2003

Telemedicine: The Practice of Medicine at a Distance

Philip A. Reed
Old Dominion University

Original Publication Citation

Reed, P. A. (2003). Telemedicine: The practice of medicine at a distance. *The Technology Teacher, 62*(5), 17-20.

Telemedicine: The Practice of Medicine at a Distance

Recent developments in computing, imaging, and telecommunications... have increased the effectiveness and uses of telemedicine.

In May of 2000, Dr. Jerri Nielsen discovered a lump in her breast while acting as the only medical doctor at the Amundsen-Scott South Pole Station in Antarctica. Dr. Nielsen knew she had to somehow diagnose the problem and begin treatment as soon as possible. However, the weather during winter is so severe at the research station that all transportation is halted for eight and a half months.

Fortunately, the creativity of a colleague allowed her to receive outside help from a specialist. Dr. Nielsen took a biopsy of the tissue and a friend used a microscope and Polaroid® camera to send tissue images via the Internet to a pathologist in Indianapolis, Indiana. The proper medication was air dropped to Dr. Nielsen, and she was airlifted as soon as the weather permitted.

The story of Dr. Nielsen quickly brought telemedicine into the international spotlight. The concept of practicing medicine at a distance, however, has been around as long as people have been communicating medical information.

History of Telemedicine

Doctors and patients have always had the need to exchange information when they could not meet in person. Initially, couriers would hand deliver information from experts to patients in remote locations. Advances in communications such as the telegraph, radio, and telephone permitted distances to increase and delivery times to decrease.

Philip A. Reed

The introduction of photographic and video images allowed one of the major cornerstones in telemedicine, education, to flourish. Instructional materials could be developed in one location and shared or analyzed by others far away.

In the space program, significant telemedicine advances started to take place over 40 years ago. The transmission of physiological measurements from mice and rhesus monkeys during sub-orbital flights paved the way for humans in space. The need for life support was established as well as the effects of microgravity and radiation.

The communication and scientific advances of the last ten years have drastically broadened the field of telemedicine. Personal computers, new imaging technologies, satellites, and computer networks are a few of the tools that have expanded the field beyond doctor/patient consultations and education. Telemedicine is defined as "the use of advanced telecommunications technologies to exchange health information and provide health care services across geographic, time, social, and cultural barriers." (Reid, 1996)

Areas of Telemedicine

The prefix tele- is often added to many medical procedures and disciplines to focus on a particular area of telemedicine. For example, the story of Dr. Nielsen highlights an effective use of telepathology in the diagnosis and treatment of cancer.

Standards for Technological Literacy: Content for the Study of Technology (ITEA, 2000) indicates nine areas that have had a significant impact on the development of telemedicine: medicine, telecommunications, virtual presence, computer engineering, informatics, artificial intelligence, robotics, materials science, and perceptual psychology. Although these areas are by no means inclusive, they are an excellent starting point to learn about telemedicine.

Medicine. Diseases such as AIDS, cancer, and heart disease have all increased the demand for medications. Medicines are being developed and tested at an ever-increasing rate with

the help of modern communication tools. Databases are ensuring more accurate development and testing techniques. Large data files can be shared through the increasing availability of broadband network connections.

Newer networking capabilities also allow doctors to download the most current drug information directly from the manufacturer right to their personal data assistants (PDAs). The worry over a physician's handwriting is even disappearing as character recognition software improves and more prescriptions are submitted electronically.

Telecommunications. The story of Dr. Nielsen highlights the significant telemedicine advantage the Internet has provided. However, this is only one of the various ways patients in remote locations can communicate with their physicians. Traditionally, the telephone or two-way radios were used. Now the Internet, e-mail, video conferencing, and even cellular telephones provide more comprehensive service to these patients (Figure 1).

Alliances between governments, educational agencies, and medical organizations can demonstrate the benefits of modern telecommunications. Physicians for Peace®, for example, is working with several educational institutions in the U.S. to provide medical and educational services within Turkey and the Philippines via the Internet and satellite links.

