Telepathology Networking in VISN-12 of the Veterans Health Administration

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ABSTRACT

The Veterans Integrated Service Network (VISN)-12, headquartered in Chicago, has implemented a telepathology network between the eight VISN-12 hospital laboratories and Loyola University Medical School linked by an economical, high-speed wide-area network (WAN). Implementation of the WAN has reduced monthly telecommunications costs in VISN-12 by approximately 67%. In addition to telepathology, the WAN enables real-time teleradiology (general, computer tomography, and ultrasound), telefluoroscopy, telenuclear medicine imaging, telepsychiatry, and other forms of teleconsultation. Current applications of telepathology in VISN-12 include: primary diagnosis and consultation in surgical pathology, interpretation of serum protein electrophoresis and immunofixation gels, provision of support for consolidated microbiology laboratories, review of problematic peripheral blood smears, and distance learning. We have learned a variety of lessons from telepathology. The enthusiasm and technical skill of providers are essential for success. As well, frequent communication and rapid technical support are necessary. Finally, in a supportive environment, telepathology is a tool that can help bring together clinical laboratories with shared missions and goals.

INTRODUCTION

TELEPATHOLOGY INVOLVES THE SENDING and viewing of video and digitized images for the purpose of rendering primary or consultative diagnoses by pathologists at a distance.[1–4] In mid-1996 we implemented a routine surgical telepathology service using a commercially available, robotic, hybrid dynamic store-and-forward (HDSF) system between the Iron Mountain and Milwaukee Veterans Affairs Medical Centers (VAMCs),[5–7] which are separated by a distance of approximately 220 miles. This service was implemented to maintain frozen section diagnostic capability and provide more timely routine pathology service upon the retirement of the single on-site pathologist. Our experience with telepathology in surgical pathology has been described previously.[5–8] Applications of telepathology have been described by others as well.[9–14]

In late 1995, the Veterans Health Administration (VHA) of the Department of Veterans Affairs was reorganized into 22 Veterans Ser-

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vice Integrated Networks (VISNs). VISN-12, headquartered at the Hines VAMC in suburban Chicago, consists of eight medical centers and numerous community-based outpatient clinics located in upper Michigan, Wisconsin, northern Illinois, and northwestern Indiana. The VAMCs involved include the following: Iron Mountain, MI; Tomah, WI; Madison, WI; Milwaukee, WI; North Chicago, IL; Hines (Maywood), IL; and VA Chicago Health Care System Westside and Lakeside Divisions. From the Milwaukee VAMC, a centrally located site, driving distances are approximately 220, 170, 80, 55, 90, 95, and 95 miles, respectively, to the seven other sites listed in order above. The Iron Mountain and Tomah VAMCs are located in rural settings and lack on-site pathologists, as does the North Chicago VAMC. With the exception of Iron Mountain and Tomah, all VISN-12 VAMCs are affiliated with medical schools. The Tomah and North Chicago VAMCs do not maintain inpatient surgery programs, whereas the other six sites support inpatient surgery.

The purpose of this article is to outline the current and future status of telepathology in our network.

TELEPATHOLOGY NETWORKING

In early 1996, a robotic microscope and control system (both from Apollo Telemedicine, Alexandria, VA) were installed in Iron Mountain and Milwaukee, respectively.[6] In late 1997, a nonrobotic Apollo microscope system, similar to that located in Milwaukee, was installed at the Hines VAMC to allow second-opinion consultations and conferencing between pathologists at Milwaukee and Hines. In mid-October 1998, a similar nonrobotic Apollo microscope system was installed at the Loyola University Medical School, located adjacent to the Hines VAMC. As a result, pathologists located at the Milwaukee and Hines VAMCs and Loyola University Medical School are able to exchange images for second-opinion consultation and quality assurance studies. Pathologists at Hines and Loyola are also able to control the robotic microscope located in Iron Mountain.

Based on the success of the initial telepathol-

ogy network,[15] VISN-12 has implemented an HDSF telepathology network consisting of one robotic (Iron Mountain VAMC) and seven non-robotic microscopes at the remaining VISN-12 hospital laboratories linked by an economical, high-speed wide area network (WAN), as shown in Figure 1. Currently, the telepathology unit at Loyola University Medical School can communicate with that at Hines (or any of the other sites) using an integrated systems digital network (ISDN) connection.

An interface is being developed by Apollo Telemedicine that enables downloading patient demographic information from the Veterans Health Information Systems Architecture (VistA), the VHA hospital information system, into the HDSF telepathology system database. Eventually, this interface will allow storage of static pathology images in VistA using software. The stored images will be accessible to clinicians using computer workstations. Thus, when appropriate, each pathology or autopsy report will be accompanied by an electronic image of relevant gross and/or microscopic material.

