Issues of a Manned Mars Mission

Khang Duong

Virginia Aerospace Science and Technology Scholars

Abstract

Radiation, poor nutrition, and microgravity are three big issues surrounding a Martian manned mission. Radiation causes cancer, cell damage, cataracts, mental decay, and even death (NASA, n.d.a). For a 500 day long Mars mission, astronauts will face enough radiation to increase their risk of cancer by 5% (SciNews, 2013). To counteract this, a spacecraft could be lined with liquid hydrogen. On Mars, living quarters could be covered in Martian regolith or built near a cliff (NASA, 1991d). Next, poor nutrition leads to a performance decline in crewmembers, disease, and death. Space food currently lasts for about 1.5 years. A single Mars mission could last five years, so nutrition is a big issue. Astronauts could be able to grow their own food with hydroponics or some other crop system (Lockheed Martin, 2012). Lastly, microgravity weakens muscles and bones and leads to many other illnesses, like sleep deprivation and anemia (Howell, 2017). This can be counteracted with exercise, diet and medication, or artificial gravity (Talas, 2019). Nutrition is the most dangerous of the three.

Issues of a Manned Mars Mission

**Introduction:**

Radiation, nutrition, and microgravity are three issues involved in a manned Mars mission. Each of them has its risks and solutions. Radiation can cause cancer, mental decay, and death (NASA, n.d.a). Some kind of radiation shielding will protect crewmembers on a journey to Mars. Similarly, poor nutrition can lead to performance decline and diseases (Lockheed Martin, 2012). Growing food and increasing food shelf life are two possible solutions. Lastly, microgravity leads to muscle loss and bone embrittlement (Howell, 2017). Exercise machines and electrotherapy can counteract microgravity.

**Radiation:**

Radiation is one of the biggest risks in a manned Mars mission (NASA, n.d.a). Radiation comes in three forms: trapped belt radiation from Earth’s magnetosphere, Galactic Cosmic Rays from the Milky Way, and Solar Particle Events from the sun (NASA, n.d.a) The biggest threat to the crew during a mission is Galactic Cosmic Radiation (GCR). It is mainly heavy elements, such as iron, flying near the speed of light. When these hit the human body, they tear apart DNA, which can lead to cancer, cell damage, cataracts, mental decay, and death (NASA, n.d.a, 2002e). Astronauts on a manned Mars mission will likely experience enough radiation to increase their risk of cancer by five percent (SciNews, 2013). Another risk is machinery. Under large doses of radiation, computer circuits malfunction, which could lead to disaster (NASA, n.d.a). While both Mars and interplanetary space have radiation, Mars has less of it because of its magnetosphere and atmosphere. However, Mars is still not safe. About 50% of radiation reaches the ground on Mars (NASA, n.d.c). Many solutions to radiation have been proposed. For example, a diet high in antioxidants, like “vitamin E, C and beta-carotene” would help the body ward off cancer.

Collecting stem cells from bone marrow before the mission would also aid in the treatment of cancer if it occurs (NASA, n.d.a). On Mars, a possible outpost would have to be protected. Some possible ideas are frozen water and Martian regolith shielding (NASA, 2016g, 1991d). Base modules could also be built near cliffs to stop radiation from one side (NASA, 1991d). “Mars bricks” made from Martian regolith and carbon dioxide polymers could provide adequate protection. Computers would also need radiation shielding to prevent malfunction. For deep space, lining the ship with a layer of 50-100 centimeter liquid hydrogen will stop cosmic rays. However, the system that will enable this is “heavy and awkward” (NASA, 2002e). In addition to the issues mentioned above, radiation degrades nutrients in food over time (Lockheed Martin, 2012).

