EXPLORING AEROBIC FITNESS TO REDUCE RISK OF HYPOBARIC DECOMPRESSION SICKNESS

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INTRODUCTION
Decompression sickness (DCS) is multivariable. We hypothesize an aerobically “fit” person is less likely to experience hypobaric DCS than an “unfit” person given that fitness is exploited as part of the denitrogenation (prebreathe, PB) process prior to an altitude exposure. Aerobic fitness is peak oxygen uptake (VO2pk, ml/kg/min). METHODS: Treadmill or cycle protocols were used over 15 years to determine VO2pks. We evaluated dichotomous DCS outcome and venous gas emboli (VGE) outcome detected in the pulmonary artery with Doppler ultrasound associated with VO2pk for two classes of experiments: 11 exposures with no PB or resting conditions to ascertain in an altitude chamber, and 25 PB that included exercise for some part of the PB. There were 165 exposures (mean VO2pk 40.5 ± 23.6 ml/kg/min with 25 cases of DCS in the second. Similar incidence of the DCS (12.5% ± 14.5%) and VGE (48.5% ± 44.8%) (between the two classes indicates that denitrogenation process was similar). The strength of association between outcome and VO2pk was evaluated using univariate logistic regression. RESULTS: An inverse relationship between the DCS outcome and VO2pk was evident, but the relationship was stronger when exercise was done as part of the PB (exercise PB, coef. = -0.028, p = 0.07; rest or no PB, coef. = -0.025, p = 0.16). There was no relationship between VGE outcome and VO2pk (exercise PB, coef. = -0.030, p = 0.09 vs. rest or no PB, coef. = 0.046, p = 0.98). CONCLUSIONS: A significant change in probability of DCS was associated with fitness only when exercise was included in the denitrogenation process. We believe a fit person that exercises during PB efficiently utilizes nitrogen from tissues.

METHODS
Two general classes of experiments that include VO2pk information are available from the NASA Hypobaric Decompression Sickness Database.

165 exposures with 25 cases of DCS where no PB or PB under resting conditions was performed prior to ascent in an altitude chamber, and

172 exposures with 25 cases of DCS where exercise was performed during the PB prior to altitude.

TABLE 1: Summary of Information from Two Classes of Experiments about Hypobaric DCS

<table>
<thead>
<tr>
<th>VO2pk (ml/kg/min)</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>125</th>
<th>150</th>
<th>175</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>No PB</td>
<td>40.5 ± 23.6</td>
<td>47.2 ± 27.5</td>
<td>53.9 ± 22.1</td>
<td>61.6 ± 18.4</td>
<td>68.3 ± 14.7</td>
<td>75.0 ± 10.9</td>
<td>81.7 ± 7.2</td>
<td>88.4 ± 3.5</td>
</tr>
<tr>
<td>Resting PB</td>
<td>42.8 ± 25.9</td>
<td>49.5 ± 21.2</td>
<td>56.2 ± 16.8</td>
<td>62.9 ± 12.4</td>
<td>69.6 ± 8.1</td>
<td>76.3 ± 4.7</td>
<td>83.0 ± 2.3</td>
<td>89.7 ± 0.9</td>
</tr>
</tbody>
</table>

REFERENCES

Figure 1: Linear regression using 165 exposures where 25 of 165 exposures resulted in DCS (15.1%) after protocols that had no PB or PB under resting conditions (n = 0.028, p = 0.07; rest or no PB, n = 0.025, p = 0.16). There was no relationship between VGE outcome and VO2pk (exercise PB, n = 0.030, p = 0.09 vs. rest or no PB, n = 0.046, p = 0.98).

Figure 2: Linear regression using 172 exposures (185 from PRP and 7 from NASA) where 25 of 172 exposures resulted in DCS (14.5%) after PB protocols that included exercise during the PB where all subjects did not ambulate. Logistic regression coefficient for VO2pk was -0.095 with p-value of 0.001. Trade-offs in a "visual" inverse association between VO2pk and the DCS outcome.

Figure 3: Expression of signs and symptoms of decompression sickness (DCS) are dictated by many factors, both subject-specific and environmental.

Figure 4: Data from (6) shows modest inverse relationship between altitude DCS susceptibility and VO2max from 43 women and 130 men. Results apply to a combination of no PB, PB under resting conditions, or PB under exercise conditions, which may account for some of the variability. The SOR on the y-axis is a measure of DCS susceptibility, the greater the value the more susceptible the subject (see 6 for details).