

EFFECTS OF TIME IN MISSION: ISS ASTRONAUTS RATINGS OF STRESSD. F. Dinges¹, M. Basner¹, D. J., Mollicone², C. W. Jones¹, A. J. Ecker¹, R. Bartels², C. Mott²¹Division of Sleep and Chronobiology, Department of Psychiatry, University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, USA; ²Pulsar Informatics Inc., Philadelphia, PA, USA**INTRODUCTION**

Astronauts on the International Space Station (ISS) must manage the stressors of space flight, which can include working at a high level for long periods, experiencing altered sleep, and coping with a range of physical and psychological reactions to living in microgravity. Because exploration spaceflight will require missions even longer than the current 6-month stays on ISS, there is a need to identify whether the chronic effects of stressors across time in mission produce cumulative or escalating behavioral and biomedical risks for astronauts. Recent findings from the Mars 500 analog study of isolation and confinement for 17 months indicated that time in mission was associated with cumulative increases in adverse neurobehavioral responses [1] and stress in some individuals [2]. To inform the question of whether time in mission in microgravity is associated with increasing stress, we analyzed astronauts' ratings of their stress levels, and other indications of negative neurobehavioral reactions, as a function of time in mission during 6-month stays on ISS.

METHODS

Data were derived from the Reaction Self Test (RST), which was developed by the authors via support from the NSBRI through NASA NCC 9-58. RST software is located on ISS SSCs, which permits astronauts to make rapid psychometric ratings of their levels of perceived stress, mental fatigue, physical exhaustion, workload, tiredness, and sleep quality using visual analog scales (VAS), and to record their sleep timing. In addition, the RST includes a brief (3-min.) Psychomotor Vigilance Test (PVT-B) that is validated to be sensitive to sleep loss [3]. The RST study is assessing, among other factors, the effects of time-in-mission in N = 24 astronauts throughout their 6-month ISS missions. RST data acquisition is scheduled to occur every 4 days (once in the AM and once in the PM) throughout each mission, and more frequently during slam shifts and EVAs. The study is over 75% complete and consequently the results reported here are preliminary until data acquisition and analyses are finalized.

RESULTS

For purposes of this report, analyses focused on astronauts' ratings of stress. Data provided by the first N = 15 astronauts studied resulted in 1,055 stress ratings throughout 6-month ISS missions. Ratings were averaged by mission quarter (45 days), and mixed model analyses were used to analyze the effect of time in mission. Astronauts' ratings of their stress levels increased systematically in the third and fourth quarters of 6-month ISS missions ($p < 0.0001$). Correlational analyses between stress ratings and days in mission for each individual astronaut revealed that N = 8 astronauts had significant positive correlations (i.e., stress ratings increased with time in mission [ranges: $r = 0.223$ to 0.639 ; $p = 0.03$ to $p = 0.0001$]), while N = 3 astronauts had significant negative correlations between stress ratings and time in mission. Astronauts who had higher stress ratings across time in mission, also had greater physical exhaustion ($\rho = 0.547$, $p = 0.028$) and less sleep ($\rho = -0.692$, $p = 0.004$). Physical exhaustion was also negatively related to sleep quality ($\rho = -0.797$, $p = 0.0002$) and positively to tiredness ($\rho = 0.805$, $p = 0.0002$).

CONCLUSIONS

Astronauts perceived their stress levels as higher in the second half of 6-mo. ISS missions, and especially in the fourth quarter. While perceived stress increased reliably with time in mission in more than half of the astronauts, others showed either no relationship, or a negative relationship, suggesting phenotypic stress vulnerability to time in mission. Reduced sleep time and poorer sleep quality appeared to contribute to stress in space, and consistent with this were elevated ratings of physical exhaustion and tiredness in those most stressed inflight. This suggests that sleep and other effects of microgravity and the space environment may collectively contribute to the stress burden. There is a need to identify astronauts most vulnerable to stress with time in mission, the factors that contribute to the stress, and the extent to which it reflects a cumulative (allostatic) burden on astronaut health and performance.

REFERENCES

[1] Basner M., Dinges D.F., et al. (manuscript in review). [2] Basner M., Dinges D.F., et al. (2013) *Proc Nat Acad Sci USA* 110, 2635-2640. [3] Basner M., Mollicone D., Dinges D.F. (2011) *Acta Astro* 69, 949-959.

FUNDING

NASA NNX08AY09G