EXPLOITING AEROBIC FITNESS TO REDUCE RISK OF HYPOBARIC DECOMPRESSION SICKNESS

J Conkin, ML Gernhardt, JH Wessell, III, National Space Biomedical Research Institute, Baylor College of Medicine, NASA Johnson Space Center, Wyle Laboratories, Life Sciences Systems & Services, Houston, Texas, USA 77058.

ABSTRACT

The prediction of signs and symptoms of decompression sickness (DCS) are dictated by many factors, both subject-specific and environmental.

Aerobic fitness, as VO2 peak (ml O2 / kg / min), may be linked with resistance to DCS and venous gas emboli (VGE) outcome. It is not possible to distinguish a “fit” person from an “unfit” person based on resting oxygen (O2) consumption, both consume about 3.5 ml / kg / min. So why should aerobic fitness be of any value during denitrogenation (prebreathe, PB) prior to ascent in an altitude chamber, and PB needed at the lower percentage of VO2pk, or some other combination if both fit and unfit persons are to have comparable DCS risk.

Hypothesis: Exercise during the PB is a necessary condition to understand if aerobic fitness is associated with hypobaric DCS and VGE outcomes.

RESULTS

The VO2pk for subjects who perform no PB or resting PB has no bearing on the DCS outcome as seen in Fig. 1, the slope is essentially zero.

Figure 1: Linear regression using 165 exposures where 25 of 165 exposures resulted in DCS (15.1%) after protocols that had no PB period or included rest during the PB where most subjects (75%) breathed at altitude. Logistic regression coefficient for VO2pk was 0.098 with a p-value of 0.869. In this chart, no particular "vascular" association between VO2pk and the DCS outcome.

However, if you exercise a percentage of your VO2pk during PB as a means to accelerate denitrogenation, it appears that (at all else is equal), you are at less risk for DCS if you are fit then if you are unfit, as seen in Fig. 2.

In the second, similar incident of the DCS (15.2% versus 14.9%) and VGE (46.5% versus 44.8%) between the two classes indicates that denitrogenation stress was the same. 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. = -0.058, p = 0.07; rest or no PB, coef. = -0.005, p = 0.86). There was no relationship between VGE outcome and VO2pk (exercise PB, coef. = -0.003, p = 0.88) or rest PB (coef. = 0.004, p = 0.90).

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 eliminates dissolved nitrogen from tissues.

METHODS

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

1. 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

2. 172 exposures with 25 cases of DCS where exercise was performed during the PB prior to altitude.

Table 1 shows summary information from the two classes of experiments done to understand more about hypobaric DCS

<table>
<thead>
<tr>
<th>VO2 peak (ml/kg/min)</th>
<th>25 29 33 37 41 45 49 53 57 61 65</th>
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<tbody>
<tr>
<td>%DCS</td>
<td>0.0 0.0 0.0 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3</td>
</tr>
<tr>
<td>%VGE</td>
<td>0.0 0.0 0.0 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3</td>
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Figure 2: Linear regression using 172 exposures (165 from PRP and 7 from NASA) where 25 of 172 exposures resulted in DCS (14.8%) after PB protocols that included exercise during the PB where all subjects did not ambulate at altitude. Logistic regression coefficient for VO2pk was 0.098 with a p-value of 0.007. Total subjects "vascular" inverse association between VO2pk and the DCS outcome.

An identical analysis performed on the dichotomous VGE outcome showed there was no association between VO2pk and incidence of VGE regardless if exercise was done during the PB.

Figure 3: Exploitation of exercise PB result from (2). Once "acceptable risk" is defined for a particular activity, then an exercise PB prescription is created based on VO2 peak.

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 OR on the y-axis is a measure of DCS susceptibility, the greater the value the more susceptible the subject (see 6 for details).

REFERENCES