WIDE-AREA NETWORK

VISN-12 has implemented a virtual medicine program that relies on the IGX 8400 series wide-area switching platform from Cisco Systems (San Jose, CA). This network integrates data, voice, video, and diagnostic imaging systems. In addition to telepathology, the VISN-12 IGX 8400 network enables real-time teleradiology (general, computer tomography, and ultrasound), telefluoroscopy, telenuclear medicine imaging, telepsychiatry, teleconsultation, and other forms of teleconsultation.

One IGX 8400 switch is deployed at each of the eight VISN-12 hospitals. The four Chicago-area switches are connected via DS3 connections to an OC-12/STM-4 Synchronous Optical NETwork (SONET) ring. The SONET speed is scaleable up to 622 mbs. T1 trunks extend to Milwaukee, Madison, Tomah, and Iron Mountain. Centralized data switching occurs at the North Chicago facility where a Cisco Systems 7500 series router directs data traffic to the IGX 8400 network backbone. The data switching network is designed as a full redundant mesh
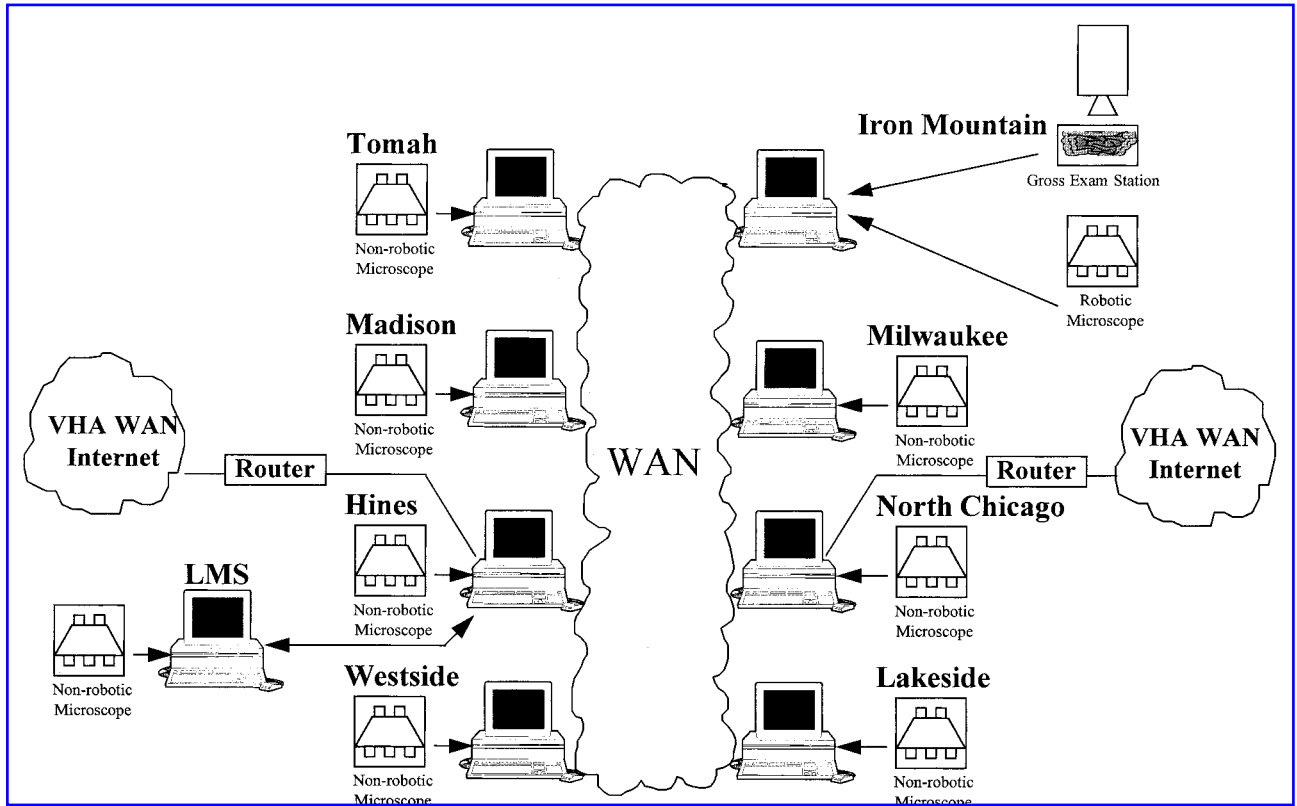
FIG. 1. Configuration of the Veterans Integrated Service Network (VISN)-12 hybrid dynamic store-and-forward telepathology network as of May 2000. A robotic microscope is located at the Iron Mountain Veterans Affairs Medical Center (VAMC). Nonrobotic microscopes equipped with Sony (Sony Electronics, Inc., Park Ridge, NJ) DKC 5000 3CCD cameras have been installed at the Tomah, Madison, North Chicago, and VA Chicago Health Care System Westside and Lakeside Division VAMCs, in addition to those previously installed at Milwaukee and Hines. The eight VISN-12 telepathology units are interconnected via the VISN-12 wide-area network (WAN) but can also be connected to the Veterans Health Administration WAN or the Internet via routers located at the Hines and North Chicago VAMCs. In contrast, connectivity between Loyola University Medical School and Hines or any of the other VISN-12 sites is achieved using a commercial integrated systems digital network connection.

