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SPACE MEDICINE BRANCH REPORT

Role of Medical Personnel and Medical Systems for International Space Station, and Beyond

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The medical operations concept for inflight health maintenance consists of providing full time medical/dental care from the time a crewmember is selected. Biomedical data acquired from preflight, inflight, and postflight help to support health care delivery and improve mission success. Collected biomedical data are also applied to help improve inflight preventive, diagnostic, and treatment capability in selected areas.

Presently the Shuttle Orbiter Medical System (SOMS) contains medical equipment and supplies to maximize crew health and safety during shuttle missions. This equipment is maintained in kits that allow the Crew Medical Officer (CMO) the ability to deliver ambulatory medical care, basic life support and first aid, and to respond to contaminant spills. The SOMS includes emergency medical supplies, diagnostic equipment, medications, bandages, splints, contaminant cleanup equipment, IV solution bags, a sharps container, and air sample bottles. The recently redesigned SOMS is organized into Airway, Drug, EENT, IV Administration supplies, Saline supply bag, Trauma, and sharps container subpacks. Both weight and volume continue to be the limiting factors to the SOMS design.

The International Space Station uses the Crew Health Care System (CHeCS). This system is divided into three components: Health Maintenance System, Environmental Health System, and Countermeasures System. The Health Maintenance System contains medical diagnostic and therapeutic hardware and medications including a defibrillator; the Environmental Health System which contains five major sections: acoustics, water quality, microbial analysis equipment, toxicological analysis, and radiological health; and the Countermeasures System which includes equipment for performing routine physical exercise and physiologic monitoring of fitness. The goals of the Countermeasures System include maximizing crew performance and minimizing postflight recovery time and morbidity, while also providing the crew with a source of motivation and psychological support.

The CHeCS will provide the Crew Medical Officer with the ability to diagnose and treat many types of medical problems. The CHeCS will be used to provide ambulatory care, first aid, basic life support, advanced life support, dysbarism treatment, and ongoing care to crewmembers. However, any ill or injured crewmember who cannot be adequately treated on board the Space Station may be relatively quickly transported to Earth currently using either the Shuttle, if docked, or a Soyuz capsule as a lifeboat from the Station.

The objectives of medical care for the Space Station include: Preventing early mission termination due to medical contingency, ensuring the crew safety and maintenance of health during routine operations, preventing unnecessary rescue, and increasing the probability of success of a necessary rescue. However, adequate medical capabilities should decrease the risk of terminating a Space Station mission prematurely due to medical concerns.

Early in the program at least two Space Station crewmembers per mission will be selected and trained as Crew Medical Officers. When crew size reaches seven, an additional CMO may be selected. A physician may not always be part of the crew of the Space Station nor is one necessarily needed in low Earth orbit, especially if supported by advanced telemedicine, and this must be taken into account when planning for the Station. However, the advantage of having a physician on board is that it is probably the single most effective means of delivering the medical care via the Health Maintenance System Enhancements under consideration for the CHeCS are intended to assist the non-physician CMO by building "intelligence" into medical devices. For example, an automated data system could be used to alert the CMO of time-critical or action-orientated events, e.g. notification of abnormal laboratory values. Similarly, diagnostic algorithms could be utilized for interpreting medical data, ECG interpretation for both morphology and rhythm, or interpretation of blood gases data. Artificial intelligence may also aid decision support to accelerate or simplify an action, e.g. data collection during a physical exam, and analysis and validation of decisions including selection of prescriptions and in management algorithms for treatment. Other enhancements under consideration include an integrated medical record, medical references, and inventory management utility for medical supplies and pharmaceuticals, in addition to enhanced data communication with audio and video components between the Crew Medical Officer in the Space Station and ground based medical personnel.

