International Telemedicine / Disaster Medicine Conference

Papers and Presentations

December 9-11, 1991
Bethesda, Maryland

NP-207

Donald F. Stewart, M.D.
Program Chairman

Preface

The first International Telemedicine/Disaster Medicine Conference was held on December 9-11, 1991, at the Uniformed Services University of the Health Sciences (USUHS) in Bethesda, Maryland. It was jointly sponsored, organized, planned, and conducted by the USUHS, the National Aeronautics and Space Administration, and the American Institute of Aeronautics and Astronautics. The overall purpose was to convene an international, multidisciplinary gathering of experts to discuss the emerging field of telemedicine and assess its future directions; principally the application of space technology to disaster response and management, but also to clinical medicine, remote health care, public health, and other needs.

The papers contained herein were written by many of the foremost members of the biomedical and space science communities who addressed the Conference. The papers reflect the diversity of disciplines, ideas, visions, and individuals associated with telemedicine, which was defined by Dr. Harry C. Holloway for the purposes of the Conference as "medicine practiced at a distance." This collection is intended to acqaint the reader with recent landmark efforts in telemedicine as applied to disaster management and remote health care, the technical requirements of telemedicine systems, the application of telemedicine and "telehealth" in the U.S. space program, and the social and humanitarian dimensions of this exciting new area of medicine.

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OPENING SESSION

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Vice Chairman on the Commission on Disaster Management
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Conference Goals

Participants at the International Telemedicine/Disaster Medicine Conference considered the following questions:

1. What is (or are) the definition(s) of telemedicine?

2. Under what conditions can modern communications and information technologies contribute to the improvement in disease prevention or efficacy of medical practice? Specific considerations include
   a. types of applications (e.g., disaster, care to remote areas or informatic applications—medical imaging, or applications to laboratory or electronic data transfer)
   b. factors related to scales (e.g., local, national, international)
   c. economic impacts (e.g., through improved efficacy or lower overall cost).

3. Are the potential telemedical applications and related informatics requirements being addressed by the medical academic community so that training programs exist to communicate the applications of telemedicine? Is information about telemedicine well represented in medical school curricula and the continuing medical education of practicing physicians? If not, what should be done to change this?

4. How should telemedicine be used in medical education—local (e.g., in district, state, or urban setting), national, or internationally? Who can serve as a proponent for such applications?

5. What institutional entities should be involved in the development of the practice of telemedicine? What national and international institutions? What should the private and governmental contribution to telemedical activities be?

6. What institutional entities should be responsible for developing and evaluating protocols for the practice of telemedicine?

7. What can be done to document the effectiveness of telemedical applications and specific protocols for improving medical efficacy, cost saving for specific applications, and applications to disaster relief?

8. Does telemedicine provide a critical resource to disaster relief efforts? What should be the role of telemedicine in the various of disaster relief?

Introduction

The value of telecommunications technologies in the delivery of health care has been amply demonstrated over the last 20 years, as the papers gathered in this publication show. A major step forward was the large-scale application of space technology to the treatment of disaster casualties in 1988 and 1989, with the U.S./U.S.S.R. Telemedicine Spacebridge. The first International Telemedicine/Disaster Medicine Conference, conducted in December 1991, was planned as a follow-up activity to the Spacebridge.

The objective of the conference was to provide a forum for an international body of experts to discuss the ways in which space technology could improve the delivery of medical care to remote sites and disaster-stricken areas. The list of participants (including specialists in communications, medicine, and public policy) and the agenda give a ready indication of the diversity and range of experience of the interested organizations and individuals, and demonstrate the rich variety of ways in which the emerging field of telemedicine may contribute to the alleviation of human suffering.

The conference focused in large part on the potential contributions of telemedicine within two major areas of endeavor—disaster medicine and remote health care. In most cases the protocols and technologies will be identical, similar, or complementary, and, as the conference participants emphasized repeatedly, it would be most effective if the infrastructure emplaced for the routine practice of telemedicine could be modified, if and when necessary, for disaster medicine. "Disaster" was defined as a natural event, industrial or technological accident, or military conflict where human death and injury, property destruction, and environmental damage overwhelm local resources. The challenges for remote health care include delivery of care to rural areas and extreme environments (such as the Antarctic), oil rigs, battlefields, and, of course, space.

