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Basic Biomedical Engineering Term Paper

Healthcare exploration in Space

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Acknowledgement

Perseverance and passion, along with focused work in the proper direction, can lead to success. However, the harsh fact that the road to success is paved with a plethora of tempting, obstructions and traps can be discouraging. In such a case, it is the able advice of a knowledgeable person that guides one through the challenges and assists him in achieving success.

I am indebted to my well-educated guide a great debt of appreciation and thanks for his invaluable instructions and support, which enabled me to complete my seminar report successfully and on time.

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Abstract

Exploring the Universe has been a human desire since the dawn of humanity. Human curiosity has fueled a desire to explore and discover new worlds, push the boundaries of what is known, and learn more about science and technology.In recent years, space-based technologies have become increasingly important in achieving global health goals. For example, data from remote sensing technologies is used to investigate the epidemiology of infectious diseases. Data is used to track disease patterns, determine environmental triggers for disease propagation, anticipate risk zones, and identify areas where disease control is needed. In developing nations, where infectious diseases remain one of the leading causes of death, tele-epidemiology is especially important.Health and medical skills can also be shared using computer and telecommunications technology, including satellite communications. Telehealth and tele-medicine can increase access to medical and health-related services by putting medical specialists into virtual contact with patients and health practitioners in remote, rural, and underserved locations.

1 Introduction

The International Space Station is a one-of-a-kind laboratory for doing research on human health in space and on Earth. The space station has enabled research that is improving our understanding of many areas of human health, including ageing, trauma, disease, and environmental consequences, during its time in orbit. Several biological and human physiological experiments have provided valuable insights that we on Earth can benefit from, driven by the need to sustain astronaut health. New approaches to prevent bone loss, new insights into bacterial activity, and novel wound-healing procedures are among the findings.

Telemedicine, illness models, psychological stress response systems, nutrition, and cell behaviour are just a few of the benefits derived from studying human health in space.

2 Health technology

Figure 1: Health technology

The world's first robotic system capable of doing surgery inside MRI machines was developed aboard the International Space Station, allowing for advancements in surgical performance. This technology makes tough brain tumour procedures easier and surgeries that were before impossible doable. Medical technology derived from space station robotics will soon be tested in clinical trials for use in the early detection and treatment of breast cancer, allowing for enhanced access, precision, and dexterity, resulting in highly accurate and less invasive operations. The design stages of an enhanced technological solution for paediatric surgery are also underway. A novel technology developed on the International Space Station is currently utilised on Earth to follow the patient's eye and accurately steer a laser scalpel in common laser procedures to repair eyesight.

Thermal regulation research aboard the International Space Station has also led to the application of sensor technology for surgical monitoring.

Ultrasound units are used in conjunction with protocols for performing difficult procedures quickly with remote expert assistance and training where

medical facilities are not easily available, such as in distant and undeveloped places of the world. These telemedicine and remote guiding approaches empower local healthcare providers, give patients more timely and diagnostic care, and improve the efficiency of the healthcare system.

To examine possible airway inflammation before health concerns arise, astronauts aboard the International Space Station use a lightweight, easy-to-use gadget to monitor nitric oxide in air exhaled by them. This technology is currently being utilised in some health centres to track asthma control levels, resulting in more precise medicine administration, fewer episodes, and a better quality of life.

Plasmas (charged gases that can permeate numerous materials and spread uniformly and swiftly) have been found to aid in the disinfection of chronic wounds, the neutralisation of bacteria, the enhancement of tumour inactivation, and even the jumpstarting of plant development, according to research.

NASA needed a way to monitor an astronaut's health that didn't involve hauling a full-scale diagnostic lab to space (both too heavy and too expensive to accomplish). The solution? Shrink the lab. NASA's nanosensor device can diagnose diseases just by using your breath. How? Many diseases are accompanied by characteristic odors. For example, the acetone in the exhaled breath from a person can indicate Type I diabetes. This tool can detect diabetes and many other diseases faster and cheaper than traditional lab testing with higher accuracy.

3 Bone loss Prevention

Figure 2: Bone loss

Bone loss is a typical condition among the elderly, and it is also seen in astronauts in space. Ongoing ISS research show that taking a bisphosphonate and exercising to boost bone load and muscle training, as well as eating a well-balanced, low-sodium diet, can reduce bone loss and kidney stone risk. Improved scanning technologies are being developed to give a reference tool for early identification of osteoporosis and the development of more effective countermeasures to its effects in the elderly at risk of osteoporosis.

4 Immune Reactions

Almost everyone is infected with one of eight herpes viruses, four of which reactivate and emerge in body fluids in response to spaceflight stress. A patent-pending gadget that may be used at a doctor's office or on a spacecraft can detect one of these viruses (VZV) quickly, allowing for earlier treatment and the prevention of painful shingles. Microgravity research on the International Space Station helps researchers pinpoint genetic triggers for immunological responses in T-cells, paving the way for future immunosuppressive treatments on Earth.