Figure 1: Modern telecommunication systems allow data to be transmitted and analyzed in a variety of ways (NASA).

Virtual presence. New broadcasting technologies allow in-home monitoring of the elderly or patients with chronic conditions. Pacemakers do not just stimulate the heart anymore; they also transmit vital information to the doctor's office and even let the doctor know when the battery needs to be changed!

Virtual monitoring devices give the patient peace of mind and the freedom to live at home. In case of an emergency, medical help can be summoned even if a person is incapacitated. Virtual presence devices also reduce expensive visits from health care workers and help eliminate errors with medication, all by monitoring from a distance.

Computer engineering. More powerful processors and imaging techniques have allowed the exchange of medical information, as well as the quality of that information, to drastically increase in the last ten years. Medicines, procedures, and new materials can be tested in a virtual environment. Figure 2 illustrates how three-dimensional software can be used to perform virtual surgery.

Doctors can download important information to PDAs so they always have the most current information on drugs, techniques, and research right in the examination room. Multilingual software and speech recognition software are making computers more useful in fieldwork and remote areas.

Figure 2: New computer imaging technologies allow three-dimensional simulated surgeries (NASA).

Informatics. Medical informatics is commonly defined as "the study of the way we think about patients, and the way that treatments are defined, selected, and evolved" (Coiera, 1997, p. xxi). Some of the many tools that shape informatics include clinical guidelines, formal medical languages, information systems, and other communication systems like the Internet.

One significant debate in the field of informatics, however, is the protection of patient records. As more data is entered into electronic databases, how should this information be protected and who should have access? There are many advantages to using electronic medical records (EMR), but some worry about placing confidential information on networks.

Artificial intelligence. Medical instruction is being influenced heavily by artificial intelligence (AI). Already, robots with some level of intelligence are used as training devices for cardiopulmonary resuscitation (CPR). More advanced artificial intelligence systems will provide doctors or emergency workers with information on a heads-up display (HUD) as they are dealing with an emergency medical situation.

Robotics. Surgeons are experimenting with operations over great distances by using robotics. The surgeon can be in one location and the patient and robot in another location. Such technology is still experimental but will eventually allow top doctors to perform surgeries all over the world without leaving their offices.

A second robotics benefit includes the elimination of the natural hand tremors that even the best surgeons have. Robotic tools can even reduce fatigue by allowing doctors to sit while performing lengthy telesurgeries. Small devices called endoradiosondes can be swallowed, so that they can collect data while traveling through the digestive tract. Scientists are working on more advanced endoradiosondes, however, that will perform small surgical tasks, not just gather data.

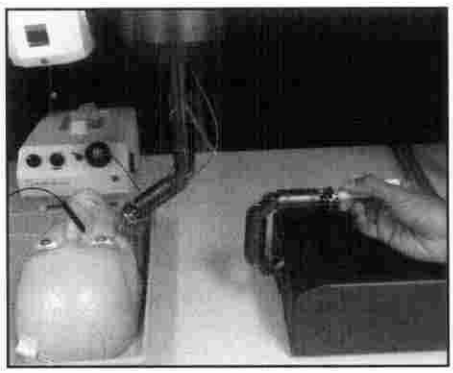

Figure 3: The Robot Assisted Microsurgery (RAM) device above was developed by NASA.

Materials science. The deciphering of the human genome as well as the genomes of other animals is a significant accomplishment that is providing a vast amount of data. This data can only be used to help create medicines and treatment procedures if it can be easily shared and accessed. Broadband networks, improved storage devices, and other computing breakthroughs have allowed researchers to share, store, and conduct tests with these large sets of data.

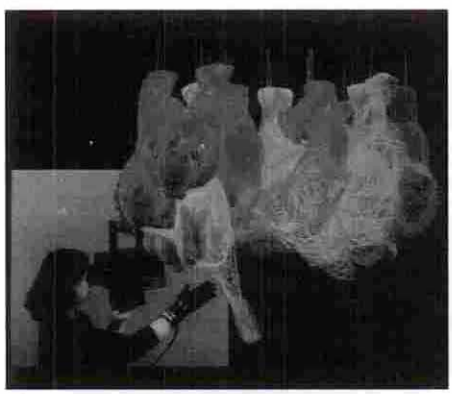

Figure 4: Artificial intelligence can be used to place researchers in virtual environments to help analyze tissue and medical materials (NASA).