The papers contained herein document the conference and provide an overview of the state of the art of telemedicine. This introduction briefly highlights prior experience in telemedicine, explores the challenges for future telemedicine systems, and previews a venture in U.S./Russian cooperation that is developing as a follow-on to the U.S./U.S.S.R. Telemedicine Spacebridge.

EXPERIENCE

The National Aeronautics and Space Administration (NASA) is particularly interested in the advancement of telemedicine, since the agency is in the unique position of providing health care to crews in the most remote of environments, space. As described in the paper by Huntoon, Schneider, and Karamanos, NASA's use of medical telescience during the infancy of the U.S. manned space program focused on monitoring astronauts' basic vital signs. Mercury and Gemini crews were monitored by voice communications and transmission of blood pressure, respiratory rate, body temperature, and electrocardiogram data. Metabolic expenditure was monitored during extravehicular activities in the Apollo missions. With the advent of Skylab, telescience was expanded to include downlinking of data from in-flight medical investigations.

The Space Shuttle era requires more intensive biomedical monitoring. Crew health is assessed daily. Ground-based NASA flight surgeons track crew health through biomedical monitoring and daily private medical conferences, and are responsible for supporting the crew in the event of a medical emergency. Communications with the Space Shuttle consist of two-way audio and data transmission and video downlink via the Tracking and Data Relay Satellite System. Space-to-ground data transmission supports experimentation on dedicated biomedical Shuttle missions, as well. Telemedicine capabilities are used to address issues of space-flight physiological deconditioning, radiation exposure, confinement, and to augment the limited medical resources onboard spacecraft.

The upcoming Space Station Freedom's Health Maintenance Facility will enhance onboard medical capabilities and make even greater use of telemedicine during extended stays in orbit. As exploration missions arise in the future, it will be crucial to have established telemedicine systems available for crewmembers to receive medical consultation, since in many cases a swift return to Earth will not be possible in an emergency.

The United States' first venture into the use of satellite-based communications systems to provide long-distance medical consultation on Earth involved delivery of care to remote villages in Alaska during the early 1970s. This project utilized NASA's Applications Technology Satellite (ATS-1), and was sponsored by the Public Health Service.

Between 1973 and 1978 a project initiated in part as a testbed for space technology brought telemedicine to the remote Papago Indian Reservation in the Sonora Desert of Arizona. This demonstration, known as Space Technology Applied to Rural Papago

Advanced Health Care (STARPAHC) and described in Dr. Pool's paper, was jointly sponsored by NASA and the Indian Health Service. The goal was to test health care systems that would lend insight into systems envisioned long duration space missions. A mobile health clinic was outfitted with state-of-the-art health care equipment and staffed with a physician's assistant (PA) and laboratory technician. The capabilities tested included advanced bioinstrumentation, computers, and video. The PA administered medical care under the supervision of physicians based remotely in Sells, Arizona. These physicians made diagnoses and recommendations for treatment based on the clinical data transmitted to them.

As discussed in Dr. House's paper, Canada made strides in the use of telemedicine throughout the late 1960s and early 1970s. Using Canada's Hermes satellite, the Telemedicine Centre of Memorial University of Newfoundland (MUN) established one-way video and two-way audio links with four hospitals, initially for educational programs. Since 1978, Memorial's Teleconference System has continued to link numerous Canadian communities, using telecommunications technology to provide medical consultation nationwide. In an experimental program using the Anik B satellite in 1980-81, MUN tested a hybrid system combining terrestrial and space communications technology. In one phase of the experiment, an oil rig's sick bay was connected via satellite to the emergency department of a tertiary care hospital. Among the technologies employed in both of these Canadian programs was slow-scan television, with applications in radiology, nuclear medicine, and ultrasound.

Canada also has been a major participant in international telemedicine. In the 1980s, under Project SHARE (Satellites in Health and Rural Education), teleconference links were established between MUN and universities in the East African cities of Nairobi and Kampala. SHARE was later expanded to cover six Caribbean countries. The system was used for education, medical consultation, and transmission of biomedical data.

