Autonomic cardiovascular control in Paralympic athletes with spinal cord injury

Christopher R. West, Shirley C Wong & Andrei V Krassioukov
Sympathetic NS
Parasympathetic NS

Cortex
Hypothalamus
Medulla

Chest and blood vessels of the upper extremity

Gut and blood vessels of the lower extremity

- Heart rate
- Blood pressure
- Venous return & stroke volume
- Cardiac output
- Temperature

Krassioukov et al., (2009); Resp. Neurobiol & Physiol; 157-164
Cardiovascular function during exercise

Thijssen et al. (2009)

Dela et al. (2003)

West et al., under review
Autonomic cardiovascular control and exercise performance

West et al. (2013) Medicine and Science in Sport & Exercise; Feb;45(2):261-7
Interim summary

• Spinal cord injury elicits a lesion-dependent impairment in resting cardiovascular function
• Paralympic athletes with cervical/high-thoracic SCI exhibit impaired cardiovascular control during exercise
• Markers of exercise performance are accurately predicted by the degree of remaining autonomic control after SCI
Autonomic control in Paralympic athletes with SCI – Lessons from the London2012 Paralympics

• **Sample:** 57 Paralympic athletes from 14 countries with chronic SCI (C2-L2) were recruited

• **Location:** Cardiovascular Health Clinic at the London2012 Paralympics
Methods

• Neurological evaluation
• Blood pressure response to sit-up
• Autonomic function via sympathetic skin response
Results
Results

<table>
<thead>
<tr>
<th>Level of Injury</th>
<th>B</th>
<th>SE</th>
<th>CI (L, U)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>T6-L2</td>
<td>Ref</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1-T5</td>
<td>−6.8</td>
<td>4.9</td>
<td>−16.6, 3.0</td>
<td>0.135</td>
</tr>
<tr>
<td>C6-C8</td>
<td>−18.3</td>
<td>5.7</td>
<td>−28.0, −6.1</td>
<td>0.003</td>
</tr>
<tr>
<td>C2-C5</td>
<td>−26.9</td>
<td>5.8</td>
<td>−36.8, −13.1</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**SSR score**

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>SE</th>
<th>CI (L, U)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-5</td>
<td>Ref</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-3</td>
<td>−7.6</td>
<td>4.9</td>
<td>−17.6, 2.3</td>
<td>0.130</td>
</tr>
<tr>
<td>0-1</td>
<td>−12.9</td>
<td>5.9</td>
<td>−24.7, −1.0</td>
<td>0.035</td>
</tr>
</tbody>
</table>

West et al. (Under review) Medicine and Science in Sport & Exercise
## Results

<table>
<thead>
<tr>
<th></th>
<th>Autonomic Complete</th>
<th>Autonomic Incomplete</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total sample (n=44)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor/Sensory Complete</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Motor/Sensory Incomplete</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td><strong>Cervical only (n=21)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor/Sensory Complete</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Motor/Sensory Incomplete</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td><strong>Thoracic only (n=24)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor/Sensory Complete</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Motor/Sensory Incomplete</td>
<td>0</td>
<td>15</td>
</tr>
</tbody>
</table>

Autonomic completeness of injury agrees with neurological completeness of injury < 50% of the time
Implications for athlete health

Krassioukov et al., (2009); Resp. Neurobiol & Physiol; 157-164
Conclusion

• We demonstrate for the first time that assessment of lesion-level and autonomic completeness of injury provides the optimal combination to identify those at risk of abnormal cardiovascular control after SCI.

• We also demonstrate for the first time that SCI-induced differences in autonomic cardiovascular control are not reflected in the current clinical classification of Paralympic athletes.

• These findings suggest that more attention should be directed towards autonomic classification within wheelchair sports.
Acknowledgements

Research Team

Prof Andrei Krassioukov
Jacquelyn Cragg
Melissa Pak
Shirley Wong
Dmitri Krassioukov-Ens

Members of the IPC SSC

Dr Peter Van de Vliet
Dr Yves Vanlandewijck
Dr Walt Thompson
Greg Vice

Funding

CRAIG H. NEILSEN FOUNDATION
icord

All of the athletes, coaches and translators