Crew Medical Officers on the Space Station will probably be treating injuries that are less immediately critical in nature. These injuries might include fractures, lacerations, progressive medical or surgical conditions, or possibly behavioral conditions. Due to the possibility of a delay in a return to Earth from the orbital outpost, it would seem appropriate to also emphasize training in skills of longitudinal management of medical illness. Therefore, a Space Station CMO and their supporting ground physicians should not only be expert in emergency stabilization but also skilled at ongoing treatment of a broad spectrum of medical and behavioral conditions. In 1999, the International Space University planned a space medicine residency describing the required training for space medicine and this incorporated many areas of medical knowledge. Such types of medical training programs would probably produce the most suitable candidates for future Lunar or Mars outpost physicians.

The International Space Station will help to establish norms for human habitation of space and to qualify and quantify the reaction to isolation and confinement. The knowledge and experience gained regarding crew health issues and health needs aboard the International Space Station will be used for verification of requirements for long duration space flight and in the planning and preparation of Lunar and Mars exploration and colonization. For a Lunar outpost a Health Maintenance System, similar to that on the Station, could be planned but with expanded capabilities beyond the Station's to perform certain types of surgery and other procedures.

There are ongoing epidemiological studies from the Antarctic and the National Science Foundation, which have provided NASA with information that can be used as a guide for habitat design, life support and the study of human factors. Analog data from Antarctica have been helpful in confirming the hypothesis that medical problems do occur in remote or isolated locations on Earth, and so they may be expected on the Moon and Mars as well. The response to significant medical problems that are required in most analog cases relies on evaluation and management by a physician on site at the facility. This is often due to the difficulty of medevac from these sites. Similarly, the ability to transport an ill or injured crewmember from a Lunar outpost back to Earth for medical care should prove to be just as problematic and certainly more so than it would be from the International Space Station in low Earth orbit. This factor will probably be a major influence for placing a physician at a Lunar outpost.

Medical support philosophy for missions to Mars must change even more from what is currently employed on the Space Station or even planned for the Moon. Crewmember injury will need to be treated inflight, as the crew will be from 35 to 230 million miles away, making return to Earth impractical. A round trip radio communication could take up to 40 minutes depending on the positions of Mars and the Earth, and extended periods of complete communication "blackout" are also calculated to occur.

This kind of isolation from Earth means that the crew must be almost completely self-reliant for medical care. They must be able to manage medical problems on-site. Due to the long duration of exploration missions, crew selection based on crew interpersonal and group interactive psychosocial factors will also be important. Mars missions involving extended microgravity exposure will pose several prob
See SPACE MEDICINE BRANCH, p. 1059.

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lems for the crew as already seen in other long duration missions, especially musculoskeletal deconditioning, orthostatic intolerance, and radiation exposure. Ample time in the schedule will need to be set aside to allow for maintaining physical condition in flight and for rehabilitation and readapting upon returning to the Earth.

An important part of a Mars mission health care system will be computerized medical informatics that are capable of acquiring and managing medical information, providing medical references, decision support, and automated medical record keeping. This medical system would also have an onboard telemedicine capability, although its uses could not support real time scenarios. Equipment for Mars explorers will need to be designed to be modular and portable to ensure that it is interchangeable between vehicle and planet surface. This should include miniaturization to reduce mass and volume.

Another point to consider is that in order to ensure crew health and safety, appropriate preventive measures must be taken to halt physical and psychological health problems before they become serious medical problems. Also, the medical system on board a Mars mission spacecraft should be adaptable to the level of medical expertise present in the crew. Finally, it is recommended that all the non-medical astronauts going to Mars should be trained at least in first aid techniques.

It is unlikely that more than one crew physician will be flown on a Mars mission as indicated by the reasons given above. However, at least one other Mars mission crewmember should be designated as a second Crew Medical Officer. With careful planning and preventive surveillance future space outposts will have an excellent health maintenance system with designated medical personnel as part of the team.

Remember!

Council Meetings are open to all members of the AsMA. Your input and attendance are always welcome. Our next meeting will be on Nov. 14, at the Holiday Inn Eisenhower Ave., Alexandria, VA..