A Review on Astronauts Life in Space

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Abstract: ***Living in space is not the same as living on Earth. Many things are different. Our body will get change in space. There are many problems which encountered over the astronauts body. We can not say the age of Earth. The day will come when some human being will spend all their time in space. But we have to know the problems which can affects in our body if we spend for a long or short time in space. Astronauts have done over 200 spacewalks outside of the International Space Station and gave their different views. But the common thing they shared that there is a huge difference between spending time in zero gravity and on Earth.***

Keywords: Bone demineralization, Cardiovascular changes, Immunological changes, NASA's Life Support System, Nutrition in Space, Physiological changes in Space, Space environment, Space Medicine.

1. Introduction

Since Gravity is a constant factor throughout the evolution of life, it has shaped the architecture of all biological systems on the Earth. Therefore, one would not be surprised of sudden changes of the Gravitational force lead to deviation of normal function of life. At current levels of knowledge, microgravity leads to a variety of deconditioning symptoms like bone demineralization, muscle atrophy, reduced performance of the cardiovascular system, altered perception as well as strong impairment of immune system. Functional disturbance of lymphocytes and consequently immune deficiency are discussed as a credible risk for manned long-term space flight. After investigation on astronauts, it has been seen that visual problem and kidney stone sometimes occurred in them. To prevent these problems NASA's Life Support Systems develop the capabilities to sustain humans who are living and working in space – away from Earth's protective atmosphere.

This review article provides an overview on space environment, life in space of astronauts and some physiological changes in them.

2. Space Environment

The environment of space is lethal without appropriate protection: the greatest threat in the vacuum of space derives from the lack of oxygen and pressure, although temperature and radiation also pose risk.

2.1 Vacuum

In the vacuum of space, gas exchange in the lungs continues as normal but results in the removal of all gases, including oxygen, from bloodstream. After 9 to 12 seconds, the deoxygenated blood reaches the brain, and it results in the loss of consciousness. Exposure to vacuum for up to 30 minutes is unlikely to cause physical damage. Another effect from a vacuum is a condition is called ebullism. Technically ebullism is considered to begin at an elevation of around 19 km or pressure less than 47 mm Hg. Experiments with other animals have revealed an array of symptoms that could also apply to humans. The least severe of these is the freezing of bodily secretions due to evaporative cooling. Severe symptoms, such as loss of oxygen in tissue followed by circulatory failure and flaccid paralysis would occur in about 30 seconds. The lung also collapse in this process, but will continue to release water vapour leading to cooling and ice formation in the respiratory tract. A rough estimate is that a human will have about 90 seconds to be recompressed, after which death may be unavoidable. Swelling from ebullism can be reduced by containment in a flight suit which are necessary to prevent ebullism above 19 km. During the Space Shuttle program astronauts wore a fettle elastic garment called a Crew Altitude Protection Suit which prevented ebullism at pressure as low as 15 torr.

2.2 Temperature

In a vacuum, there is no medium for removing heat from the body by conduction or convection. Loss of heat is by radiation from the 310 K temperature of a person to 3 K temperature of outer space. There is a slow process, especially in a clothed person, so there is no danger of immediately freezing. Rapid evaporative cooling of skin moisture in a vacuum may create frost, particularly in the mouth.

2.3 Radiation

Without the protection of Earth's atmosphere and magnetosphere astronauts are exposed to high levels of radiation. A year in low Earth orbit results in a dose of radiation 10 times that of the annual dose on Earth. Solar flare events can give a foetal radiation dose in minutes. On 31st May 2013, The NASA's Scientists reported that a possible manned mission to Mars may involve a great radiation risk based on the amount of energetic particle radiation detected by RAD on the Mars Science Laboratory while travelling from the Earth to Mars in 2011-2012. In September 2017, NASA reported radiation levels on surface of the planet Mars were temporarily doubled, and were associated with an aurora (sometimes referred to as polar lights). It produced when the magnetosphere is sufficiently disturbed by the solar wind that the trajectories of charged particles in both solar wind and magnetosphere plasma, mainly in the form of electrons and protons, precipitate them into upper atmosphere due to Earth's magnetic field.