**Nutrition:**

Astronauts onboard a Mars mission will, of course, have to eat. In addition to getting enough calories, astronauts will have to receive the correct micro and macronutrients to survive. This is an issue because a Mars mission could take five years, compared to the 1.5-year shelf life of space food today (Lockheed Martin, 2012). Over time, vitamins in food start to degrade. This degradation can lead to a greater “risk of performance decrement,” disease, or death (Lockheed Martin, 2012). In addition to vitamin degradation, food could spoil, and needs to be palatable, and sustainable. If even one of the crewmembers contracts food poisoning, the mission could be in jeopardy (Reynolds, 2018). In a crew of only a few, one member unavailable is significant. Food also has to be palatable. If astronauts do not like the meals, they will not eat it and miss out on nutrients. If astronauts grow plants, however, the issue of space and time arises. Plants use up space, water, and energy, so picking the correct ones is imperative. Scientists must also check how the plants will affect each other and humans. For example, gasses expelled from lettuce could affect the growth and quality of potatoes, or they could cause an allergic reaction to a crewmember (Malik, 2004). In space, plants grow perfectly fine. Some kinds of systems, such as hydroponics could grow plants and double as radiation protection (Cannon, n.d.). On Mars, the soil is devoid of nutrients, so it will not be possible to grow plants on it without chemical reactions (Koren, 2019). There are several possible solutions to be addressed. First, food must be able to survive for five years. While this is not feasible right now, with more research, astronauts could bring all their food with them on a mission (Reynolds, 2018). The other option is to grow food on the way to Mars. This can be done with engineered bacteria that break down human waste and produce a fatty paste, similar to peanut butter (Steinberg, Kronyak, & House, 2017). In terms of growing plants, hydroponics is the most doable option right now because it can be used in space and on Mars. Additionally, it requires less work than fertilizing Martian regolith. On Mars, the plants will have to be grown in pressurized modules with LED lights (Cannon, n.d.). GMOs can be used to increase food yield. For example, plants could be engineered to consume more CO2, speeding up the process. Plants would also have to be water-efficient, like beans, tomatoes, or potatoes. Another option is clean meat and insects. Both of these options allow astronauts to get their proteins for minimal space and effort. For insects, crickets are especially viable because they can be made into flour and hidden in meals. Lastly, single-celled proteins like algae can be mass-produced in water tanks for healthy protein (Cannon, n.d.). A drawback to growing food is that it is not reliable. It would be dangerous to have astronauts rely on a source of food that is not guaranteed. It also takes time, space, and energy for astronauts to grow food. One final point is that crewmembers must eat food that is high in calories, helps maintain muscle mass, and supports bone density. This is because, in a microgravity environment, astronauts must exercise to support their health (Howell, 2017).

**Reduced and Microgravity:**

Microgravity is the absence of feeling gravity, or weightlessness. In space, microgravity temporarily disorients astronauts (Howell, 2017). In the long term, microgravity weakens muscles and bones, hinders eyesight, increases the risk for kidney stones, can lead to injury and fatigue, and many other ailments, like sleep deprivation, immunodeficiency, and anemia (Howell, 2017; Sutton & Cintrn, 2005). Compared to Earth, Mars has 62.5% less gravity (NASA, n.d.b). This means that astronauts will have to exercise on Mars as well as in deep space. Astronauts are expected to exercise for about 2 hours a day, just like on the International Space Station (Howell, 2017). Some solutions include exercise, specialized suits, electrostimulation, diet and medication, and artificial gravity. Some exercise solutions include the CEVIS (Cycler Ergometer with Vibration Isolation and Stabilization) System, the TVIS (Treadmill with Vibration Isolation and Stabilization) System, and the ARED (Advanced Resistive Exercise Device). These exercise machines would allow astronauts to counteract the effects of microgravity. Another option is specialized suits. The “Penguin Suit” is one such example. It applies stresses all over the body so that certain muscle groups are used more often. Electrostimulation is commonly used in sports on Earth to improve muscle growth and repair, so it could also help astronauts in space maintain form. Additionally, a diet high in “calcium and Vitamin D” could “reduce bone demineralization.” Finally, building living quarters with artificial gravity would remove the problem of microgravity. However, a structure like that is not feasible for the first missions to Mars (Talas, 2019).

**Danger Assessment:**

The biggest danger to a Martian manned mission is nutrition. This is because, on a 5-year mission, astronauts will have to eat. Compared to radiation and microgravity, nutrition has the most immediate impact on performance (Lockheed Martin, 2012). Radiation can lead to cancer, and microgravity leads to muscle loss (NASA, n.d.a; Howell, 2017). However, poor nutrition leads to a decline in performance immediately. Poor nutrition could lead to not only poor performance, but a multitude of diseases. It is also the most dangerous because it is harder to fulfill than radiation and microgravity. Right now, food only lasts for 1.5 years. It will require much research to achieve a 5-year shelf life without vitamin degradation (Lockheed Martin, 2012). Comparatively, astronauts on the ISS have exercise machines and radiation protection has been tested as far back as 1991 (NASA, 1991d). However, space agencies do not have access to food that lasts that long as of now.

**Conclusion:**

Some of the biggest issues surrounding Mars are radiation, nutrition, and microgravity. For example, radiation can lead to cancer or death. Poor nutrition affects performance and causes disease. Microgravity decreases bone density. Poor nutrition is the most dangerous of its immediate impacts on a possible mission. While going to Mars will come with many unforeseen and dangerous risks, with perseverance, humans will always find a way.

