ECG Acquisition Using Telemedicine in Alaska

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ABSTRACT

The Alaska Federal Health Care Access Network includes a telecommunications network supporting telemedicine carts and store-and-forward telemedicine software throughout Alaska. Electrocardiograms are being acquired at remote locations and being interpreted at regional and tertiary care facilities as part of routine and acute care. This promising new technology is just beginning to have an impact on cardiovascular patient care.

INTRODUCTION

The Alaska Federal Health Care Access Network (AFHCAN) began as a project in 1998 to improve health care for federal beneficiaries using modern telemedicine technology. During the early years of the project there was overwhelming response for creating a store-and-forward telemedicine system in Alaska. Clinical needs assessment indicated that primary care, otolaryngology, and cardiology were those services most needed and amendable to store-and-forward applications. This article reviews the statewide telemedicine network with particular focus on ECG transmission.

METHODS

AFHCAN has designed and implemented a statewide telecommunications network allowing sites to send and receive healthcare information in a secure manner. The AFHCAN Project Office is staffed to support an infrastructure of Software Development, Training, Customer Support and Network. The network is structured whereby health care organizations purchase dedicated bandwidth (mostly satellite based) from long-distance carriers to a central core in Anchorage. The network is used for store-and-forward telemedicine such as electrocardiogram (ECG) transmission as well as teleradiology, access to health records (e.g. RPMS), voice communications (e.g. Anchorage-based dial tone), and real time videoconferencing.

AFHCAN has also developed and deployed two key technologies to meet clinical needs: a mobile telemedicine cart with biomedical peripherals and a web-based telemedicine software package. The telemedicine carts include a touch-screen monitor, computer, UPS (uninterruptible power supply/battery backup), wireless network capability and may include any of the following devices: video otoscope, digital camera, scanner, and/or electrocardiogram (ECG).

The ECG hardware that was selected is the IQmark Digital ECG manufactured by Midmark Diagnostics Group (formerly Brentwood). The hardware is physically small measuring 6"x3"x1" and is connected to a computer via a serial cable (See Figure 1). The other end of the unit has the ten standard wires with ECG leads. Two AA batteries power the unit.

The AFHCAN telemedicine software provides a simple user interface to access the ECG and other devices on the cart. After logging into the software, the user can access any of the biomedical peripherals on the cart with no more than 3 mouse clicks or touches to the screen. To begin, the user logs on, and presses "Create a Case" and then selects "ECG" (See Figure 2). Patient name, age, and other demographics are entered into the system. For the ECG,

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instructions for lead placement are included on the computer screen. The patient is prepped for the ECG and leads are placed. When the practitioner and patient are ready, the user selects "Start ECG" (See Figure 3). The next screen displays all 12 leads actively monitoring the patient (See Figure 4). The Midmark Diagnostics software utilizes ActiveX controls to permit a real time display of the cardiac waveforms as well as the ability to store and review the data at a later time. In order to capture the last 10 seconds, the user presses "Analyze." This can be pressed multiple times to capture multiple consecutive ECGs. ECGs can be displayed, saved or discarded. When displaying the ECG, the user selects an option to magnify waveforms, display interval times, or view all twelve leads over the ten second interval it was captured, as well as other options. The ECG can be printed out on any standard printer. The printed version appears similar to a typical ECG and the quality is very good.

The system is user-friendly and meant to follow normal clinical referral patterns. The AFHCAN Telemedicine Software is web-based, and providers conduct telemedicine by running a browser on their local computer (i.e. Microsoft's Internet Explorer), which connects to the web pages on the server. Consequently, providers may conduct telemedicine from any standard computer on the organization's local area network – either directly from their own laptop or from a computer in an examination room. In many cases, a village community health aide generates a telemedicine case using the cart and the case is then sent to a family physician at a regional facility. The physician most often responds to the case, but may elect to forward the case for referral to a specialist at a tertiary care facility. The physician can access the system from his or her desktop computer, respond with typed comments and send the case back to the sender.

RESULTS

Telemedicine carts were deployed to 235 sites managed by Alaska Native tribal organizations, United States Army, United States Air Force, Veterans Administration, United States Coast Guard, or the Alaska State of Health and Social Services Department, Public Health Nursing. Approximately 150 of the sites are utilizing an ECG unit as part of the telemedicine application. In 20 months, approximately 8000 telemedicine cases have been created statewide, and approximately 6% of the cases include one or more ECGs.

Most ECGs are being obtained by Community Health Aides/Practitioners in village clinics and sent to family physicians in regional medical centers. Increasingly, some ECGs are also being sent to emergency room physicians and cardiologists. To date, approximately 510 telemedicine cases have included an ECG. Each case includes several ECGs so that approximately 1,500 ECGs have actually been performed. In the Bristol Bay region, for example, the outlying villages have created a total of 348 ECGs in 20 months. As more health care facilities join the network, and as more community health aides are trained to perform ECGs, utilization is expected to markedly increase.

DISCUSSION

These units have several advantages over standard send receive ECG systems, which typically require an expensive input station and a similar unit (from the same manufacturer) at the receiving station with a printer. The AFHCAN telemedicine system requires the Midmark hardware at the originating site to capture the ECG data, but only requires the web-based software at the receiving computer.

Until now, those sites with ECG machines have been faxing from referring to consulting provider, as this has been the simplest and most cost effective means for sending ECGs from distant locations. The AFHCAN approach increases access to ECG acquisition and has several advantages over a fax-based system. The image quality of the digital ECG is usually better than the faxed version. ECG data is most easily shared digitally rather than by Fax – because it allows the receiving provider to more accurately view the details of the data and print the data with greater detail. There is time saved in not having to cut and mount ECG strips. Using a digital format and secure network also avoids the risk of faxing a copy to a public fax machine.

