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LONG TERM HUMAN SPACE TRAVEL – PHYSIOLOGICAL EFFECTS ON AUSTRONAUTS

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ABSTRACT

Space travel in both human and animals has shown that no organ system in the human body is spared from the effects. Astronauts are commonly depicted returning to earth in a state of physical weakness. Parameters such as heart rate, breathing rate, or even sleeping patterns are disturbed during space flight. The effects of space flight on physiologic systems such as Neurologic, Ophthalmology, Cardiovascular, Pulmonary, Gastrointestinal, Genitourinary, Musculoskeletal, Hematology, Immunology, Oncologic etc are discussed in this paper.

Keywords: Space, Astronaut, Physical Weakness, Physiologic System.

I. INTRODUCTION

Astronomy and space technology are used in space exploration to learn more about the universe. While astronomers use telescopes to explore the universe, both unmanned robotic space missions and human spaceflight also participate in the physical exploration of space. Future space travel is inevitable. It satisfies the human desire to explore and roam, and in the coming years and decades, it might even give our species new homes, which is important given how crowded Earth is right now. It is entirely possible for humans to travel to the furthest regions of our solar system. But the stars are a different story. Even though light is the fastest object we know of in the universe, interstellar space is so vast that it takes years, centuries, and millennia for light to travel through it. Traveling in space is risky. In order to enter orbit, one must accelerate to about 28,000 kph (17,000mph, or 22 times the speed of sound). When something goes wrong at such speed, it rarely turns out well. Space travel in both human and animals has shown that no organ system in the human body is spared from the effects. Astronauts are commonly depicted returning to earth in a state of physical weakness (Carpentier WR, Charles JB, Shelhamer M., 2018). Parameters such as heart rate, breathing rate, or even sleeping patterns are disturbed during space flight (Haney NM et al., 2020). The effects of space flight on physiologic systems such as Neurologic, Ophthalmology, Cardiovascular, Pulmonary, Gastrointestinal, Genitourinary, Musculoskeletal, Hematology, Immunology, Oncologic etc are discussed in this paper.

II. EFFECTS OF SPACE FLIGHT ON HUMAN PHYSIOLOGICAL SYSTEM

Some of the important physiological effects due to space flight are discussed in this section.

Respiration

Humans have been demonstrated to be harmful when exposed to lunar dust from Mars, the moon, and other planets (McKay DS et al., 2015). Lunar dust, also referred to as regolith, has been examined from astronauts' space suits. The hazardous particles were directly contacted while cleaning the suits in between uses, exposing the wearer to breathing exposure. Regolith was shown to be permeable through spacesuits, increasing the risk of suit-related injuries (NASA, 2017). The toxicity of the dust has also been shown to affect the cardiovascular and nervous systems in addition to the lungs (Brook RD et al., 2010; James JT et al., 2013).

Digestion

Uncertainty surrounds the best way to supply long-term space missions with a sustainable food source. Food availability, repeatability, freshness, radiation stability, and nutritional content are among the variables. Even though research on the gut microbiome is still in its early stages, it may be crucial to determine which vitamins and minerals are optimal for crew members (Garrett-Bakelman FE et al., 2019). Short-term missions by researchers showed negligible impacts of radiation on food, but long-term implications are yet unknown (Zwart SR et al., 2009).

Elimination

Aborted missions could be caused by kidney stones, which can be treated medically or surgically (Leapman MS et al., 2017). This is particularly true when dehydration, high sodium meals, and circumstances that enhance the urine excretion of calcium (such as accelerated bone resorption in microgravity) are present. A kidney stone has only ever been accidentally passed in outer space before the crew redirected the ship back towards Earth (Lebedev, 1990). It has been proven in space that urinary retention can lead to persistent kidney damage and severe pain. Treatments for urine retention on aeroplanes have included self-catheterization and percutaneous bladder drainage under ultrasound supervision (Leapman MS et al., 2017).

