Space Flight Causes Drop in T-Cell Production in Astronauts

By Alex Berezow, PhD — August 5, 2016

Being an astronaut is not easy. Not only must you be in top physical and mental shape, but your body undergoes a constant assault from the effects of microgravity. According to Scientific American, prolonged space flight results in muscle atrophy, cardiovascular problems, neurological and perceptual difficulties, and circadian rhythm disruption. To this long list of ailments, researchers have added another: A drop in T-cell production.

T-cells, which can be thought of as the "intelligence officers" of the immune system, are produced in bone marrow. Next, they head to the thymus, where they undergo a process called thymopoiesis, part of which involves receiving a rigorous education. Each T-cell is equipped with a unique T-cell receptor (TCR) that is crucial for the immune system's ability to recognize pathogens. The thymus meticulously tests the quality of these TCRs, and only about 2% of T-cells meet the stringent requirements to graduate from the thymus; the other 98% are destroyed.

The purpose of thymopoiesis is to generate a diverse army of T-cells that can effectively identify microbial intruders. Most of this army is already generated by adulthood, but thymopoiesis continues throughout life in order to maintain the troops. Any slowdown in thymopoiesis, which would decrease the number of new T-cells being generated, could in theory deplete the army and make a person more susceptible to infection.

To examine how thymopoiesis changes in astronauts, a team of researchers led by Cara Benjamin and Krishna Komanduri examined the blood of astronauts prior to space flight and after their return. By counting the number of new T-cells (which are identified by the presence of a particular circle of DNA, a leftover from the thymus graduation ceremony), the researchers were able to
determine the level of thymopoiesis. As shown in the figure, a 45% decrease in the production of new T-cells was detected after astronauts landed on Earth. After about two days, production rebounded to roughly normal levels.

[3] Thymopoiesis in astronauts. (Credit: Benjamin et al., JCI Insight, 2016.)

Because the team was unable to retrieve blood samples while the astronauts were in space, there is no data on thymopoiesis during that time. Thus, while the data suggests that thymopoiesis is suppressed by microgravity, it certainly does not prove it. (An alternate explanation is that the stress of re-entry temporarily lowered thymopoiesis.) Whatever the explanation, it is clear that -- at least for some period of time -- astronauts have a depleted T-cell army.

There are two logical next steps for researchers. The first would be to obtain and analyze blood samples from astronauts while they are in space to determine the effect of microgravity, if any, on thymopoiesis. The second would be to examine if astronauts are more susceptible to infectious diseases following re-entry. The latter may be difficult, since such data (if it exists) has not been made available to the researchers, Dr. Komanduri told ACSH.

There is a hint, however, that astronauts may be at least temporarily immunocompromised. Dr. Komanduri says that other studies have shown that astronauts are prone to the reactivation of latent herpesvirus infections, such as cytomegalovirus (CMV) and Epstein-Barr virus (EBV). This is not common in healthy people.

To those of you who are eager for a trip to Mars, add "immunosuppression" to your list of concerns.

*Source: Janeway's Immunobiology [4].

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