TELEMEDICINE SPACEBRIDGE

In December 1988, a severe earthquake struck the Soviet Republic of Armenia, resulting in 25,000 early deaths and over 125,000 casualties. The Telemedicine Spacebridge was proposed by the co-chairs of the NASA U.S./U.S.S.R. Joint Working Group on Space Biology and Medicine. The Spacebridge employed satellite telecommunications to effect medical consultation among U.S. medical centers and physicians in Armenia. Although several previous telemedicine projects had provided intercontinental clinical consultation and education programs, Spacebridge marked the first interactive video telemedicine effort to provide medical support after a disaster. It remains the most significant example of international telemedicine cooperation to date.

Two-way audio and one-way full motion color video (from Armenia), and data and facsimile transmission were utilized to communicate between the Republic Diagnostic Center of Yerevan, Armenia, several regional Armenian hospitals, and the four participating American medical centers (Uniformed Services University of the Health Sciences (Bethesda, Maryland); Texas Medical Center (Houston, Texas); LDS Hospital (Salt Lake City, Utah); and the Maryland Institute for Emergency Medical Services Systems (Shock-Trauma)).

Clinical medical areas addressed during the consultation sessions included infectious disease, surgical intervention, burn treatment, epidemiology, orthopedics, and neurology. Psychiatric consultations were also given, addressing disaster-related topics such as post-traumatic stress syndrome, loss of or separation from family, and the effects on medical relief workers of the daily stress of working under duress amidst wide-ranging destruction and human carnage.

While the Spacebridge was in operation in Armenia, a second disaster struck the U.S.S.R. Two trains passing each other in a cloud of natural gas from a leaking pipeline triggered a gas explosion near the city of Ufa in Northern Russia. Hundreds of passengers were killed, with others suffering burns and trauma. The Spacebridge was promptly extended to Ufa, providing swift medical support for this second disaster.

As reviewed in the paper by Houtchens et. al., during Spacebridge's 3 months of operation, over 400 American and Soviet medical professionals participated in clinical conferences. Of the more than 200 cases discussed, 25 percent of diagnoses were altered, with many modifications in diagnostic studies and treatment plans also formulated. Spacebridge truly demonstrated that effective, interactive telemedicine consultation can play a major role in the aftermath of a major disaster.

TELEMEDICINE AND INTERNATIONAL RESPONSE TO DISASTERS

The Spacebridge revealed a number of important lessons for the international practice of telemedicine. For example, it took several months for the necessary bilateral agreements to be completed before consultations could proceed. Clearly, global telemedicine agreements and organizations, not to mention the technological infrastructure, must be in place if we are to respond quickly to disasters. This must be achieved by utilizing telemedicine internationally on a more routine basis, with issues of international law, liability, and responsibilities for cost and implementation resolved in advance.

There was a consensus at the conference that telemedicine capabilities for disasters and emergencies should indeed build upon existing infrastructures, maximizing the use of in-place systems and resources. Conference participants emphasized that telemedicine systems should be used routinely under non-disaster conditions, and that adequate technical training is a primary requirement. The need to extensively train technicians and physicians to operate a telemedicine system in the acute phases of a disaster would diminish that system's effectiveness. Moreover, effective training would ensure that consultants have at least a working knowledge of the culture, sociology, and environmental conditions of the region they will serve, all of which could influence diagnosis or treatment. Thus, telemedicine protocols should account for the inevitable differences in expertise and experience among physicians in individual nations. As Dr. Clemmer and others point out, standardization of protocols can improve communication in the face of cultural and language differences, assist decision making, protect against liability, promote the evaluation of new technologies and therapies, reduce costs, and aid quality assurance.

The international, coordinated response to the Armenian earthquake emphasized the need for prehospital emergency medical services infrastructure. The ability to resuscitate crush injury victims with intravenous crystalloid fluids, for example, is vital to helping reduce the incidence of renal failure from myoglobinuria. Efforts must be made to educate communities to allocate resources to develop prehospital medical service to the best of their ability in view of economic limitations. An in-place network of mental health services and psychological support systems is necessary to help both the local population and relief workers deal with overwhelming stressors.

