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AN EXPLORATION OF HOW THE RELATIONSHIP BETWEEN THE GLYMPHATIC SYSTEM,
SLEEP, AND CIRCADIAN RHYTHM IN THE MICROGRAVITY ENVIRONMENT MAY IMPACT
NEURAL COGNITION AND NEURODEGENERATIVE DISEASE IN CREWED SPACEFLIGHT.

Abstract

As the duration of crewed spaceflight continues to increase, it is crucial to understand the risks to normal health and performance by extended exposure to the microgravity environment. This paper focuses on the relationship between the glymphatic system, sleep, and circadian rhythms in the microgravity environment.

The glymphatic system is thought to serve two key functions: the provision of some nutrients to neural tissue, and the removal of waste products. The accumulation of some of these waste products, particularly proteins, has been identified as a pathological hallmark of some neurodegenerative diseases.

The function of the glymphatic system is intimately linked to sleep. Past studies of spaceflight crews have shown that the microgravity environment can induce a shift in both circadian rhythm and sleeping habits. Furthermore, the system is dependent on certain physiologic factors, including interstitial and circulatory pressures. Microgravity has been shown to induce changes in circulatory volume; an effect of this is a cephalad fluid shift that may raise intracranial pressure. By changing the quality and quantity of sleep, and by altering human physiology, microgravity may pose a threat to the sound functioning of the glymphatic system. An alteration to glymphatic function may also affect the quality and quantity of sleep. The overall result may be a decrease in crew neural cognition, and may predispose crews to neurodegenerative disease.

This paper reviews the available literature to better describe the relationship between the glymphatic system, sleep, and circadian rhythms in the microgravity environment. It offers a view of the possible clinical sequelae, and suggests what steps might be taken to resolve the underlying issues.