Determining the changes in the immune system that occur in space provides the means to develop targeted countermeasures to adverse effects in space, as well as additional information for targeted treatments on Earth, such as pharmaceuticals that can suppress immune response to help manage autoimmune diseases or organ transplants.

5 New Therapies in Development

5.1 Medical remedies

Medical Remedies are developed by studying the unique and complex configurations of proteins in the human body. Microgravity creates ideal circumstances for protein crystal development because gravity and convection aren't present to stifle their growth. The protein expressed in particular muscle fibres of Duchenne Muscular Dystrophy sufferers, which affects one in every 3,500 boys, was effectively crystallised in space, revealing a novel inhibitor that is hundreds of times stronger than the original inhibitor.

5.2 Microencapsulation

Microencapsulation is the technique of creating tiny, liquid-filled, biodegradable micro-balloons that contain specific anti-tumor medication combinations. The idea is to administer this drug to precise therapy areas within a cancer patient using specialised needles. The development of technologies on Earth to make these microcapsules and devices that will aid in drug administration utilising this technology has been made possible by the microgravity environment, where density changes do not cause stacking of the medication. Clinical trials in cancer patients are being worked on now and in the future.

5.3 Gravitational unloading research

Gravitational unloading research supported by dry immersion technology is allowing for a wide range of clinical applications, including early diagnosis of slow-developing neurological disorders, combating edoema that does not respond well to medication, post-operative rehabilitation, sports medicine, and premature baby rehabilitation.

6 The Environment and Food

Figure 3: Enviroment and Food

Microbiology is critical not only for human spaceflight but also for humans on the ground. Bacteria, archea, fungus, and algae are microorganisms that have a negative or positive impact on our daily life. Because microbes play a role in food spoilage, waste and sewage treatment and processing, nutrient cycling and exchange, pollution control, and increasing greenhouse gas emissions, this research has far-reaching implications.

The invention of an ethylene scrubber was inspired by research into the effects of gravity on plants. This technology is now being utilised as an air purifier to kill bacteria, mould, fungi, viruses, and odours in the air.The scrubber is utilised in major supermarkets, high-end refrigerator technology, and vehicles that transport foods to remote areas in nations like India, Saudi Arabia, and Kuwait, to mention a few. The employment of these devices in clinics, surgical rooms, neonatal wards, and waiting rooms assists the health care business by making these facilities safer for their residents.

Plant research in a space greenhouse has allowed scientists to analyse root zone substrates in space, improving predictions of how artificial soils will behave when irrigated in space and in experimental forests on Earth.

7 Heart health and biorhythms

Figure 4: Heart health and biorhythms

The development of unique sensors that can be used on Earth to detect the early changes in health status has resulted from research into the impacts of spaceflight on the cardiovascular system. These technologies are currently being utilised to evaluate hazards and avoid accidents in motor vehicle drivers and civil aviation pilots. Astronauts' 24-hour ECGs were also evaluated in order to better understand the effects of the space environment on biological rhythm and cardiac autonomic nerve activity, leading to recommendations for maintaining a healthy biological rhythm on Earth. Maintaining a regular sleep schedule is one of these suggestions. Information is recorded and relayed to Earth for sleep quality analysis while investigating the sleep patterns of cosmonauts using a small device that fits in their pocket.

The Earth model of this device is placed beneath the pillow or mattress to track heart and breathing movements.

8 Improving your balance and mobility

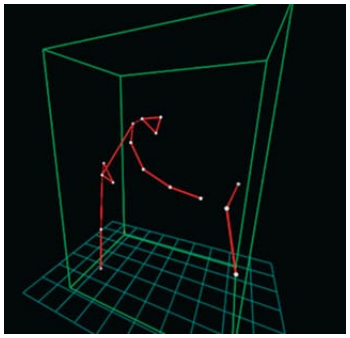

Figure 5: Improving your balance and mobility

Patients with cerebral palsy, stroke, spinal cord injuries, balance issues, and motor loss related to ageing have all benefited from a new technique created to repair motor irregularities in weightlessness. Preflight and postflight evaluations of cosmonauts' eye movement reactions have resulted in faster and less expensive diagnoses and treatments for patients suffering from vertigo, dizziness, and balance disorders. Patients and astronauts are taught how to control vertigo, dizziness, and balance problems using an unique computerised, non-pharmacological way of avoiding and correcting negative perception and sensorimotor reactions

Motor imagery protocols are being employed in the research setting of a hospital in Rome in the treatment of adult stroke patients and children with cerebral palsy thanks to a system of hardware and software that collects data on astronauts' body movements on the International Space Station. Other body movement studies on the International Space Station led to the creation of a suit for astronauts to compensate for the lack of daily gravity loading. In Russia, the clinical version of this suit is used to treat children with cerebral palsy in a thorough and drug-free manner. A different clinical form of this garment is utilised on patients who have had a stroke or have had a brain injury.