A major issue to be resolved for the practice of telemedicine across international boundaries, with special ramifications for disaster medicine, is that of organizational involvement. Certainly there are roles to be played by the United Nations (including the U.N. Department of Humanitarian Affairs, the World Health Organization, and the International Telecommunications Union), the International Red Cross and Red Crescent Society, and many others. The entanglements of international law, bureaucracy, and the regulatory morass were cited as major obstacles by many conference participants. For example, which nations or organizations can or should pay for the creation and operation of a permanent telemedicine infrastructure? Who will operate it in times of disaster? What is the most effective chain of command? What are the implications of the international laws (or lack thereof) that govern communications systems? What are the proper ways to handle interfaces with individual governments, particularly in times of national emergency, when widespread injuries and property damage have severely stressed local resources and decimated existing social and governmental structures?

The commercial application of telemedicine was another future direction discussed at the conference. It was generally agreed that the expansion of telemedicine in private practice will depend largely on demonstrating the "value-added" dimension, i.e., reducing/controlling costs and improving care. Easing access to specialists may serve as an example here, especially when patients cannot travel or are geographically isolated. The Medical College of Georgia currently operates a telemedicine system that allows physicians to consult remotely with rural patients, with a PA on site. Other possibilities include nursing homes, correctional facilities, oil rigs and cruise ships, military bases, and polar stations: Telemedicine may reduce critical delays in health care in most of these instances.

In exploring these possibilities, we need to make intelligent use of the limited financial resources available for cooperative efforts, and we must educate the public and policy makers as to the tremendous potential for telemedicine. Health care providers must be instilled with greater confidence in informatic systems that retain many of the "personal" elements of care delivery through remote interaction with patients.

FUTURE DIRECTIONS

Based on the success of the 1989 U.S./U.S.S.R. Spacebridge, the Telemedicine Implementation Team of the the First U.S./Russian Joint Working Group on Space Biomedical and Life Support Systems met during the summer of 1992 in Washington, D.C., to develop plans for a follow-on program known as the Telemedicine Demonstration Project (TDP). The TDP is slated to begin in March 1993, and will continue for 6 months. One 4-hour session will be conducted every other week, originating on a rotating basis from the three main U.S. medical institutions participating in the program: Uniformed Services University of the Health Sciences (Bethesda, Maryland); Texas Medical Center (Houston, Texas); and LDS Hospital (Salt Lake City, Utah). These centers will be connected to a clinical hospital in Moscow and the Moscow Medical Academy, with plans for future expansion to other regional hospitals in Russia.

Communications for the TDP will utilize both U.S. and Russian satellites. The U.S. sites will uplink to a U.S. domestic satellite (DOMSAT), which will then downlink to an earth station at NASA's Lewis Research Center. Signals will then be transmitted from Lewis to the Russian "Loutch" satellite for the transatlantic link, and subsequently downlinked to the Moscow central station. The system will include audio, facsimile, and two-way color video transmission.

The TDP will provide expert consultation between the U.S. and Russia in clinical and preventive medicine, disaster and trauma management, epidemiology, cancer treatment/research, surgery, and public health. The agreement calls for the medical experts from both countries to exchange visits and acquaint themselves with the facilities and capabilities of the institutions with which they will interact.

Hopefully, the TDP will be a forerunner of additional telemedicine cooperation between the U.S. and Russia. It will serve to strengthen the scientific and cultural exchange between the two nations, expand on technologies that can develop into international medical exchange programs, and provide NASA with experience in distant health care delivery systems, which is important for Space Station Freedom and subsequent exploration missions.

CONCLUSION

Telemedicine is a new and dynamic field, and we are as yet in the first stages of exploring its possible applications. With the growing demand for broader delivery of health care and more attention to cost-effectiveness (and with economic restraints a fact of life), it is highly likely that telemedicine will play an ever increasing role in medicine. The health care industry has a total value in excess of $800 billion dollars per year; any increase in cost-effectiveness realized by telemedicine will be significant. Creative thinking and careful planning will be required as we further integrate telecommunications technologies into health care, both routine and disaster-oriented. The papers contained herein give an overview of the challenges we face.

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Welcoming Address / Introduction to the Conference

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National Aeronautics and Space Administration
Washington, D.C.

