How Reactivation of SARS-CoV-2 in Astronauts with Dysregulated Immune System Can Affect the Chance of Success of the Future Space Missions

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ABSTRACT

We have previously reported that during future space missions the risk of severe COVID-19 infection will be a cardinal issue that needs careful attention. Our studies show that even with the most reliable pre-mission screening and quarantine strategies, astronauts with a latent (hidden, inactive, or dormant) SARS-CoV-2 infection might be sent to space. Given this consideration, an asymptomatic individual with dormant SARS-CoV-2 infection may successfully pass all the pre-launch medical tests. Then during a space mission such as a journey to Mars or beyond, when the immune system of these astronauts starts to weaken, the dormant infection may progress to a severe infection that possibly affects the chance of the mission's success. The effects of microgravity and the elevated space radiation are two key factors that should be evaluated. Furthermore, the limited size of the spacecraft, the proximity of crew members during flight operations, spacecraft atmospheric composition, limited exercise capability, effects of viral response to space radiation, and uncertainty in the likelihood of the virus to mutate and evolve during a space mission merit additional study.

Keywords

COVID-19; SARS-CoV-2; Space; Reactivation; Infections

Introduction

Although it seems that current medical tests and clinical monitoring procedures such as pre-launch quarantine can decrease the risk of infectious disease (e.g. COVID-19), during the flight, the issue of immune system dysregulation and astronauts' increased vulnerability to infectious disease may seriously affect the health and safety of astronauts. We have previously reported that the risk of severe COVID-19 infection during future space missions is a cardinal issue that needs careful attention [1, 2]. Our studies show that even with the most reliable pre-mission screening and quarantine strategies, astronauts with a latent (hidden, inactive, or dormant) SARS-CoV-2 infection can be sent to space (Figure 1). While some early studies reported the rate of asymptomatic infections as high as 81% [3], a more recent meta-analysis that included 13 studies involving 21,708 individuals reported asymptomatic presentation in 17% of the population [4]. Given this consideration, when there is a dormant infection in these individuals, not only are they not aware of their infection, but also it is likely that they will successfully pass all the pre-launch medical tests.

The findings of new studies clearly support the key idea discussed in

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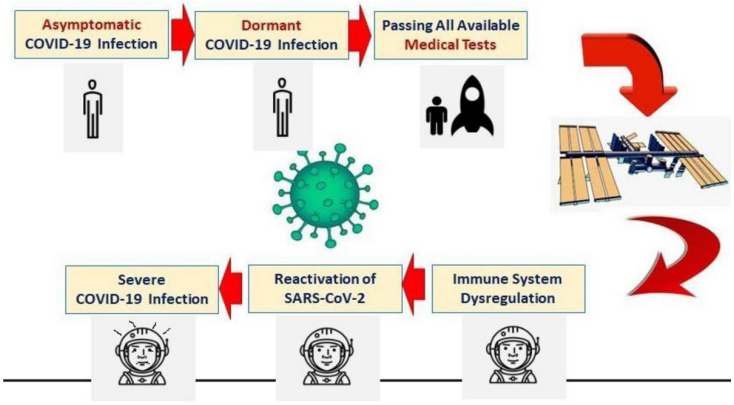

Figure 1: An asymptomatic individual with dormant SARS-CoV-2 infection may successfully pass all the pre-launch medical tests. During a space mission, when the immune system of this astronaut starts to weaken, the dormant infection may progress to a severe infection that possibly affects the chance of the mission success. [image credit: https://thenounproject.com By João Miranda, GB; AnsteyDesign, CA; and Sergey Demushkin, RU].

our in press paper "Can Reactivation of SARS-CoV-2 Decrease the Chance of Success of Future Deep Space Missions?" A recent study shows that among 109 patients, 29 (27%) experienced reactivation, and seven (24%) of these were symptomatic [5]. Therefore, during a space mission, when the immune system starts to weaken due to radiation, microgravity, disturbed circadian rhythm, confinement, and isolation, a dormant infection may progress to a severe infection. This issue is of crucial importance because it directly affects the chance of success of any space mission. Further studies are warranted to clarify different aspects of SARS-CoV-2 reactivation in space.

The application of terrestrial astronaut health data and its implications for space flight merits careful review and assessment. The effects of low gravity and the elevated radiation environment of space are factors that should be evaluated. In addition, the limited size of the spacecraft, proximity of crew members during flight operations, spacecraft atmospheric composition, limited exercise capability, effects of viral response to radiation, and uncertainty in the likelihood of the virus to mutate within a spacecraft environment merit additional study. Moreover, the results of the study conducted by Chen et al. [5] uggest the potential risk of crew illness if their symptoms are missed during a terrestrial physical exam must not be underestimated.

Conflict of Interest

None

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