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RESEARCH ARTICLE

SPACE MEDICINE – A REVIEW.

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Abstract

Over the last several decades, space flight and ground based research have indicated that astronauts suffer from a number of significant ill effects such as loss of bone mass, alterations in sleep rhythm, exposure to radiations, infections and alteration in drug dynamics. The purpose of this paper is to advance our knowledge of the effects of the space environment on biological systems.

Introduction:-

SPACE, the boundless regions of the infinite.

Mars is a cold and inhospitable place with an extreme environment and an atmosphere with high levels of carbon-di-oxide that cannot support human life, it is also the nearest and most earth like planet in solar system. Mars has seasons, polar ice caps, mountains and canyons, volcanoes and evidence of ancient rivers and lakes. It is the most accessible body among the planets and moon in the solar system, where a sustained human pressure is believed to be possible (Hoffman and Kaplan, 1997).

Gravity is one of the fundamental forces that shapes life on earth and space flight affords a unique opportunity to study and characterize basic biological and behavioral mechanisms in the absence of gravity. It presents environmental stressors to the individual and provides us with new insights into how organisms adapt. In a zero gravity situation, the human body is not able to maintain bone mass resulting in a type of osteoporosis. It is estimated that a human being loses approximately 1% of bone loss for each month in space. A typical mars mission of 30 months could therefore result in 30% bone loss, which is severe osteoporosis. The bone calcium and phosphorus are excessively excreted in urine and faeces. This results in high risk of fracture upon return to earths gravitational field. Various protocols have been developed in an attempt to minimize the bone loss in zero gravity which include vigorous exercise programs, which may last several hours each day, and weightlifting using elastic cords as a substitute for weights. In space, the slow muscles undergoes a change to take on the characteristics of fast muscles. This change causes astronauts to experience difficulty with walking and circulation once back on earth.

Exposure to microgravity degrades the cardiovascular system. One such autonomic changes is the altered baroreceptors reflex function, which contribute to post-flight orthostatic dysfunction.

Astronauts on long mission will endure the isolation and confinement of space environment. They manage to work according to a tight schedule in a monotonous room for several months and with crew members of different cultural backgrounds. Thus long duration missions are likely to produce significant changes in individual, group, and organizational behaviour.

Poor sleep is common on space missions, and even on long term missions. Insomnia is prevalent to the extent of impairing judgement. Microgravity decreases the need to tonically activate upper airway muscles. Alterations in upper airway control may develop during space flight and increase the risk of hypoventilation during sleep and sleep fragmentation upon return to earth gravity.

Astronauts do not drink enough water in space so their urine output is lower and the space meals is dehydrated and high in sodium. A good preventive care cannot gurantee that no caries will develop in anyone over a 3 year mission course. The factors that could contribute to the development of tooth and gum diseases are changes in bacterial flora in oral cavity, inattention to good dental hygiene, changes in food consistency due to consumption of dehydrated space meals and lack of foods with natural gingival cleansing properties. Hence, the crew should be prepared to use restorative techniques in microgravity. If a dental problem arise in a 3 month period prior to flight and a restoration becomes necessary, then the astronaut should be subjected to reduced barometric pressure to ascertain the tooth condition or else a sudden, severe toothache can occur when barometric pressure is reduced as a result of expansion of air entrapped in a dental restoration in space.

In April 2000, IOM committee workshop on oral health included a presentation on atraumatic restorative treatment (ART). Here the carious tooth tissue is removed with hand instruments instead of electric rotating handpieces and then cavity is restored with an adhesive restorative material such as glass ionomer, resulting in sealed restoration (Estupiñän-Day, 2000). The advantages of ART are little/no pain, reduced need for local anesthesia, minimum tooth trauma, conservation of healthy tooth tissue, simple and easy to perform technique.

Recent research in Periodontology has shown that osteoporotic periodontal bone is more susceptible to breakdown than healthy bone, and tooth loss is more frequent in subjects with osteoporosis. Measures to preserve oral bone include dietary and pharmacologic measures, as well as artificial gravity.

During space travel, every cell nucleus in an astronauts body, on average, be hit by radiation particles every few days. This causes cellular and tissue injury, including genetic damage. According to NASA, the risks of radiation exposure include cancer, damage to CNS and radiation sickness. Protective shielding, shielding chemicals and careful monitoring of radiation exposure are used to reduce radiation exposure.

In zero gravity space, the human body does appear to adjust fairly quickly but problems do occur upon return to earth. In microgravity, the quantity and distribution of body fluid alter and results in facial edema, specially around eyes and cranial veins dilate.

Crew members also suffer from space adaptation syndrome (nausea, motion sickness and sensory disorientation), weakened immune defenses, loss of bone mass and muscle mass and space anemia.

Space anemia is one of the complications of prolonged weightlessness. This is due to reduced red cell production, low reticulocyte response, and loss in hemoglobin content. There is reduction in plasma volume due to microvascular permeability. Lymphocyte function is altered leading to weakening of immune system.

Neurovestibular system is especially challenged by weightlessness. The most common consequence being nausea which is closely linked to parasympathetic activation and concomitant sympathetic withdrawal.

Space traveling salmonella had changed expression of 167 genes. After the flight, animal virulence studies showed that bacteria that were flown in space were almost 3 times as likely to cause disease when compared with control bacteria grown on ground. Study discovered that an important regulatory protein, Hfq, may be responsible for increased virulence due to space flight.

While the complex biobehavioral effects of pharmacological compounds generally have been well characterized on earth, but in space, the cognitive, psychomotor and other biobehavioral effects of drugs may be quite different when ingested during space flight.

The physiological processes which affect drugs are:-
Renal functions: Renal excretion of many drugs is proportional to glomerular filteration rate (GFR), GFR tend to increase during space flight which is estimated by creatinine clearance.

Cardiac output and organ blood flow: It is clear that drug distribution to organs is dependent on blood flow. Zero gravity induces alterations of cardiac output.

Organ size: Fluid redistribution is also an established phenomenon during space flight leading to changes in organ size. Enlargements of liver and kidney could affect drug distribution.

Drug metabolizing enzyme activities: Zero gravity affects all physiological processes in humans and there may be no room for enzymes to be spared.

An ongoing study of antibiotics, motion sickness drugs and other remedies provided to astronauts show that some products degrade during space treks causing concern. Radiation levels are variable between flights and may be contributing to the degradation of pharmaceuticals in space.

It is crucial to be able to adequately measure the level of various gases that may seep into the spacecraft. The danger is especially severe during long missions, when contaminants can buildup in air supply, threatening the health of any crew members and functioning of sophisticated instrumentation. Nanotechnology is also used to protect crew members from diseases. They monitor circulatory and lymphatic systems and send messages when there are irregularities. Nanotechnology is also useful to check pulse and brain wave activities.

Conclusion:-
At this stage, we know that hostile environment like space flight do cause physiological changes in man. But there exists many queries for which International Space Station and NASA should help us provide with more information and better understanding through research.

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