Harry C. Holloway, M.D.
Deputy Dean
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I would like to welcome you to the International Conference on Telemedicine and Disaster Medicine. Our intention when we were formulating plans for this conference was to convene a group of people who were playing significant roles in the evolution of telemedicine as a medical specialty. Specifically, we wanted to gather policymakers to discuss the current and future applications of telemedicine technology to disaster medicine, public health and epidemiology, and remote health care.

As you would well imagine, NASA's interest in remote health care results from our responsibility to provide quality health care services to astronauts undertaking space travel. Where our current Shuttle missions involve flights of only 7-10 days, discussions are under way regarding the possibility of 90-day Shuttle flights, which would involve docking the Shuttle to certain elements of the planned Space Station Freedom. These flights, and future flights being discussed in the context of exploration missions, would involve stays of up to 6 months or more in microgravity or the partial gravity (.17g) of the Moon. Telemedicine will have a key role to play in supporting medical operations for those missions in that it will not be possible to place on board spacecraft all the medical resources that we would optimally need. As you know, weight, volume, power, and crew time are very precious resources on board any spacecraft. Telemedicine support allows those on-board capabilities to be used in an optimal manner. Future interplanetary missions, such as to Mars, will involve distances of several hundred million miles—on this type of mission, due to the communications delay of up to 20 minutes, only non-emergency medical consultations will be possible. These circumstances strongly suggest the need for a high degree of self-sufficiency in exploration medical systems.

NASA's experience with telemedicine dates to the 1960s, when the need for biomedical monitoring of early space crews drove the development of biotelemetry systems. Future missions will require the further evolution of compact medical delivery systems, which will be supported by a crewmember physician, an integrated telemedicine capability, and possibly computer-aided medical diagnosis. In addition, advanced medical care systems for space will clearly benefit from ongoing developments in the terrestrial medical community, such as improved fiber optic endoscopes, and laparoscopes. The increasingly common use of these devices to do endoscopic or laparoscopic surgery raises the possibility that these same procedures could be performed using a remotely located surgeon. Other advances, such as the development of compact, digital radiographic systems, will allow simultaneous in-flight creation and ground transmission of medical images. These advances will allow the Crew Medical Officer, whether he or she is a physician or allied health personnel, to effectively deliver sophisticated medical care to a sick or injured astronaut.

Over the next several days, we hope to challenge all of you to think of telemedicine from a new perspective. The evolution of telemedicine as a distinct medical speciality appears to be gathering momentum by providing solutions to a crucial problem in contemporary health care. This problem is the poor distribution of medical care specialists in certain geographic areas. Or, in some instances, the complete lack of physicians in certain locales. In this latter case, a physician's assistant, with telemedicine support, can deliver the caliber of care normally associated with the presence of a physician.

While certain sponsors of specialized, remote operations, such as the oil industry and NASA, will routinely provide telemedicine support for their operational platforms regardless of cost, the truer test of telemedicine lies in its potential to facilitate health care for a broader populace now underserved by medical care providers.

Remarks Delivered at the International Telemedicine/Disaster Medicine Conference

Vice Adm. Richard H. Truly
NASA Administrator

On behalf of NASA I would like to welcome you to this conference. Over the years, practical applications from NASA's space science programs have yielded tremendous benefits to people around the globe—in such ways as weather forecasting, enhanced communications, and resource monitoring, to name a few, and I'm especially excited about the contributions of NASA's space research and technology to the fields of disaster medicine and telemedicine.

NASA routinely uses telemedicine now to support its manned space flight program. Exciting new developments in the field are helping to build the foundation for even more ambitious and far-reaching uses of telemedicine in space. I'm talking about Space Station Freedom, and manned flights to the Moon and Mars, where our astronauts will be hundred of thousands, or millions, of miles from a doctor.

We have learned that there are many similarities between administering quality health care in space and in remote areas on Earth. In both cases, the physician must treat patients under very difficult conditions, where clinical equipment is limited, where there is a lack of adequate facilities and limited access to medical specialists.

Disaster medicine is a specialty that provides medical care to victims who have survived catastrophes and who, without such aid for their injuries, would suffer tremendously or possibly die. Telemedicine utilizes telecommunications to enable medical consultations over great distances, allowing us to provide a high level of medical expertise and capabilities to geographically remote areas.