3. Physiological Changes

3.1 Bone demineralization

Bone loss increases when the human body is in a reduced gravity environment. Astronauts on the ISS, or on a future long duration mission, may lose an average of 1% BMD per month while in space. An astronaut's bones may weaker in a way similar to Osteoporosis (is a condition in which bones have lost minerals, especially calcium, making them weaker, more brittle and susceptible to fractures).Astronauts go into negative calcium balance early and continuously throughout a space mission. They have a reduced net intestinal absorption of calcium. The amount of calcium lost per month of exposure to microgravity is about 4 grams, or 0.4% of the total body calcium. Bone loss has been observed during spaceflight since at least as early as Gemini in the 1960s. Although most early measurements of the amount of bone loss were not reliable, they did show bone loss in Gemini, Soyuz 9, Apollo, Skylab, Salyut 7, Mir and the ISS.

3.2 Cardiovascular changes

When astronauts spend long periods of time at zero gravity in space, their heart become more spherical and lose muscle mass which could lead to cardiac problems. Echocardiography of several space shuttle crew members before, during and after a space mission showed changed changes in cardiac anatomy. On the first day of a space mission, ultrasound measurements show that the left size of the heart unexpectedly decrease as does the central venous pressure. During the second day of space mission, the entire heart becomes smaller than pre-flight and does not return to pre-flight size for at least one week post-flight. Space travel has also been known to cause irregular heartbeats, and the increased radiation in space may speed up arterial hardening or atherosclerosis. The researchers are now adapting their models for conditions such as coronary artery diseases, hypertrophic cardiomyopathy, and diseases of valves of heart. The blood pressure is also lower in space than on earth. The cardiac output of the heart the amount of blood pumped out of the heart each minute decrease in space.

3.3 Blood volume changes

The fluid shifts observed on space missions might be expected to cause temporary changes in the total blood volume and haematocrit. The initial fluid overload may cause passive congestion and sequestration of erythrocytes in the liver, spleen and lungs. Erythropoiesis is probably suppressed by 10% to 15% rather than completely suppressed. In vitro erythrocytes under zero gravity do not show evidence of crenation, burr cells or other unusual shapes. About four to six weeks are required after space travel for the erythrocytes mass to return to normal. Space anemia is one of the complication of prolonged weightlessness.

3.4 Immunological changes

The immune system is effected in space by different factors like radiation, stress, altered sleep cycles etc. High levels radiation damage lymphocytes, cells heavily involved in maintaining the immune system. There is scientific concern that extended space flight might slow down the body's ability to protect itself against diseases. Radiation can penetrate living tissue and cause both short and long-term damage to the bone marrow stem cells which create blood and immune systems. In particular, it causes chromosomal aberrations in lymphocytes. In space T-cells are less able to reproduce properly, and the T-cells that do reproduce are less able to flight off infection.

3.5 Renal stone

Renal stone formation and passage during space flight can potentially pose a severe risk to crew member health. Calcium containing stones are the most common type of kidney stones occurring in humans. Post flight changes to the urinary chemical composition increases the risk of uric acid and calcium oxalate stone formation, while in flight assessment has shown a greater risk of calcium oxalate, calcium phosphate stones. The major causes are dietary changes, bone metabolism, dehydration, increased salt intake as well as decreased urine volume (astronauts do not drink enough water in space so their urine output is lower) saturation are all possible cause of renal stone formation.

3.6 Fatigue and sleep loss during space flight

Research suggested that astronauts quality and quantity of sleep while in space is markedly reduced than while on Earth. The most common factors that can affect the length and quality of sleep while in sleep include: noise, physical discomfort, voids, disturbances caused by other crew and temperature. Studies have shown that lack of sleep can cause fatigue that leads to errors while performing critical tasks. Astronauts and ground crews frequently suffer from the effects of sleep deprivation and circadian rhythm disruption.

