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SPACE MEDICINE BRANCH REPORT

Space Station Freedom's Health Maintenance Facility Revisited: Results of Restructuring

by Michael Barratt, M.D.

Recent restructuring activities mandated by Congress have led to a redesign and overall downscaling of Space Station Freedom (SSF). Modules will be smaller to allow ground assembly and outfitting, and the supporting truss structure will be launched in preassembled segments to reduce orbital construction efforts. A phased growth is planned, in which station capability, mission duration, and crew demands become increasingly complex. The Crew Health Care System, which consists of the Health Maintenance Facility (HMF), the Environmental Health System (EHS), and the Exercise Countermeasures Facility (ECF), will evolve in step with SSF.

While the capabilities have diminished somewhat with restructuring, the mission of the HMF has not changed. Formally stated, this is to provide preventive, diagnostic, and therapeutic health care to crewmembers, to reduce the likelihood of a medical evacuation, and to better ensure success in the event a medical evacuation is necessary. Many factors and activities unique to the SSF environment, including microgravity, extravehicular activity (EVA), and potential exposure to radiation and toxic substances, drive development of medical hardware items and approaches to medical problems. Capabilities of medical hardware and level of crew medical officer (CMO) training must combine to support a planned level of care at each phase of space station development.

At the first operational stage, known as the Man Tended Capability (MTC) phase beginning in early 1997, an Orbiter will always be docked at SSF. A crew of five will conduct assembly and science missions on the order of 12 to 30 days in length. The general medical philosophy will be to handle minor problems on station with the Shuttle Orbiter Medical System (SOMS), with a "stabilize, load, and go" approach to more serious medical events, effecting a timely Earth return. The HMF at MTC will be located in a station node and consist of an Advanced Life Support (ALS) pack, a cardiac defibrillator/monitor, an automated ventilator, prepackaged intravenous fluids totaling 14 L, a Crew Medical Restraint System (CMRS), and a portable oxygen supply. Although the items are conceptually familiar to the medical community, several specialized constraints influence design and use of medical hardware on SSF. For example, sensitive station avionics must be shielded from electromagnetic interference from the defibrillator, and the ventilator breathing circuit must be vented overboard to avoid enriching cabin atmosphere with oxygen and increasing fire hazard. As expected, adequate restraint for the patient, CMO, and needed hardware in microgravity is a limiting factor in delivering medical care. Recent simulations in ground facilities and in parabolic flight on NASA's KC-135, consolidating medical equipment and SSF environmental constraints, have demonstrated effectiveness of MTC hardware in delivering advanced cardiac life support (ACLS).

In addition, hyperbaric medical capability will be provided. The EVA airlock serves a dual role as a hyperbaric chamber to treat on-orbit decompression sickness, aeroembolism, and ebullism, all possible consequences of EVA. Chamber pressure has been downrated from 6 to 2.8 atmospheres absolute (ATA); otherwise restructuring has had minimal impact on hyperbaric airlock (HAL) capability. The HAL will support normal and extended Table 6 treatment profiles beginning at MTC, and all HMF hardware must interface with the HAL to provide a common level of care during hyperbaric treatment.

Upon reaching the Permanently Manned Capability (PMC) phase in late 1999, SSF mission duration will increase to up to 90 days with a crew size of four. Although other options are being explored, as currently planned an Orbiter will not be continually docked; however, an Assured Crew Return Vehicle (ACRV) should be available to evacuate an ill or injured crewmember. The HMF at PMC will expand to meet the requirement to maintain a critically ill patient on station for 3 days, allowing maximal stabilization prior to transport or possibly avoiding transport. Resources to treat the more frequent and less serious medical problems of everyday life aboard SSF will be expanded. Additions to MTC capability include a system for producing intravenous fluids from potable water supplies, clinical chemistry, hematology and blood gas analyzers, enhanced physical diagnosis and restraint hardware, dental and surgical instruments, a transport monitor, expanded pharmacy and central supply, and a cardiac compression assist device. CMO training will be enhanced accordingly to match capability with available materials.

As SSF is allowed to evolve in size and complexity, post-PMC (PPMC) phase additions to the HMF are planned. Anticipating a crew size of eight and mission durations of up to 180 days, further additions to the HMF will include diagnostic X-ray capability, a laminar flow surgical chamber, and a warm blood collection system to facilitate inter-crewmember transfusions. As the most distant phase, the PPMC medical equipment list will be the most subject to amendments and revision, building on experience and incorporating developing technologies. Given crew size, mission duration, and HMF capabilities, it is reasonable to expect that the PPMC CMO will be a clinically current physician-astronaut.

The requirement of available, onsite medical care during extended spaceflight missions is an inevitable consequence of human presence. Increasing crew size, mission duration, and remoteness drive a parallel increase in the need for independent medical capabilities. Experience gained by the Freedom's HMF will be invaluable in defining medical requirements for other extraterrestrial ventures such as exploration of the Moon and Mars. It is a logical first step on a medical frontier, and its deployment is anxiously awaited.

AsMA Member Named Payload Specialist Candidate

Jay Buckey, M.D., an AsMA member, has been named one of three payload specialist candidates by NASA. After further training and evaluation of these candidates, NASA will choose one to fly as the prime payload specialist aboard Columbia on the Spacelab Life Sciences-2 mission, STS-58, a 7-day flight scheduled for launch in mid-1993. The other two will support the mission from the ground as backups.

The SLS-2 mission will be the second Shuttle Spacelab mission dedicated to the investigation of microgravity's effects on human physiology. SLS-1, flown in June of last year, was the first such Spacelab mission. Life sciences experiments and flight techniques developed on missions such as SLS-2 are precursors for research that will be done on Space Station Freedom. These investigations are crucial if humans are to live and work in space safely and effectively.

Dr. Buckey is an assistant professor at the University of Texas, Southwestern Medical Center, Dallas.

AsMA FUTURE MEETINGS

May 10–14, 1992
Fontainebleau Hilton
Miami Beach, FL

May 23–27, 1993
Sheraton Centre Hotel
Toronto, Ont., Canada

May 8–12, 1994
Convention Center
San Antonio, TX