Cancer

Due to the loss of the planet's magnetic shielding, radiation from space is stronger than that on earth, however it is unknown how much of a danger space flight poses for developing cancer (Doarn et al., 2019; Cinelli I, 2020). Leukemia, thyroid, breast, colon, and lung cancer can all be brought on by radiation here on earth (Almeida-Porada G et al., 2018). The epigenome of human bronchial epithelial cells revealed some long-lasting consequences of cosmic radiation exposure (Kennedy EM et al., 2018).

Mental health

The research clearly demonstrates that astronauts struggle with sleep. According to research, sleep deprivation occurs frequently throughout the months leading up to takeoff (Barger et al., 2014). While astronauts were in space for 79 early US trips, insomnia was treated with medication more frequently than any other medical ailment (Putcha et al., 1999). Alterations in sleep patterns may be caused by radiation, light-dark cycles, microgravity impacts on the environment, and other factors. Other hypotheses include impaired brain perfusion, dysfunctional lymphatic drainage systems, or sleep apnea flare-ups generating even more tissue hypoperfusion. Other psychological changes, which are also probably connected to sleeplessness, include mood changes, changes in neurocognitive function, higher stress levels, and conflicts both within the crew and with mission control (Kanas N, 1998).

Bones and Muscles

Due to the reduced load bearing environment, astronauts also experience a loss of bone mineral content in addition to general weight loss. Microgravity is also thought to have a deleterious impact on cartilage, leading to more problems with spinal diseases (Ramachandran V et al., 2018). Resistance training and dietary adjustments are two strategies used to combat musculoskeletal waste during flying (Zwart SR et al., 2018).

Blood and Blood products

In astronauts on missions, plasma protein synthesis has been demonstrated to be suppressed, which is consistent with expected drops in red blood cell counts. This makes anaemia symptoms worse for a longer period of time in harsh conditions (Kononikhin AS et al., 2017). Additionally, data suggests that spaceflight may modify the mechanisms of hemostasis connected to alterations in endothelial cells and clotting factors (Brzhozovskiy AG et al., 2019).

Nerves

MRI scans of astronauts after they have returned to Earth reveal startling alterations to the brain's architecture. Space travel has resulted in the central sulcus shrinking, the brain moving upward, and the cerebrospinal fluid (CSF) gaps getting smaller (Roberts DR et al., 2017). Neurocognition, the spinal column, and intracranial pressure are three categories of general neurologic system alterations (Swinney CC et al., 2018). It is unknown if these modifications are permanent and that they were depending on the length of the travel.

Eyes

The space flight-associated neuro-ocular syndrome (SANS), which has been observed after extended space trips (Lee AG et al., 2016; Lee AG et al., 2018). Astronauts have idiopathic intracranial hypertension-like optic disc edoema, globe flattening, choroidal and retinal folds, hyperopic refractive error alterations, and nerve fibre layer infarcts. Years after they had returned to Earth, several crew members' issues persisted (Lee AG et al., 2018).

Heart

In general, being in space causes the heart to beat more quickly and the blood pressure to drop (Carpentier et al., 2018). In the presence of microgravity, it has been demonstrated that the autonomic nervous system, arterial blood pressure, cardiac contractility, and electrophysiology all alter (Indo HP et al., 2016). According to research, just six months in space is enough to change the heart's structure and conduction system, raising the risk of cardiac dysrhythmias (Khine HW et al., 2018). One instance of a team aborting a mission because a crew member experienced a cardiac dysrhythmia after takeoff is known to exist (Summers RL et al., 2005).

III. CONCLUSION

Long-term human space travel faces many challenges but creates great opportunity for innovation. The existing medical patterns seen on earth should not be blindly applied to the everchanging gravity and microenvironment found at different aspects of spaceflight. New datasets built from multiple flights over many years will be required for medical intelligence to be functional outside of LEO.

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