Topic Page: space medicine

Definition: **space medicine** from *Collins English Dictionary*

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1 the branch of medicine concerned with the effects on man of flight outside the earth's atmosphere Compare aviation medicine

Summary Article: **space medicine**
From *The Columbia Encyclopedia*

study of the medical and biological effects of space travel on living organisms. The principal aim is to discover how well and for how long humans can withstand the extreme conditions encountered in space, as well as how well they can readapt to the earth's environment after a space voyage. The medically significant aspects of space travel include weightlessness, strong inertial forces experienced during liftoff and reentry, radiation exposure, absence of the earth's day-and-night cycle, and existence in a closed ecological environment. Less critical factors are the noise, vibration, and heat produced within the spacecraft. On longer space flights, the psychological effects of isolation and living in close quarters have been a concern, especially among multinational crews with inherent differences in language and culture.

A large body of useful medical data on the effects of a prolonged U.S. space flight was obtained during the Skylab program of the early 1970s and from several medical missions of the space shuttles *Challenger* and *Columbia*. The Soviet Union's Soyuz program began Russia's experience with long stays in space; the current record of nearly 439 days was set by Russian cosmonaut Valery Polyakov (Jan. 8, 1994–Mar. 22, 1995) on the space station *Mir*. With the change in the international political climate in the 1990s, the two countries began to cooperate in life-science research that combined the more sophisticated diagnostic and monitoring equipment of the NASA missions with the greater long-term-stay experience of the Russians. In May, 1995, the *Spektr* module, containing U.S. medical and research equipment, was added to the *Mir*. A few months later, American physician-astronaut Norman E. Thagard broke the former U.S. record of 84 continuous days in space when he spent 111 days on the Russian space station. The American record was subsequently broken by Miguel López-Alegría, who spent 215 days aboard the International Space Station (ISS; 2006–7), and then by Scott Kelly, who spent 340 days aboard the ISS (2015–16). Cosmonaut Gennady Padalka, who has served for 5 periods on Mir and the ISS, holds the record for most cumulative time in space, 879 days.

There have been many indirect benefits to medicine from space science. The need to maintain close watch over the physiological conditions of astronauts has spurred the development of improved means for electronically monitoring essential body functions. The development of programmable heart pacemakers, implantable drug administration systems, magnetic resonance imaging (MRI), and computerized axial tomography (CAT) all depended to some extent on knowledge gained from the space program. Studies of how astronauts would walk in the moon's weak gravitational field led to a deeper understanding of human locomotion.

See also aviation medicine; space science.

Medically Significant Aspects of Space Flight

Weightlessness

Of all the medically significant conditions experienced in space flight, weightlessness has the most drastic effects; moreover, it will be impossible to eliminate this aspect of space travel unless large space stations can be constructed that produce artificial gravity, as by rotating. Because life evolved under the constant influence of gravity, the effects of weightlessness even on the cellular level have been a concern. It was at first feared that a human being in space might lose all coordination and become completely incapacitated. While the human body does appear to adjust fairly quickly in a state of weightlessness, associated problems do occur, often causing difficulties only upon return to earth. Problems include space adaptation syndrome (nausea, motion sickness, and sensory disorientation during the first few days), weakened immune defenses, loss of bone mass, loss of muscle mass (including loss of heart muscle), a reduction in the amount of blood in the body (which may lead to low blood pressure for a time upon return to earth), and space anemia, which results as the number of red cells decreases. Many astronauts also have vision problems upon their return due to the effects of weightlessness. Space-station astronauts undergo strenuous exercise routines to maintain bone and large muscle mass, but deterioration is only slowed and rehabilition is still required after the return to earth to restore bones and muscles to their preflight conditions.

Inertial Forces

Inertial forces due to acceleration are experienced only during liftoff and reentry, but the consequences can be traumatic. The circulatory system is most strongly affected; deprivation of blood to the brain causes dimming of vision and sometimes loss of consciousness. However, lying on a body-contoured couch, astronauts have survived inertial forces eight times stronger than normal gravity.

Ionizing Radiation

In space the astronauts are exposed to ionizing radiation from particles trapped in the earth's magnetic field, from solar flares, and from the onboard nuclear reactors that help power the spacecraft. This radiation can produce deleterious effects, ranging from nausea and lowered blood count to genetic mutations and leukemia. Protective shielding, shielding chemicals, and careful monitoring of the doses of radiation received by each astronaut have been used to reduce radiation exposure to acceptable levels.

Absence of Day and Night

The absence of the earthly cycle of day and night during space travel produces subtle effects, both physiological and psychological. The period from sunrise to sunset in a quickly orbiting spacecraft may be as little as 1 1/2 hours long. All body rhythms, such as heartbeat, respiration, and changes in body temperature, are regulated by biological clocks (see rhythm, biological). These rhythms are related to human patterns of sleep and wakefulness, which in turn are based on the alternation of day and night. On most flights, adherence to “home” schedules maintains normal human cycles.

A Closed Environment

In the closed environment of the spacecraft care must be taken to prevent the buildup of toxic material to dangerous levels; this is accomplished by recycling waste material. The nature of the artificial atmosphere astronauts breathe is an important biomedical consideration. Ideally, this atmosphere would be identical in composition and pressure to the earth's atmosphere. Any alteration involves the risk of decompression sickness. The space shuttle used a pure oxygen atmosphere or a mixture of oxygen and nitrogen.

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