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CARDIAC PARAMETER EXTRACTED DURING DEEP BREATHING AS A POTENTIAL SLEEP APNEA INDICATOR IN CONCORDIA STATION

Abstract

Future space missions may expose astronauts to hypobaric hypoxic conditions akin to high altitudes, intensifying existing concerns over astronauts' sleep disturbances. The Concordia station in Antarctica, situated at an equivalent altitude of 3800 meters, offers an ideal setting for such investigations. Previous research in Concordia showed a high incidence of periodic breathing and central apnea. While polysomnography is the standard for diagnosing sleep apnea, it may disturb normal sleep, it is expensive, and requires expertise. Recent studies have explored alternative diagnostic methods, including heart rate variability (HRV) during breathing cycles, showing promise in identifying sleep apnea, especially in cases of moderate to severe obstructive sleep apnea where lower respiratory HRV is observed during daytime. This study aims to assess the applicability of HRV in investigating sleep disturbances induced by hypobaric hypoxia.

Our study involved 9 male crew members assigned to a 12-month mission at the Concordia station. Electrocardiography data (500 Hz) was collected three months before the mission and in the 10th month

onsite. Participants followed a breathing protocol consisting of 10 cycles of 10-second breathing. HRV was measured as ΔHR, the difference between maximum and minimum heart rates within a respiratory cycle.

We examined the changes in ΔHR between baseline and the 10th month at Concordia, and against both sea-level participants and obstructive sleep apnea patients. Wilcoxon signed rank test was used for paired comparisons and Mann-Whitney test for unpaired comparisons, with a significance level of $p = 0.05$.

Although not significant ($p = 0.07$), 8 out of 9 subjects experienced a decrease in ΔHR after ten months at Concordia from (14.85[12.70; 21.75] bpm) to (12.47[10.10; 18.61] bpm). The sole participant exhibiting an increase in ΔHR also underwent substantial weight loss (12 kg), potentially influencing the results. Interestingly, even after 10 months in high altitude, participants' ΔHR remained higher than that of sleep apnea patients study (8.30[4.79; 10.84] bpm, $p = 0.018$) but similar to that of a control group at a sea-level Antarctic station (16.54[11.86; 22.31] bpm, $p = 0.275$).

Patients with obstructive sleep apnea have significantly lower ΔHR than subjects exposed to prolonged high-altitude with a high incidence of central apnea. We hypothesize that ΔHR is influenced by sleep disorders possibly due to an increase in sympathovagal balance. However, future studies should assess the correlations between ΔHR and other factors.