

The Evolution of a Teledentistry System Within the Department of Defense

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Total Dental Access (TDA) is the teledentistry project within the Department of Defense. This project enables referring dentists from the US Armed Forces to consult with specialists on the status of a patient. TDA focuses on three areas of dentistry: patient care, continuing education and dentist-laboratory communications. One of the goals of this project is to increase patient access to quality dental care. The other goal is to establish a cost effective telemedicine system.

This paper describes the evolution of a teledentistry system, the main features of POTS-based, ISDN-based and Web-based systems used, advantages, disadvantages and cost-effectiveness of these systems. Data has been collected on the frequency of use, technical problems occurred, avoided patient or specialist travel and the total number of consults. A cost-effectiveness analysis has been conducted on the data collected. The results of this analysis will be presented.

Introduction

Telemedicine is the use of electronic information and communications technologies to provide and support health care when distance separates the participants.¹

Telemedicine has been widely indicated as an effective way to improve the quality of care and reduce the cost of health care delivering a better employment of resources and professional health care providers' time.² Studies should focus on costs and benefits measured not only in terms of direct dollars spent but also in terms of organizational costs, such as manpower, time, and other resources. Estimates of costs should reflect the full cost of telemedicine, including the value of donated services and equipment.³

Background. The United States military formally launched a coordinated telemedicine program in 1994. The ultimate purpose of this program is to investigate clinically relevant applications of rapidly emerging technology. The military efforts in telemedicine are part of a broad attempt to "re-engineer" the delivery of health services.⁴

One of the military telemedicine efforts was to start a teledentistry project. Total Dental Access (TDA) is a

tri-service Teledentistry project, which started in 1994. One of the goals of this project is to increase patient access to quality dental care. The other goal is to establish a cost effective telemedicine system.

Total Dental Access project focuses on three areas of dentistry:

- *Patient care:* In some of the remote clinics, a patient must travel hundreds of miles to receive specialty care. Often pre-and post-operative visits take only a few minutes of actual appointment time but require hours of travel by the patient. With the implementation of teledentistry, there is a potential of savings in cost and travel time required by the patient. Referral to specialists, consultations and laboratory communications are some of the clinical areas where teledentistry could improve the patient care.

- *Continuing Dental Education:* Through the use of video teleconferencing equipment, the lectures could be broadcasted to any clinic where continuing dental education is difficult to obtain.

- *Dentist-laboratory communications:* Occasionally, cases submitted to the dental laboratories have subtle complications or esthetic nuances that require direct contact between the dentist and the laboratory technician. In these instances, the ability to send color images of the patient's teeth and then to talk about the images can help to prevent making improperly constructed appliances, thereby saving time and money.

Step 1: Image File Transfer via Modem

The US Army conducted the first study of teledentistry at Fort Gordon, Georgia in July 1994. In this study a dental image management system was used in conjunction with an Intra-oral camera to capture color images of a patient's mouth. These images were then transmitted over a 9600 baud modem from the dental clinic in Fort McPherson, Georgia to Fort Gordon, a distance of 120 miles.

Fifteen periodontal patients were referred to Fort Gordon for surgery. One week after their surgery, each patient reported to Fort McPherson for suture

removal and intra-oral imaging. At the time of suture removal, color still images were obtained of the surgical sites and these images were transmitted to Fort Gordon for examination by the periodontist who performed the surgery.⁵

Results

The results of this study showed that 14 of the 15 patients saved the return trip to Fort Gordon. The patients uniformly felt that they had received better care than they normally received and were especially pleased at the elimination of the long trip to Fort Gordon. The dentists were also comfortable in their ability to make proper decisions and diagnoses using the equipment.

Step 2: File Image Transfer via Satellite

The second study was performed in Haiti in 1995. In this Study a CLI video teleconferencing system was used over International Maritime Satellite (INMARSAT) allowing the deployed dentists to talk face to face with specialists at Walter Reed Army Medical Center in Washington. In addition, a high-resolution still camera was used to capture color still images. The images were then transmitted with the color still images to Walter Reed where the specialists reviewed them.

Results

Results of this study showed that the video quality of the CLI unit operated at 56 Kbps was insufficient for dental diagnosis of most pathologic conditions but that the Kodak gave diagnostic images.

Because of the encouraging results of these two studies, it was decided to expand the scope of the Fort Gordon study to an actual research project.

