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# CHANGES IN SLEEP-WAKE RHYTHMS AND CREW COHESION DURING TWO 1-YEAR ANTARCTIC WINTER-OVER MISSIONS

**Abstract**

Exploration-type missions will require humans to live in isolated, confined, and extreme environments for prolonged periods of time. Antarctic research stations are considered a high-fidelity ICE analog for long-duration space missions (LDSM). We investigated N=13 and N=12 crew overwintering in the French-Italian Antarctic station Concordia in 2015 and 2016, respectively. During the winter-over, the Concordia crew continuously wore actigraphs (Actigraph Link, Pensacola, FL) that recorded wrist movements and were used to infer activity levels in addition to times spent sleeping and awake. The actigraphs also had a proximity feature, i.e., they were able to detect other devices (either worn by other crewmembers or strategically placed across the station) via Bluetooth and log the time and signal strength. 17 crew

members wore the actigraph consistently throughout the mission and contributed to the sleep analyses. Mean 24 h time in bed (7.41 h +/- 0.10 h) and mean 24 h total sleep time (6.46 h +/- 0.11 h) stayed relatively stable across the mission, with >90% of sleep obtained between 9 PM and 9 AM. Sleep efficiency averaged 84.9% +/- 0.9% throughout the mission with no significant linear trend across the mission (p=0.13). Most crewmembers stayed entrained to the 24 h day throughout the winter-over period, but 5 crewmembers showed variable sleep-wake timing while another 5 regularly napped during the daytime. The crew spent most of their time awake in light and moderate activity states, with a tendency of more sedentary behavior during the Antarctic winter. Periodic breathing was commonly observed during sleep. Crew proximity measurements were used as a surrogate measure of crew cohesion. N=21 crew wore the watch enough during the daytime to contribute to the analysis. With this technology, we were able to identify systematic changes in crew cohesion with time in mission, which showed a declining trend in the 2015 crew, and a lower but stable trend in the 2016 crew. Factor analysis was used to identify crew subgroups that spent a lot of time together, and how each individual contributed to subgroup and overall crew cohesion. Finally, we found systematic trends in how the facility was used by time of day and across the mission. For example, sensors placed in the gym revealed differences in exercise patterns between individual crewmembers. Overall, this unobtrusive technology provided a lot of relevant information both in the social-behavioral and in the sleep-wake domain considered critical for the success of LDSM.