<td>49 (27.4)</td>
<td></td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Independent predictors of mortality outcomes

- 30-day mortality: AT<10.2 ml/kg/min
- 90-day mortality: peak VO2<15 ml/kg/min
- Survival: peak VO2<15 ml/kg/min and VE/VCO2 at AT of >42
Can the introduction of a CPET-based risk-stratification strategy improve patient outcomes after elective AAA repair?

- Risk stratification by pre-operative cardiopulmonary exercise testing improves outcomes following elective abdominal aortic aneurysm surgery: a cohort study

- Perioperative Medicine 2013

After stratifying the patients

<table>
<thead>
<tr>
<th>Total no. (%)</th>
<th>Before 2007</th>
<th>After 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median length of stay</td>
<td>128 control</td>
<td>230 subjects</td>
</tr>
<tr>
<td>EVAR</td>
<td>25 (19.5)</td>
<td>69 (40.8)</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>OPEN</td>
<td>103 (80.5)</td>
<td>100 (59.2)</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Conservative</td>
<td></td>
<td>61</td>
</tr>
</tbody>
</table>
## 30 day mortality in Open repair

<table>
<thead>
<tr>
<th>Stratification (n)</th>
<th>30 day mortality (%)</th>
<th>Odds ratio</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-CPET (103)</td>
<td>12.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPET era (100) Total</td>
<td>4.0</td>
<td>0.29</td>
<td>P &lt;0.05</td>
</tr>
<tr>
<td>CPET pass (74)</td>
<td>2.7</td>
<td>0.19</td>
<td>P &lt;0.05</td>
</tr>
<tr>
<td>CPET fail (8)</td>
<td>12.5</td>
<td>0.989</td>
<td>P =1.00</td>
</tr>
<tr>
<td>CPET sub-max (3)</td>
<td>33.3</td>
<td>2.31</td>
<td>P =0.43</td>
</tr>
<tr>
<td>No-CPET (15)</td>
<td>0</td>
<td>0.18</td>
<td>P =0.21</td>
</tr>
</tbody>
</table>
Survival: Conservative v Pre-CPET

**b**  
Survival Data: pre-CPET EVAR vs conservatively managed CPET-era patients

**C**  
Survival Data: pre-CPET OPEN vs conservatively managed CPET-era patients
Conclusions from the published evidence

- There is evidence that CPET can be used for risk stratification.
  - survival benefit of intervention
  - length of stay; critical care and in total
  - Likelihood of complications
  - Pre-intervention optimisation
CPET – info beyond the AT

- Anaerobic threshold – AT
- MVO₂ / peakVO₂
- Ventilatory equivalents for CO₂ at AT – VE/VCO₂
Work-rate/VO₂ relationship

- Linearity and consistency
- For normal subjects 10.3ml/min/w
- Rigid physiological coupling
O2 pulse – stroke volume

- Dividing instantaneous oxygen uptake by the heart rate.
AT 11.9, MVO2 15.5, VE/VCO2 30.7

Work-rate/VO2

O₂ pulse
AT 13.2, MVO2 18, VE/VCO2 32.1

Work-rate/VO2  O2 pulse
AT 9.5, MVO2 9.8, VE/VCO2 35

Work-rate/VO₂

O₂ pulse
AT 8.9, MVO2 13.2, VE/VCO2 28

Work-rate/VO2

O2 pulse
AT 8.3, MVO2 13.8, VE/VCO2 48

Work-rate/VO₂

O₂ pulse
Questions?