IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Medicine in Space and Extreme Environments (4)

Author: Prof. Martina Anna Maggioni
Charité Universitätsmedizin Berlin, Germany

Dr. Mathias Steinach
Charité Universitätsmedizin Berlin, Germany
Prof. Alexander Christoph Stahn
Charité Universitätsmedizin Berlin, Germany
Dr. Oliver Opatz
Center for Space Medicine Berlin (ZWMB), Germany
Dr. Hannes Hagson
European Space Agency (ESA), United Kingdom
Prof. Simone Porcelli
University of Pavia, Italy
Dr. Stefan Mendt
Charité Universitätsmedizin Berlin, Germany
Prof. Hanns-Christian Gunga
Charité Universitätsmedizin Berlin, Germany

CIRCADIAN RHYTHMS ALTERATIONS DURING OVERWINTERING AT THE HIGH-ALTITUDE ANTARCTIC STATION CONCORDIA (CARDICORTEX PROJECT)

Abstract

Long-term isolation studies in Antarctica are considered a good terrestrial analogue for long duration space missions. In this frame, isolation and confinement are associated with extreme environmental conditions such as altered photoperiod (long-lasting darkness, the so-called polar nights during winter, i.e., days without sunrise), artificial /low illumination, and extreme cold. Additional factors might be for example hypobaric hypoxia, as for the Concordia Station (Dome C), located at 3233 m a.s.l. All these factors taken together act as stressors and can provoke physical, mental, and emotional strains, affecting mission success and safety. As upcoming deep space missions will expose astronauts to similar extreme conditions for months, possibly impairing physical ability, cognitive performance, and psychological wellbeing, it is of crucial importance to investigate adverse health effects for designing new countermeasures. Specifically, altered photoperiods are known to trigger changes in the day-night rhythm (circadian) of physiological functions, leading to serious health and cognitive consequences, which might be relevant especially for astronauts. This study (covering two missions, WO2022 and WO2023) focuses on non-invasive monitoring of biomarkers such as i) actimetry (continuously throughout the whole overwintering, ¿12 months), ii) monthly 36-hour core body temperature coupled with simultaneously iii) electrocardiography, as well as iv) nocturnal blood oxygen saturation and v) fitness level assessment. The aim is to assess circadian rhythm alterations during overwintering and investigate the additional effect of high-altitude (hypobaric hypoxia) as well as the interplay between core body temperature and the cardiovascular autonomic regulation. Understanding human circadian adaptation mechanisms and human resilience, provides fundamental reference to develop effective countermeasures for deep space missions. First data, collected during WO2022 (n=10 crew members), show that the number of steps per day is significant lower during polar nights, increasing with the hours of sunlight/day. Moreover, as sunlight decreases, participants wake up later

(linear mixed models, time course changes - p¡0.05), which corresponds to a shift in the lowest CBT value, occurring 1 hour later during polar nights. CBT and actimetry data independently show dramatic changes of crew members circadian rhythm and behavior during polar nights. To preserve health and cognitive function countermeasures are needed. Results of this study can provide key information to assess (individual) training protocols and further knowledge to clinicians working with diseases characterised by chronic hypoxia, stress, and early fatigue.

Funding: DLR Project number 50WB2117 (CardiCorTEx)