Study reveals immune system is dazed and confused during spaceflight

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European Space Agency astronaut Andre Kuipers, Expedition 30 flight engineer, prepares vials in the Columbus laboratory of the International Space Station for venous blood sample draws during an immune system investigation. Credit: NASA

There is nothing like a head cold to make us feel a little dazed. We get things like colds and the flu because of changes in our immune system. Researchers have a good idea what causes immune system changes on Earth—think stress, inadequate sleep and improper nutrition. But the

results of two NASA collaborative investigations—Validation of Procedures for Monitoring Crewmember Immune Function (Integrated Immune) and Clinical Nutrition Assessment of ISS Astronauts, SMO-016E (Clinical Nutrition Assessment)—recently published in the *Journal of Interferon & Cytokine Research* suggest that spaceflight may temporarily alter the immune system of crew members flying long duration missions aboard the International Space Station. This is of concern as NASA looks ahead to six-month and multiple-year missions to asteroids, the moon and Mars because something as simple as a cold or the flu can be risky business in space.

Data generated early in NASA's Integrated Immune study indicated that the distribution of immune cells in the blood of crew members aboard the space station is relatively unchanged during flight. However, they also revealed that some cell function is significantly lower than normal, or depressed, and some cell activity is heightened. In a sense, the immune systems of crew members are confused.

When cell activity is depressed, the immune system is not generating appropriate responses to threats. This may also lead to the asymptomatic viral shedding observed in some crew members, which means latent, or dormant, viruses in the body reawaken, but without symptoms of illness. When activity heightens, the immune system reacts excessively, resulting in things like increased allergy symptoms and persistent rashes, which have been reported by some crew members.

"Prior to the Integrated Immune study, little immune system in-flight data had been collected," said Brian Crucian, Ph.D. and NASA biological studies and immunology expert. "Previous post-flight studies were not enough to make any determination about spaceflight's effect on the immune system. This in-flight data provided the information we needed to determine that immune dysregulation does occur and actually persists during long-duration spaceflight."

Japan Aerospace Exploration Agency astronaut Akihiko Hoshide, Expedition 32 flight engineer, poses for a photo after undergoing a generic blood draw in the European Laboratory/Columbus Orbital Facility. International Space Station crew members routinely perform blood draws for investigations like the Integrated Immune and recent cytokines study. Credit: NASA

Recently, in a collaboration between NASA's Integrated Immune and Clinical Nutrition Assessment flight studies, researchers examined the blood plasma of 28 crew members before, during and after their missions. They were measuring for the concentration of cytokines – the proteins that regulate immunity. Cytokines recruit immune cells to the infected or injured body site, facilitate cell-to-cell communication, and signal immune cells to activate and mount a defense against invaders. This process is usually referred to as inflammation. The data indicated that, like the changes in cell function indicated in the Integrated Immune study, crew members also have changes in blood cytokines that persist

during flight. This gives researchers an idea of what areas of a crew member's immune system may be confused during flight.

According to Crucian, the immune system is likely being altered by many factors associated with the overall spaceflight environment. "Things like radiation, microbes, stress, microgravity, altered sleep cycles and isolation could all have an effect on crew member immune systems," said Crucian. "If this situation persisted for longer deep space missions, it could possibly increase risk of infection, hypersensitivity, or autoimmune issues for exploration astronauts."

Despite these immune system changes, it has yet to be determined whether these alterations increase crew risk for medical issues during spaceflight. According to Crucian, further investigations are required to precisely assess whether there is increased clinical risk to crew members on longer duration missions.

NASA Human Research Program Chief Scientist Mark Shelhamer says continued study of the immune system is critical. "These studies tell us that this is an important issue and that we are measuring the right things," said Shelhamer. "They also tell us there is no place during spaceflight where we see stabilization of the immune system. This is critical as we pursue longer duration missions and why we are studying this further during the upcoming one-year mission."

Once these investigations are complete, Crucian expects the agency will have a decision point for establishing countermeasures that it must then decide how to implement. If deemed necessary, countermeasures for immunity could include new types of radiation shielding, nutritional supplementation, pharmaceuticals and more.

Studies of how space flight affects the immune system may provide benefits to Earth-based medicine. This includes information on how

stress causes immune system changes in healthy adults, changes that may precede disease.

In the end, NASA may just shift the immune system during spaceflight from dazed to unfazed.

Provided by NASA