SPACE MEDICINE BRANCH REPORT

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What kind of physicians for space?

We are in debt to Dr. Richard J. Hamilton for the following article. Dr. Hamilton graduated from Hahnemann University Medical School in May and is interning at the San Diego Naval Hospital. He tells me that, with any luck, he'll be permitted to enter the flight surgeon program at Pensacola. He admits to being triggered by the earlier article of Dr. Broadwell (Oct. '86). Our thanks to them both.

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Up to this point in the space program, the physician-astronaut has been mostly astronaut. The medical background of the physician has been most useful to the space program as a rigorous training in observation, attention to detail, and in biomedical/biological research. It was not necessary to have a physician's clinical presence on board the spacecraft because of the highly exacting health screening for astronauts and the limited lengths of time spent in space.

As previously reported here by Dr. David Broadwell, this situation is rapidly changing. Plans for a Low Earth Orbit (LEO) Space Station and its design have been finalized at NASA, and ambitious predictions have the station manned within a decade. The implications to the space medicine community are obvious—how to prepare for the challenge of providing care to the astronauts on board the Space Station?

The questions raised by this challenge are equally obvious. What sort of illness will occur? What will constitute an appropriate medical presence in space? What are the options available for catastrophic illness in space? And finally, the question I'd like to address, how shall we train the flight surgeons who will staff the clinic in space, and from what medical specialty should they be chosen?

Early studies using data from Skylab and Shuttle missions have provided a basic introduction into the changes in physiology provided by the microgravity of earth orbit. However, enough astronauts have not logged enough time in space to generate data on illness in space. Space medicine knows very few of the answers to clinical questions about the presentation, course, pathophysiology, and treatment of illness in space.

Typically, the Soviet space program has already had first-hand experience with illness and its sequelae in space. On board Salyut-7, Cosmonaut Vladimir Vasyutin developed what TASS reported as an "inflammatory disease that did not respond to the drugs available on board." This "inflammatory disease" was significant enough to preclude Vasyutin acting as commander during the landing. The cosmonaut required immediate hospitalization (1). Clearly, attempts were made to treat Vasyutin with the limited pharmacy on board until orbital conditions permitted a return to earth. What a disaster to think that something, such as a hypovolemia secondary to gastroenteritis or emesis, which would have responded to simple intravenous hydration and bowel rest, could end in an incapacitating illness that ended a mission. Clearly, then, the success of a long mission could benefit from some anticipation of the clinical milieu of space.

Instinctively, it would seem that beyond the physiologic response to microgravity, the flight surgeon will encounter, as Dr. Broadwell states, "common medical problems that occur in an exotic environment." And indeed, it seems that studies done in similar earthbound environments bear out this conclusion. A retrospective study done by Lawrence A. Polinkas on Antarctic winter-over personnel indicated that they experienced no greater incidence of illness after their winter-over than their age-matched counterparts (2).

In regard to the physical plant of the Health Maintenance Facility (HMF) on Space Station, the NASA Chief of Medical Operations, Dr. James S. Logan, has outlined a system to ensure the health and safety of the crew and avoid an unnecessary rescue at an estimated cost of up to $200 million and of 14–28 days (3). Implicit in the NASA proposal is the concept that there are certain illnesses that, although not fatal on earth, would be fatal in space because the facilities and personnel required to treat them would be impractical to maintain. Realistically then, major trauma, burns, or catastrophic illness that would require extensive surgical procedures with a fully equipped operating facility and intensive care unit, and all the support equipment and supplies these entail (sufficient blood and blood products, pharmacy, intravenous fluids, etc.), would be impossible to treat in space. These have been termed "acceptable risk" illnesses and the prospect of their untreatability is a horrifying possibility that inhabitants and workers in the Space Station must confront. Other illness, although not as therapeutically intensive, will be more diagnostically intensive, requiring CT scanning, nuclear imaging, complex laboratory testing. These must be treated using a presumptive working diagnosis, possibly awaiting specific diagnosis upon return to Earth. Thus, illness that may present as abdominal pain, such as renal calculi, appendicitis, diverticulitis, gastroenteritis, ovarian cyst, etc., must be distinguished using the clinical acumen of the physician on board, ground-based consultation, and the limited diagnostic capabilities of the HMF, and then be treated and stabilized.

The nature of the human interface is the one undecided medical question in the overall dilemma of illness in space. It has been proposed that, for the early missions when the station is minimally manned, an astronaut be trained in collecting medical information, performing a physical exam, and starting treatments from ground-based medical directives. Later, as the number of personnel increases and the physical screening becomes less rigorous, it will be necessary to place a flight surgeon on board.

