# Scientists use heart and lung model to calculate potential health threats facing future space tourists in microgravity

June 21 2024, by Dr. Lex van Loon

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Space exploration has always captivated our imagination, offering the promise of discovering new worlds and pushing the boundaries of human capability. As commercial space travel becomes more accessible, individuals with various underlying health conditions—including heart failure—may soon be among those venturing beyond Earth's atmosphere.

This raises critical questions about the impact of space travel on humans with potential underlying health problems. Recent research, "Computational modeling of heart failure in microgravity transitions," delves into this issue, offering insights that could shape the future of space travel.

## Why study heart failure in space?

The demographic of commercial space travelers is shifting, increasingly including older, wealthy individuals who may not be in optimal health. Unlike professional astronauts, these space tourists typically do not undergo rigorous health screenings or physical training. This shift necessitates a broader consideration of health conditions, such as heart failure, diabetes, and other chronic illnesses, in space mission planning.

Heart failure alone affects over 100 million people globally. Traditionally, space medicine has focused on the effects of microgravity on healthy astronauts. However, the inclusion of non-professional astronauts with preexisting health conditions demands a deeper understanding of how microgravity impacts these individuals. The unique cardiovascular challenges posed by space travel could significantly affect heart failure patients, making this an essential area of study.

Furthermore, heart failure is not a uniform condition and can be broadly categorized into two types. One type involves a weakened heart that cannot pump blood effectively, while the other is characterized by the heart's inability to relax and fill properly. These differences mean that each type of heart failure presents unique challenges and must be studied separately to understand the specific risks and required countermeasures in a microgravity environment.

## The challenges of microgravity

In the microgravity environment of space, the human body undergoes significant changes. One of the most notable effects is the redistribution of bodily fluids, causing what is commonly known as 'puffy face bird leg' syndrome. Imagine a person with a swollen, puffy face paired with skinny, almost comically thin legs—like a bird, what's in the name.

This fluid shift results in reduced venous pooling in the legs and increased venous pressure in the upper body. For healthy individuals, the cardiovascular system can adapt to these changes, but for heart failure patients, the risks are substantially higher.

## Using computational models to simulate space conditions

Given the lack of real-world data on heart failure patients in space, researchers turned to computational modeling to simulate the effects of microgravity. They used their previously published 21-compartment mathematical model of the cardiovascular system. By tuning the parameters of this model, they were able to predict how heart failure patients might respond during space travel with a high degree of accuracy.

The simulations revealed that entry into microgravity increases cardiac output in all individuals. However, for heart failure patients, this increase in cardiac output is accompanied by a dangerous rise in left atrial pressure, which can lead to pulmonary edema—a condition where fluid accumulates in the lungs, making it difficult to breathe. The work has been published in *Frontiers in Physiology*.

## The path forward

This research underscores the need for comprehensive health screenings and personalized medical plans for space tourists with underlying health conditions. As commercial space travel becomes more accessible, ensuring the safety of all passengers, especially those with chronic health conditions like heart failure, is paramount.

Moreover, the findings highlight the importance of further research into the long-term effects of space travel on cardiovascular health. Future studies should focus on the prolonged exposure to microgravity and the cumulative impact of comorbidities in heart failure patients.

## The role of human digital twins

One promising avenue for future research and safety in space travel is the development of human digital twins. A human digital twin is a highly detailed virtual model of an individual's physiological systems. By creating these digital replicas, the investigators can simulate various scenarios and predict how different conditions, such as microgravity, might affect an individual's health. This approach allows for personalized risk assessments and tailored countermeasures.

For heart failure patients, a digital twin could simulate how their specific heart condition would respond to the stresses of space travel. This personalized model could help identify the most effective pre-flight preparations and in-flight interventions, thereby enhancing the safety and well-being of space tourists with heart conditions.

The dream of space travel is closer than ever, but with it comes the responsibility to understand and mitigate the health risks associated with this new frontier.

The computational modeling provides a critical step toward ensuring that space travel is safe for everyone, including those with heart failure. As people continue to push the boundaries of exploration, integrating advanced technologies like human digital twins will be crucial in protecting the health and well-being of all who venture into the final frontier.

**More information:** Computational modeling of heart failure in microgravity transitions, *Frontiers in Physiology* (2024). DOI: 10.3389/fphys.2024.1351985. www.frontiersin.org/journals/p … ys.2024.1351985/full

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