Monday, June 9

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Session MP3
Room 3
2:30 - 5:30 p.m.

Clinical and Educational Support for Space Flight via Telemedicine

"Telemedicine: A User's Perspective"
Arnauld E. Nicogossian
NASA Headquarters

Telecommunications has been used to support human space flight since its inception. The recent emergence of computer technology to support medical communications has evolved over the years to make telemedicine a more widely distributed service for the delivery of health care. Recently, these systems have been demonstrated as a useful means to support medical education to remotely located physicians and allied medical professionals. In addition to the application of telemedicine in space flight, NASA has supported several terrestrial testbeds to evaluate technology and develop appropriate protocols and procedures. This evaluation has included a review of the systems and approaches by the user community, which can be defined in several categories. These include the astronauts and flight surgeons that provide medical support to the astronauts during flight; and those recipients of telemedicine services in the terrestrial testbeds, which includes physicians (both primary and consulting), the patient, and the technical support personnel that make it happen. The principle evaluation criteria can be characterized by the complexity of the system (i.e. is it user friendly), is it reliable and secure, is it convenient, is the information (e.g. images, audio, video, etc.) of diagnostic quality and representative of the illness or injury. Moreover, has the use of telemedicine enhanced decision making by the clinician. This paper will discuss the application of telemedicine from the user's perspective. It will discuss the outcomes of recent technology evaluations and testbed activities conducted domestically and internationally. It will highlight the utility of this service as it relates to the delivery of medical care in spaceflight.

Health Care in Extreme Environments
James D. Collier
NASA Headquarters

From its inception, the United States' Space Program has, by design, placed humans into extreme environments. The challenge has been to provide for the health of these particular humans while they are in these harsh environs, remote from the providers of health care. The pillars of this health care system have been: selection, prevention, the assessment of risk from which training and medical supplies can be provided for each mission class, and the use of telecommunications. Selection of healthy persons into the astronaut corps reduces the likelihood of mission-related health problems, prevention efforts are designed to prevent the onset of disease or the occurrence of injury, and the assessment of the risk of inflight disease or injury has led to the design of training programs and the provision of medical supplies consistent with the applicable mission type. Despite updates to these three pillars as mission types changed and new knowledge of preventive medicine became available, the general concepts remained the same. In fact, NASA's efforts in these areas have been relatively similar to trends in general Earth-based health care. Where NASA has stood apart, and where some of the greatest strides have been made in caring for people in remote environments, has been the integration of the three pillars with the rapidly advancing field of telecommunications. In general, this new area is called telemedicine. This article examines the advances made or contemplated by NASA in the application of the four pillars, including telemedicine, to medical care in extreme environments; from limited telemetry of the Mercury program to the possibilities of telepresence in the exploration class missions.

Integration of Emerging Technologies in Information and Telecommunications in Health
Care Systems for Space
Charles R. Doarn
NASA Headquarters

NASA has been involved in the development and application of telemedicine since
the early days of the space program. The integration of telecommunications and
information systems into health care systems is of critical importance in space flight.
Today, astronauts and medical support personnel on the ground depend on reliable
communications link between spacecraft and the ground. This link allows telemedicine to
be practiced on a routine basis in the human space flight program. In addition, limited
inflight medical care systems to meet mission risks and requirements are available to
support Shuttle and the International Space Station. However, as mission profiles increase
in duration, complexity, and distance from Earth, the ability to meet appropriate medical
needs and training of the crew will require an evolution in capability. This evolution will
encompass the advent of the application of emerging technologies in information systems,
telecommunications, medical diagnosis and treatment, and human-machine interfaces.
Such technologies will include smart sensors, decision support systems, artificial
intelligence, non-invasive diagnostic tools, haptic interfaces, and virtual presence.
Communications and computers have always been a part of the space program. These
technologies are experiencing rapid growth and demonstrate applicability to enhancing the
delivery of medical care to humans in extreme environments. Investment in enabling
technologies for the 21st Century will help NASA meet the new challenges of space
exploration in the new millennium. Advances in technology in information systems,
telecommunications, medical diagnosis and treatment, and human-machine interfaces will
enhance NASA's ability to provide appropriate medical care to astronauts in remote
environments. A strategy for developing these technologies through appropriate
partnerships with other government agencies, academia, and industrial partners, will be
presented.