Perhaps the most dramatic example of telemedicine was the U.S.-U.S.S.R. Spacebridge—a joint relief effort initiated by NASA to provide prompt medical relief for victims of the 1988 earthquake in Armenia. The Spacebridge was later expanded to aid the victims of a railway explosion outside the Soviet City of Ufa. Linked by satellite, doctors in the U.S. and the U.S.S.R. were able to combine their skills for the relief of hundreds of victims during the existence of the Spacebridge. Over 400 physicians and medical personnel from both countries participated in this activity, treating a wide range of injuries, along with psychiatric and public health problems. The success of the Spacebridge provided invaluable lessons in the operation of a complex telemedicine consultation network, which should prove to be extremely useful in future emergencies.

These recent successes and the promising future of telemedicine have developed partly through the application of research into communications, remote sensing, and biomedical research, both on the ground and space-based.

The space program has stimulated advances in biotelemetry, a method first used to monitor astronauts' vital signs during Project Mercury. Our need to gather physiological data, convert them into signals and send them to monitoring personnel at remote locations, has lead to advances including miniaturization of equipment, computer enhancement, and improvements in the character of the signal.

The practice of telemedicine was further developed through the STARPAHC Project, or Space Technology Applied to Rural Papago Health Care, where medical data of patients in the remote Papago Indian Reservation in Arizona were transmitted, via microwave communications network, from a mobile clinic to a distant base of operations. Hospital-based physicians monitored the data, made diagnoses, and prescribed treatments.

Another promising application enabled by our vantage in space is the ability to monitor subtle changes in the biosphere. Since 1985 NASA's Biospheric Monitoring and Disease Prediction Project has been using remote sensing technology in an effort to model the relationship between malaria spread and its environment. Malaria remains a serious health problem worldwide. The goal of this project is to develop models that will improve our ability to predict future outbreaks.

A host of spacecraft have been designed to fundamentally improve our understanding of how the Earth functions as a system. The recently launched Upper Atmosphere Research Satellite will vastly increase our understanding of the dynamics and chemistry of the Earth's upper atmosphere. The Laser Geodynamics Statellite, a joint project between the U.S. and Italy, will continue important measurements needed for research on plate tectonics and ocean tides, and thus could potentially help in predicting earthquakes and sea-level change over the coming decade.

It is inevitable that breakthroughs in research and technology resulting from the Space Shuttle missions and later from Space Station Freedom will continue to generate advances which will benefit all of the human race.

I am hopeful that these past few days will lead to new, innovative applications of telemedicine, and NASA is proud to play a continuing role in these important endeavors. Those of you participating in this conference face enormous challenges in providing care and relief for the unfortunate victims of natural disasters. I applaud your efforts.

Medical Informatics and Telemedicine: A Vision

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I. INTRODUCTION

A. On April 12, 1961, Yuri A. Gagarin rode the spacecraft Vostok 1 for man's first trip into space. This trip was a testimony of man's commitment to a vision. Today I would like to convey to you another vision; a vision of what we are about to embark upon in medicine. I hope we can generate a commitment toward this vision as we have towards so many others.

B. The vision is how medical information systems are going to impact the way we deliver medical care in the future.

II. The goal of Medical Informatics is to improve care. This requires the commitment and harmonious collaboration between the computer scientists and clinicians and an integrated database.

III. The integrated database receives input from all departments and, where feasible, is automated from bedside and laboratory devices.

A. Examples: Infusion pumps, Ventilators, the medical information bus.

IV. Medical Information Systems today are used primarily to:

A. Retrieve, process, organize and display data for the healthcare provider.

B. Alert the healthcare provider of dangerous situations.

C. Provide a database for research efforts.

V. The real power of medical informatics is much greater.

A. It is a tool which can foster the **standardization of care**. With standardization comes enormous power to improve care while reducing costs.

