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EFFECTS OF IMPAIRED SLEEP ON THE AUTONOMIC NERVOUS SYSTEM AND HEART RATE VARIABILITY – A PILOT STUDY (ANSISS)

Abstract

Introduction: Impaired sleep is highly prevalent, especially due to irregular work shifts and extreme working conditions (e.g. astronauts). It influences the regeneration of the autonomic nervous system (ANS) and affects cognitive performance ability. A cooperation with the IBMP (Russian Institute of Biomedical Problems) was formed to identify a way to predict performance ability of astronauts after impaired sleep. As part of the ANSISS project (autonomous nervous system in sleep and space), we aimed to identify non-invasive ANS biomarkers that capture the effects of impaired sleep.

Methods: A study protocol, measuring ANS parameters with a portable non-invasive polygraphy system applicable in space was developed. It was pilot tested under sleep laboratory conditions with two sleep alterations: sleep restriction (5 hours sleep and 3 hours wake bedtime) and sleep fragmentation (8 hours sleep, light on every hour). Sixteen healthy male participants (397 years, BMI: 252 kg/m3) underwent both sleep interventions (each including a baseline with subsequent intervention night) in a randomized cross-over design. ANS parameters were recorded with the polygraphy system Somnotouch RESP. Parameters of the heart rate variability (including SDNN - standard deviation of normal to normal R-R intervals), blood pressure variability, and Kerdo Index (1-diastolic blood pressure/heart rate) were calculated. Recordings of paced breathing (12/minute) before bedtime and after 8 hours bedtime were compared (MED = morning-evening difference). During restriction night, a recording after being woken up was added.

Results: The mean SDNN showed a nighttime increase during all nights: mean SDNN-MED (fragmentation baseline) = 16.233.1ms, mean SDNN-MED (fragmentation night) = 10.824.3ms; mean SDNN-MED (restriction baseline) = 2.217.8ms, mean SDNN-MED (restriction night) = 22.026.7ms. During restriction night, the SDNN initially decreased before subsequently significantly increasing (p¡0.01): mean SDNN (evening) = 65.831.1, mean SDNN (waketime) = 64.429.4, mean SDNN (morning) = 87.838.6. Only during sleep restriction, the mean SDNN-MED was significantly higher than during baseline night (p¡0.05). Other autonomic parameters showed no significant changes.

Conclusion: Our pilot study revealed that the SDNN parameter of the heart rate variability may be a suitable ANS biomarker to capture effects of impaired sleep. The SDNN increase overnight indicates a positive ANS regeneration. The restriction night revealed a lack of increase after 5 hours of sleep with a compensated strong increase in the following three hours, showing that a sleep restriction has a strong need for recovery. Next, the study protocol will be applied in isolation experiments lasting several months and simulating a space mission.