The final issue then, in light of an analysis of the types of illness that will occur and the types of illness that will be treatable, is what type of physicians should go and how shall they be trained?

Obviously, there is a definite requirement for expertise in aerospace physiology, crew safety, public health, radiation hazards, toxicology, etc., that are typically associated with the specialty of aerospace medicine. However, training in this specialty would not be enough. The clinician on board a space station is, in fact, the only medical presence for the crew and must be equally familiar with minor surgery, invasive procedures, dental procedures, critical care, ambulatory medicine, gynecology, trauma, and radiologic diagnosis. Others have argued that a surgeon should be the physician on board because of the training in trauma a surgeon receives (4). Unfortunately, it is not plausible to hope to have the capability on space station to handle major trauma in the near future. Also, the surgeon is poorly trained in simple ambulatory medicine. Conversely, internists would be well versed in general medicine but have poor training in surgery, orthopedics, lacerations, and invasive procedures. However, the program for training specialists in emergency medicine seems to be ideally suited for the requirements of the space station. Specialists in this field have backgrounds in general medicine, critical care, trauma, orthopedics, ambulatory medicine, surgery, and gynecology. They are trained to examine patients and to make diagnostic decisions based upon routine laboratory tests and radiology. They are well versed in triage and stabilization. Finally, the nature of their practice would allow them time to train for a space mission and maintain their vital clinical skills.

However, the physician entering the realm of space medicine, even with a background in emergency medicine and aerospace medicine, would need further training to be truly ready to begin taking care of people in orbit. There is little data on the effects of microgravity on man, and only a small percent of that raw data represents clinically useful information. What does a microgravity chest film look like? How does a radiographic air fluid level appear in microgravity? What are normal lab values for space? What happens to a fracture in microgravity? What is the most effective means of cardiopulmonary resuscitation in space? In short, a bank of data must be created to establish a baseline space variant from which the clinician in microgravity can draw to treat and stabilize a patient. The flight surgeon would be guessing every step of the way without it.

Some equipment data can be collected using the 30–40 seconds of microgravity that parabolic flights create. Such data as microgravity chest films, abdominal films, and

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ECGs can really only be collected while man's presence in space proceeds.

One solution to the whole problem would be to set up a fellowship in space medicine that would incorporate a study of basic aerospace physiology, radiation, toxicology, preventive medicine, and emergency medicine into the specifics of the space station environment. During this year, the physician could practice on a part-time basis while performing research that would contribute to the broad-based clinical understanding necessary for the application of medicine in space. Research is desperately needed about medical equipment such as intravenous lines, compact laboratory diagnostic equipment, and the logistics of simple surgery and invasive procedures in space. Other questions in areas such as preventive medicine will require data from ongoing Shuttle missions as the station is assembled.

Although the building of a LEO space station seems to be a vague, futuristic consideration in light of a grounded Shuttle program, the fact is that man is now and will be in outer space for as long as he dares imagine. Where man goes, his illness will follow, and so must physicians. The space medicine community must take the lead to study and organize for that inevitable moment. Determinations must be made now so that training and selection can occur in proper anticipation of a large, permanent, working presence in space—and of its medical needs.

REFERENCES

1. Rich V. Medical hazards to cosmonauts. Nature 1985; 318:306.
2. Palinkas LA. Health and performance of Antarctic winter-over personnel: a follow-up study. Aviat. Space Environ. Med. 1986; 57:954–9.
3. Logan JS, Shulman EL, Johnson PC. Health care delivery system for long duration manned space operations. AIAA Tech. Info. Service 1983. A84-29064.
4. Houtchens B. System for the management of trauma and emergency surgery in space. AIAA Tech. Info Service 1984; N84-21045:4, 70.

Health services research training fellowships available

The National Center for Health Services Research and Health Care Technology Assessment (NCHSR), part of the U.S. Department of Health and Human Services, plans to award 10 fellowships for academic postdoctoral training in research to solve problems in health care service. The amount of each stipend depends on the level of experience already attained.

Further information may be obtained from the Public Health Service, National Center for Health Services Research and Health Care Technology Assessment, Chief of Review and Advisory Services Program, Parklawn Bldg., Room 18-12, Rockville, MD 20857.

NASA Life Sciences office chooses 29 experiments for future space flight

Arnauld E. T. Nicogossian, M.D., Director of NASA's Life Sciences Division, has announced that 29 life sciences experiments have been chosen for future space flights some time in 1991–94.

Of the 29 chosen, 25 are from U.S. universities, three from NASA installations, and one from a non-U.S. institution.