1. The process of computerizing a standard in itself improves care.

a. The initial logic for decision making is developed by experts who are required to publish for review and defend their decisions to their peers.

b. Once developed, the initial logic decisions are implemented by feeding the decisions to the healthcare providers in a clinical setting for validation prior to carrying them out. Any overrides of the protocol are logged and reviewed in regularly scheduled iterative sessions. When overrides are deemed justified they become the stimulus to modify and strengthen the protocols. Thus the standard is constantly improving. If the override cannot be justified then the healthcare provider is informed that they are practicing outside the computerized standard.

c. Example: The $ECCO_2R$ Study.[1]

2. Standardized care is a powerful tool for evaluating and directing new therapies.

   a. Once a standard is set, the evaluation of any new drug, device or process of care is greatly facilitated and more credible.

   b. Outcome evaluation and cost-effectiveness becomes more scientific and reproducible.

   c. The role of the new therapy can be better defined.

      (1) Example: The role of $ECCO_2R$

3. Standardization provides a platform for new and exciting methods of automated, real time quality assurance (QA).

   a. Because there is a standard, breeches can be monitored and alerted via the computer. These breeches can be reviewed expeditiously, and where indicated, immediate feedback given to the care provider. Thus prospective quality assurance can be carried out for every patient.

   b. Example: LDS Hospital's Respiratory Therapy programs.[2]

B. Standards assist and facilitate healthcare providers in decision making.

1. It allows the healthcare provider to immediately know the standard.
2. On-line epidemiology allows many of the computer decisions to be based on real time scientific data.
3. It can prospectively feed back costs of various decisions to the care provider at the time of ordering.
4. It can remind and prompt timely care decisions.

5. Examples:
    a. Antibiotic assistant program.[3]
    b. Prophylactic antibiotic study.[4]
    c. The adverse drug reaction study.[5]

VI. Today, using integrated databases, computer scientists and clinicians are beginning to step through this window of opportunity. They are just now launching the attack on the inconsistencies in the process of care via the application of medical informatics.

VII. This is just the tip of the iceberg. What is being done today is to this vision what the Mercury spacecraft was to the space program. We are in the infancy of our journey.

VIII. Medical Informatics' link to telemedicine will vastly expand the vision for improved healthcare universally.

A. One of the most difficult problems is how to improve care in areas which have sparse resources and sporadic physician coverage; such as in rural areas, disaster and battle scenarios, and in remote areas such as the Antarctic, ships at sea, and space missions.

B. There are three major problems in delivering healthcare in these areas:
    1. Lack of readily available local expertise and technology.
    2. Poor communications with experts in a timely fashion.
    3. Lack of ability to monitor, collect data and provide quality assurance in these areas.

C. By linking medical informatics systems to rural and remote areas through telemedical links the same standards of decision making can be applied everywhere. In addition, the epidemiologic data could be retrieved and continuously updated in real time for improved decision logic, quality assurance, and public health purposes.

D. Example: IHC Transurethral Prostatic Resection Study.[6]

E. Such technology will also allow us to share the process of care between nations and to include third would countries.

IX. This is a glimpse of what is about to happen. The potential impact of improving the process of care is equal to, and probably more important than, the marvelous advancements we are seeing in the basic sciences.

X. High quality care is less costly care. Given our current economic crisis in medical care we must focus on quality. We must evaluate and validate new technology and its relationship to the process of care and its cost-effectiveness. Standardization also allows the expense of care to be evaluated and as cost reduction methods are implemented, to evaluate any change in outcome and therefore assess cost and benefit. Medical informatics gives us a powerful tool to address these issues.

XI. Standardized care may allow protection against legal action where undesirable outcomes occur despite practicing within the standard. The potential impact of this on healthcare costs could be dramatic.

XII. The **BARRIERS** to realizing this **VISION** are great.

A. First, one of our major restraints is that current funding for this vision is very difficult to find. Outcomes research funding today is not a leading priority of any agency.

B. Secondly, we need visionary men and women, champions, people with determination akin to President John Kennedy's commitment to the space program.

C. Thirdly, we need ethical, caring healthcare providers who are willing to admit they frequently do not know what the best therapy is, and who are agreeable to abandoning their stylistic differences and committing to discovering truth, and discovering better ways to care for patients at reduced costs.

D. Lastly, we need a balance in research between the basic sciences and clinical applications. We need to learn how to more effectively apply the current and future knowledge to benefit mankind worldwide.

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