In addition to database development, virtual testing environments will help further materials science (Figure 4). Significant material developments are in the areas of prosthetics and medical implants. Virtual environments can often be used to perform tests on tissues and materials before devices are implanted.

Perceptual psychology. Many psychologists study the way we organize and perceive a stimulus. For years they have wondered how the mind handles illusions such as the drawings by artists like M. C. Escher. Since many medical imaging technologies produce two-dimensional images, telemedicine is using the field of perceptual psychology to help improve imaging techniques.

New technologies allow two-dimensional medical images to be enhanced so they are perceived as three-dimensional images. Software is now available to compile Computed Axial Tomography (CAT or CT) images into three-dimensional models (Figure 5). These images can have color added and be viewed from any position, thus giving physicians an accurate picture without conducting an invasive procedure. Other perceptual psychologists are trying to create computer devices that could produce artificial smells.

Figure 5: Software is available to convert CT scans into three-dimensional models that give physicians an accurate picture without invasive procedures. (NASA).

Summary

Telemedicine has been around ever since patients and doctors have exchanged information from remote locations. Recent developments in computing, imaging, and telecommunications, however, have increased the effectiveness and uses of telemedicine.

Almost any medical area can be practiced from a distance. Noteworthy areas of telemedicine include medicine, telecommunications, virtual presence, computer engineering, informatics, artificial intelligence, robotics, materials science, and perceptual psychology.

People are naturally concerned about their own health as well as the health of family and friends. Telemedicine will continue to have a growing influence on personal and public healthcare. The importance for everyone to learn about these significant technologies is obvious since we are all users, consumers, and managers of the technologies employed in our own healthcare.

Classroom Activity

Health and weather officials have developed a series of tools to aid people with weather-related health problems. Maps are used to track the respiratory index, air quality forecast, mold spores, and various pollens in the U.S.

Students can learn how to use some of these tools by looking in their local newspaper's weather section or visiting the Internet site for The Weather Channel® (www.weather.com/). Teaming up with a teacher in another state or region can help tie these tools to telemedicine. Students in both locations can monitor their local respiratory index, air quality forecast, mold spores, and pollen counts. Spreadsheet software is useful for recording these levels along with class attendance. Charts can be created, such as shown in Figure 6, to present the data visually for analyses and to assist in assessing the impact of weather conditions and attendance. Data can be exchanged between the two groups via e-mail, a Web site, or even facsimile to determine if these weather-related health issues have an influence on class attendance.

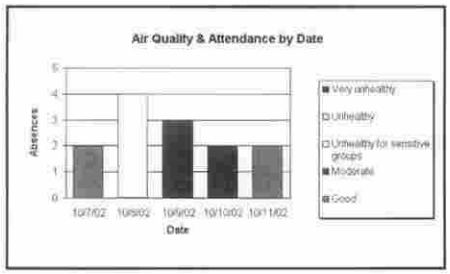

Figure 6. Incorporating a spreadsheet application enhances the interdisciplinary learning opportunities by integrating mathematics, statistics, and computer technology. Students can assess the impact of weather conditions and predict future attendance thus adding a critical thinking dimension.

References

Coiera, E. (1997). *Guide to medical informatics, the Internet, and telemedicine.* New York, NY: Oxford University Press.

International Technology Education Association (ITEA). (2000). *Standards for technological literacy: Content for the study of technology.* Reston, VA: Author.

Reid, Jim (1996). *A Telemedicine Primer: Understanding the Issues.* Topeka KS: Innovative Medical Communications.

Philip A. Reed, Ph.D. *is an assistant professor at Old Dominion University in Norfolk, VA. He can be reached via email at preed@odu.edu.*