The AFHCAN system is web-based and stores information in a digital format as part of an archived medical records system. These ECGs are easily retrieved, can be viewed in complete detail with no loss of data, and can be manipulated by the recipient to provide a variety of views of the same data. The telemedicine case may also be forwarded to other physicians – with no loss in data or detail. This workflow would be hard to achieve with faxes

and would be cost prohibitive with other send and receive systems. Finally, there is cost savings from printing on standard white paper rather than proprietary ECG print paper.

Timely acquisition and interpretation of an ECG can make a difference in patient care. A properly obtained ECG from a remote site can have a significant impact on the medical decision making process. Presently, ECGs are being acquired as part of healthcare screening, for minor complaints, and in life-threatening situations. Clinicians are discovering that telemedicine is an adjunct to the "in-person" care of their patients with cardiovascular disease. Remote acquisition of ECGs is just the beginning of what an Alaska Telemedicine network can support. Other promising technologies being considered include electronic stethoscopy and remote transmission of echocardiography.

ACKNOWLEDGEMENTS

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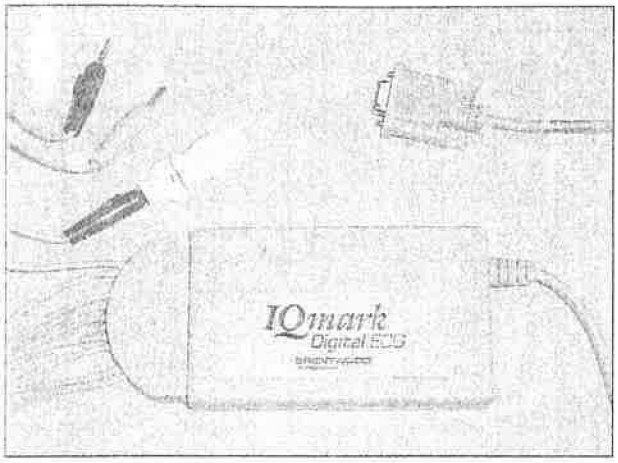

Figure 1
The small twelve lead ECG unit has a serial cable (on the right) that connects to the computer. The ten standard patient-interface cables and electrodes are on the left.

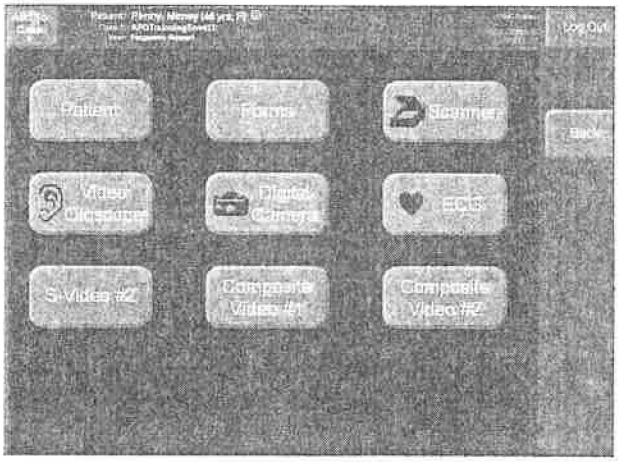

Figure 2
The AFHCAN Telemedicine Software interface that allows a user to select the ECG hardware.

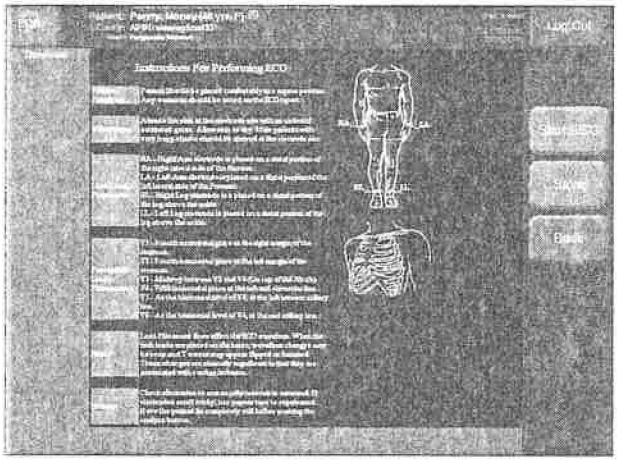

Figure 3
The user interface for beginning an ECG, with a graphic depecition of lead placement. The user selects "Start ECG" to begin a real time trace running of the ECG.

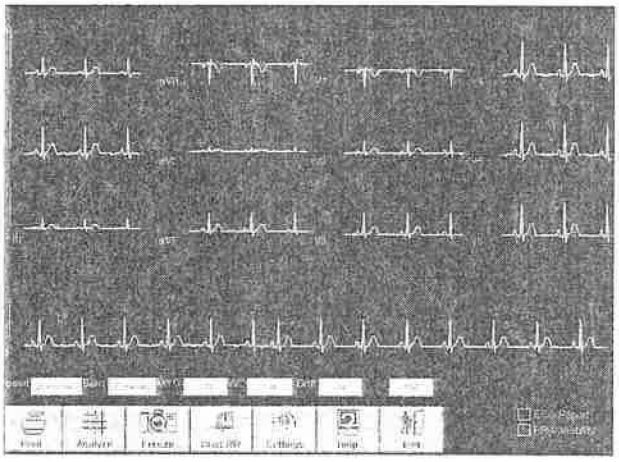

Figure 4
The user interface during a real time ECG trace. The user selects "Analyze" to store the last 10 seconds of activity. The user selects "Exit" to close the window.