Step 3: ISDN-based Teledentistry System

For this project the Army posts of the southeast Dental Service Support Area (DSSA) were networked using desktop video teleconferencing equipment (PictureTel 50) and ISDN lines at 128 Kbps data rates, an intra-oral camera and a document camera. This equipment allows live video consulting as well as capability to send still images. Whiteboarding is a feature of this system, which allows users to do annotation on an image.

In 1996, the US Department of Defense established a medical network in Bosnia that connected Army field

dentists with dentists at five regional military medical centers in the United States (Washington, Texas, California, District of Columbia, and Hawaii). The Telemedicine segment of this project (Primetime III) utilized communication satellites to allow military physicians to consult one another using real-time voice and video. Using commercially available technology, dentists transmitted radiographs, color images, and full motion videos to remote field hospitals for diagnostic support. They obtained forward delivery of laboratory and radiological results, prescription support, utilized digitized medical logistics support, online clinical information, email, and medical command and control situational awareness technologies.⁶

For Primetime III, the communication infrastructure used was an integrated frame relay ISDN architecture. The main teledentistry hub was at the Landstuhl Regional Medical Center in Germany, integrated into the Internet and the commercial ISDN gateway link to the world.

Results

The results from these projects indicate that the ISDN-based systems provide invaluable support for clinical decision making in time critical contexts, its major drawback is expense, both in initial purchase and equipment maintenance. However, the savings in travel and work hours lost were recouped in less than two years.

Step 4: POTS-based Teledentistry System

In early 1997, a POTS-based teledentistry network was tested and implemented in Germany, Italy, Belgium, England, Spain and Portugal. This system has been mainly deployed to smaller dental clinics in Europe, which did not have Internet access at the time. The POTS-based network has been established for the US Army, Navy and Air Force Dental clinics at over 52 sites in Europe and 16 sites in the United States. The POTS-based systems consist of a desktop computer, a 28.8 Kbps modem, software and hardware (Sharevision PCS3000), Intra-oral camera and a document camera.

Results

An on-line database has been developed to gather information on user satisfaction, number of consults, frequency of use, video or audio problems occurred, avoided travel. Dental providers complete this form

each time they use the system. The data collected from the use of the POTS-based systems has been analyzed.

POTS-based systems are user friendly, low in cost and easy to maintain.

Step 5: Web-based Teledentistry Systems

Internet provides an appealing medium for the communication of health related information due to its ease of use and growing popularity.

The Web-based teledentistry system which has been deployed since October 1997 consists of a laptop, a digital camera, a Web browser and requires Internet access. Since most of the dental clinics in Europe now have a local Area Network (LAN) and access to Internet through the medical hospitals, this system is being used in over 50 tri-service dental clinics in Europe.

A Web-based clinical database has been developed for storing the consults. This system uses MS SQL Server 7.0 for storing the consults as the database server and MS Internet Information Server 4.0 as the Web server.

The Referring dentist logs into a secure server using a Web browser. He chooses a specialty (orthodontics, oral medicine, oral and maxillofacial surgery, endodontics, oral pathology, periodontics, prosthodontics or pediatric dentistry). He then sends the patient demographics, complaint, images and radiographs to the specialist of his choice. The data gets sent to the database and an electronic mail notifies the specialist of the pending consult, which he will access via the Internet. The specialist reviews the consult and writes his diagnosis and treatment. A plugin developed in Visual C++ enables him to do image manipulations, such as contrast and brightness changes of the radiographs within the Web browser. He then types the diagnosis and suggested treatment. The completed consult is now stored on the database server. The referring dentist receives an email indicating that his consult has been answered.

Results

Data collected on the Web-based teledentistry referrals show an average of forty consults per month. Currently, referrals to oral surgery have the highest number of consults, followed by prosthodontics and periodontics. Advantages of a

Web-based teledentistry consultation system include low cost, expandable to a wide range of locations, more complete information for data analysis.

Conclusions

An economic analysis of the teledentistry deployment was conducted to clarify the ongoing benefits of the program and highlight its future potential. Results from this economic analysis demonstrate a return on investment for the current teledentistry system within one year of deployment and a return on investment within six months for future deployments.⁷ The return on investment is shorter for future deployments of teledentistry due to the estimated cost savings realized by improvements in telecommunications equipment. By providing dentists with easy, cost effective access to specialists, it is possible to improve the quality of care by facilitating better and timely information to the dentists for better decision making and better communication between them and their patients.

Although the current teledentistry project is successful, it is still possible to improve the system. The use of continuous speech recognition technologies will make the use of the current system easier. Due to a high mobility of patients in the US Armed Forces, development of a distributed dental record is being considered.

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