Selection of the experiments is only the first step in actually flying them. The next step involves defining the requirements for each experiment and matching these requirements with projected Shuttle and Spacelab missions.

The experiments, in alphabetical order by name of their principal investigators, are:

Dr. S. Arnaud, Ames Research Center, Mountain View, CA, Effects of Weightlessness on the Static and Dynamic Indices of Bone Histology in Man;

Dr. E. Balish, University of Wisconsin, Madison, Effects of Weightlessness on Cell-Mediated Immunity;

Dr. D. Bikle, V. A. Medical Center, San Francisco, CA, Effects of Weightlessness on Bone Formation;

Dr. G. Blomqvist, University of Texas Health Science Center, Dallas, Cardiovascular Regulation at Zero G;

Dr. A. Brown, University of Pennsylvania, Philadelphia, An Experiment to Characterize Gravitropic Responses of Gravitationally Naive Plant Seedlings;

Dr. C. Cann, University of California at San Francisco, Direct Measurement of the Initial Bone Response to Space Flight in Humans;

Dr. A. Cogoli, Laboratorium Fur Biochemie, Zurich, Switzerland, Cell Proliferation and Performance in Space;

Dr. G. J. DiGregorio, Hahnemann University, Philadelphia, PA, The Role of Human Parotid Saliva in Space Flight: Toward the Development of a System to Investigate Pharmacokinetics of Drugs at Zero G;

Dr. D. Eckberg, Hunter Holmes McGuire V. A. Medical Center, Richmond, VA, Influence of Weightlessness Upon Human Autonomic Cardiovascular Control;

Dr. V. R. Edgerton, University of California at Los Angeles, Relationship of Long-term Electromyographic Activity To Muscle Atrophy and Performance;

Dr. C. Fuller, University of California at Davis, Influence of Space Flight on Primate Physiology and Behavior;

Dr. J. Furst, Wright State University School of Medicine, Dayton, OH, Development and Inflight Testing of an Inflatable Chamber for Minor Surgical Care in the Zero-G Environment;

Dr. G. Herbison, Jefferson Medical College of Thomas Jefferson University, Philadelphia, PA, Maintenance of Human Muscle Strength by Isometric Co-contraction During Space Flight;

Dr. B. Houtchens, University of Texas Health Science Center, Houston, TX, Evaluation of Apparatus and Techniques for the Performance of Surgery and Clinically Related Physiologic Monitoring in a Microgravity Environment;

Dr. W. Kramer, University of Houston, Texas, Space Flight Effects on the Clinical Pharmacokinetics of Drugs;

Dr. A. Krikorian, State University of New York at Stony Brook, Gravity, Chromosomes and Organized Development in Aseptically Cultivated Plant Cells;

Dr. A. LeBlanc, Baylor College of Medicine, Houston, TX, Magnetic Resonance Imaging After Exposure to Microgravity;

Dr. J. Measel, Texas College of Osteopathic Medicine, Fort Worth, The Effect of Zero Gravity With and Without Stress on Murine Lymphoid Tissue;

Dr. M. Moore-Ede, Harvard Medical School, Boston, MA, Fluid and Electrolyte Homeostasis in Space: Regulatory Mechanisms in a Non-Human Primate;

Dr. C. Oman, Massachusetts Institute of Technology, Cambridge, Etiological Mechanisms of Space Motion Sickness;

Mr. G. Petersen, Jet Propulsion Laboratory, Pasadena, CA, Biological Reactors in the Microgravity Environment;

Dr. M. Reschke, Johnson Space Center, Houston, TX, Modification of Vestibulo-Spinal Reflexes as a Function of Space Flight;

Dr. D. Riley, Medical College of Wisconsin, Milwaukee, Neuromuscular Atrophy in Space Flight Studied by Biochemistry, Cytochemistry, and Electromyography;

Dr. F. Salisbury, Utah State University, Logan, Developmental Processes of Wheat in Microgravity;

Dr. P. Webb, Wright State University School of Medicine, Dayton, OH, Effects of Microgravity on Energy Expenditure as Measured by Direct Calorimetry;

Dr. J. West, University of California at San Diego, Extended Studies of Pulmonary Function During Weightlessness;

Dr. D. Wolgemuth, Columbia University, New York, NY, Effects of Space Flight on Follicular Development and Early Embryogenesis in Mice;

Dr. T. Wronski, University of Florida, Gainesville, Role of Corticosteroids in Bone Loss During Space Flight;

Dr. L. Young, Massachusetts Institute of Technology, Cambridge, Visual/Vestibular/Proprioceptive Adaptation to Weightlessness.