TELEMEDICINE AND ENVIRONMENTAL MEDICINE IN RUSSIA: A FIRST STEP IN BASIC MEDICAL EDUCATION

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INTRODUCTION

Rapid growth of world communication systems creates a problem in contemporary medical educational methodology. The main idea of modern medical education can be formulated as follows: physicians must be able to select and synthesize necessary information and to apply that information successfully. But the question is: how to prepare highly knowledgeable professionals both in clinical research and medical information exchange service? Since 1995 the Chair of Aerospace and Environmental Medicine at Space Biomedical Center for Training and Research has been helping medical students in Lomonosov Moscow State University to meet the challenge of information revolution and clinical training.

RESULTS

Among several courses which were designed for senior students during basic 6-year medical education there are Telemedicine (TM) and Environmental Medicine (EM). EM course, which is preliminary in the complete telemedicine education, deals with the main pathophysiological reactions of human body in extremal existing conditions. Students get acquainted with the principles of providing medical help under the crucial conditions of variability in atmospheric pressure and temperature, high level of solar, UV, ionizing and nonionizing radiation. The problems of adaptation and ecology are also considered, including toxic effects of the pollution. After one semester of EM students begin TM training course. It is mainly based on the principles and technical support of aerospace telemetry and includes: a) the main approaches to informational exchange, b) the technical review of the telemetric systems used in space medicine, c) the use of aerospace communication systems and multimedia stations in clinical practice, d) presentation of medical data with maximum information effectiveness, e) typical mistakes during advising and consulting by video and audio contact, f) the quality, standardization and economic effectiveness of medical help during teleconferences. At the end of the course students can take part in organizing teleconferences on urology, traumatology and cardiology.

CONCLUSION

The authors of the first Telemedicine educational program devoted considerable time and effort to make sure that information required by Russian medical school curricula is completely included.

Clinical Utility of Internet Telemedicine

Ronald C. Merrell, Yale University; Peter Angood, Yale University; Charles Doarn, NASA Headquarters

Telemedicine was introduced as an asset for clinical medicine with broad band width full motion features which required great resource commitment of satellite, transponders and the equivalent of a professional television studio. The availability of telemedicine for general use has in some ways been retarded by the tremendous cost of the pilot technology. Recent advances in computer based technology and almost generalized access to the Internet has invited experimentation with lower band width options at a fraction of the cost. Over the last three years Yale School of Medicine has been linked to the Moscow State University Medical School to test a variety of communication linkages. Currently we utilize SGI work stations and SGI Workstation has a 10mb connection to the Yale University backbone, and the University has dual T1 access to the Internet access to the Internet to produce web site storage of complex cases which can be downloaded from the server at Lewis and reviewed by clinicians. The evaluations can be discussed by Internet connectivity and a formal consultation can be generated back to the Web site. This store and forward methodology is highly appropriate given the ten hour time difference between New Haven and Moscow, Real time consultation is of limited use. The images coming from the SGI included ultrasound, computed tomography, magnetic resonance imaging, standard radiographs, patient photographs, plus large amounts of digital and graphic data.

Thirty case evaluations were completed by American specialists and returned to the web site. This connectivity offered full confidence for all static images and less so for stored moving images. The use of a standard consultation format made the confidence in presentation very high and allowed the rendering of advice without reservation. Prior experience between the two centers indicated that the information offered could be completely implemented in Russia. In the evaluation of the cases we conclude that the SGI workstation, Internet connection with Web site store and forward using a standardized is an effective and low cost structure to facilitate telemedicine consultation.

A Web-Based Human Computer Interface For Internet Telemedicine

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Despite the exponential growth in the number of telemedicine projects and systems, relatively little attention has been paid to the human factors issues associated with such systems. Particularly, no guidelines exist to assist in the development of human-computer interfaces, associated with telemedicine systems, that address the human factors issues of human-computer interaction (HCI) and interface design. HCI is a growing field with the recognition that the human-technology interface is the key to optimizing human performance. Therefore, NASA has supported this effort to apply HCI design principles to the field of telemedicine. There are several efforts underway at NASA to develop telemedicine systems for use in addressing medical care issues in unique environments where health care providers may have limited access to medical facilities. In particular, the web/videoconferencing integrated interface for the Spacebridge to Russia project will be used in this paper to illustrate the principles of good interface design in general and as related to telemedicine systems. Three principles will be addressed: 1) user-centered design 2) modeling the human processor and 3) task and constraint-oriented design, i.e. What is unique to interface design for telemedicine systems.