3.7 Vision problem

Some astronauts have experienced eyesight problems after going to space and it is related with disruption of cerebrospinal fluid. After a long time in space astronauts may have their brain shifted upward (closer to skull) and have the CSF filled ventricles spaces in the brain narrow. Research has increasingly pointed to the role of CSF, which removes waste materials and moves around nutrients in the human body regardless of their position standing up, sitting, lying -down. The process may be disrupted in space.

3.8 Space motion sickness

Once in orbit, and usually within first several hours, symptoms such as motion sensitivity, malaise, lethargy and brief episodic vomiting will develop in about half of crew. Specific cause of space motion sickness is unknown. In most cases it seems to be a self-limited sickness that resolves within several days. Symptoms sometimes last up to six days.

3.9 Dental problem

Sometimes severe toothache can occur in astronauts when barometric pressure is reduced as a result of expansion of air entrapped in a dental restoration.

4. Life Support System

NASA's life support systems activites develop the capabilities to sustain humans who are living and working in space. This includes monitoring atmospheric pressure, oxygen levels, waste management, water supplying, as well as fire detection and suppression. From the very beginning of space era, Russian space craft used a two gas environmental system design to maintain an Earth like atmosphere. Because of increased weight of two gas life support system early US space craft used 100% oxygen. The Skylab atmosphere used 70% oxygen and 30% nitrogen at 260 millibars. The space shuttle is the first US space craft to maintain an earth like atmosphere similar in both composition and pressure 760 millibars, 20% oxygen and 80% nitrogen. Removal of carbon dioxide, water vapour and temperature are also regulated by shuttle environmental control system.

4.1 Space suit

The formal name for the space suit used on the space shuttle International Space Station is the Extravehicular Mobility Unit (EMU). Space suits help astronauts in several ways. Maximal flexibility of the space suit has required a reduction in pressure to 222 millibars from the shuttle cabin pressure of 1 atmosphere. To prevent decompression sickness, shuttle astronauts first lower the cabin pressure to 527 millibars at least 12 hours before extravehicular activity. This reduction in pressure reduces tissue nitrogen. Those astronauts slated for the extravehicular activity then breathe 100% oxygen for 40 minutes-while in their space suits to wash out traces of nitrogen. Space walking astronauts face a wide variety of temperatures. Space suits also supply astronauts with oxygen to breathe while they are in the vacuum of space. They contain water to drink during space walks. They protect astronauts from being injured from impacts of small bits of space dust. Space dust may not sound very dangerous, but when even a tiny object is moving many times faster than a bullet, it can injury. Space suits also protect astronauts from radiation in space. The suits also protect astronauts eyes from the bright sunlight.

4.2 Space Medicine

It is the practice of medicine on astronauts in outer space whereas astronautical hygiene is the application of science and technology to the prevention or control of exposure to the hazards that may cause astronaut ill health.

4.3 Medical investigation in space

Astronauts are not only ones who benefit from space medicine research. Several medical products have been developed that are space spinoffs, that is practical applications for the field of medicine arising out of the space program. These applications are : Radiation therapy, Foldable walkers, Personal alert systems, CAT and MRI scans, Orthopedic evolution tools, Diabetic foot mapping, Foam cushioning, Kidney dialysis machine, Talking wheel chains, Collapsible and light weight wheel chairs, EMS communications,

Weightlessness therapy, Treadmill. Sometimes some drugs are used as space medicine such as Melatonin, Rameltenon, Barbiturates, Benzodiazepine, Zolpidem, Zopiclone, Modafinil and Dexendrine. These drugs are mainly used as sedative – hypnotics and popular sleep airs. They are inducing sleep.

5. Conclusion

At this stage, we know that hostile environment like space flight do cause physiological changes in man. Over the east several decades space flight and ground based research have indicated that astronauts suffer from a number of significant ill. Only the future can answer many of the currently unanswered questions involving space medicine and NASA should help us provide with more information and better understanding through research.

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