eliminating any one single point of failure. The data network utilizes Cisco 7500 series routers connected via OC3 interfaces to the asynchronous transfer mode (ATM) WAN backbone. Video switching occurs at the Lakeside campus where T1 and T3 interfaces connect the ISDN video-based video unit to the IGX 8400 backbone. Eventually, VISN-12 plans to use its SONET bandwidth to provide enhanced points of presence for the six affiliated medical schools to access the WAN. Recently, VISN-12 has integrated WAN services with VISN-11, headquartered in Ann Arbor, Michigan. This integration has expanded the network to include eight additional hospitals (creating a total of 16 Department of Veterans Affairs medical centers participating in this WAN).

Prior to installation of the WAN, telephone, video, and data units were interconnected using commercial or Federal Telecommunications System communication lines. Each hospital was billed on the basis of individual use. Implementation of the IGX 8400 network has reduced telecommunications costs significantly. VISN-12 now saves approximately $200,000 per month by reducing frame relay networking costs, eliminating multiple T1 lines, and providing in-house ISDN services. Since the eight VISN-12 telepathology units have been interconnected via the WAN, there is no practical limit to the extent or duration of telepathology connectivity, because VISN-12 pays a single fee for monthly communications services. Thus, there are no significant fi-

nancial limitations imposed on telepathology connectivity as we perform feasibility and diagnostic studies in a variety of areas of anatomic and clinical pathology.

CURRENT APPLICATIONS OF TELEPATHOLOGY

Consultation

In addition to allowing primary diagnosis, telepathology allows consultation among pathologists as well as demonstration of cases to clinicians at a distance.[2,16–18] In VISN-12, three part-time neuropathologists and three hematopathologists are now available to review cases by telepathology at any of the eight VISN-12 laboratories. Should a case prove too difficult or too labor intensive to diagnose directly by telepathology, slides can be sent to the consulting pathologist, then reviewed in real time by telepathology with the referring pathologist. Thus, even if telepathology does not allow a diagnosis to be rendered immediately in all cases, it can be used as an important adjunct to allow parties at distant sites to participate in case review and/or continuing education.

Serum protein electrophoresis

Currently, serum protein electrophoresis and immunofixation are performed exclusively at the Hines and Milwaukee VAMCs within our network. The pathologist formerly responsible for interpreting these gels at Hines retired in the summer of 1999. However, we continue to perform protein electrophoresis and immunofixation at the Hines laboratory. Images of gels are transmitted to the Westside or Milwaukee VAMCs for interpretation by trained pathologists at these two sites.

Microbiology

In an effort to increase network efficiency, we have consolidated the majority of microbiology studies from the North Chicago and Tomah VAMCs at the central laboratory in Milwaukee. By sending images using the gross pathology workstation[19] or the telepathology microscope system, clinicians can observe culture plates or stained preparations of microorganisms[20] transmitted from the central microbiology laboratory.

Peripheral blood smears

As noted earlier, there are three hematopathologists in VISN-12. An important application of telepathology is the real-time review of problematic peripheral smears at any of the eight hospital laboratories by these two individuals. Thus, by making the skills of these two specialists available to all sites, telepathology has helped to establish a single standard of pathology care within the entire network.

Distance learning

The videoconferencing system of the telepathology unit has been used to provide didactic teaching sessions as part of the training of the medical technologist in Iron Mountain (DLR) who passed the accreditation examination of the American Association of Pathologists' Assistants in November 1998. Since that time, continuing medical education and quality assurance have been major applications of our telepathology network.

TELEMEDICINE AND THE VHA SYSTEM

At present, the VHA system offers several advantages to the development of telepathology and telemedicine networks. For example, a single valid license allows a physician to practice anywhere within the system (i.e., across state lines). As the VHA system focuses on its provision of health care through large multistate networks, it has recognized that telemedicine plays an important role in providing uniformly high levels of care not only in metropol-itan settings but also in rural hospitals and community-based outpatient clinics.

We have learned a variety of lessons from our experience in telepathology.[21] First, the enthusiasm and technical skill of providers and technologists at the remote and hub sites are essential for success. Second, frequent and direct communications are necessary to identify and correct problems as they arise. Third, telepathology is merely a tool by which pathologists located at a metropolitan hub site can provide ac-

curate and timely services to clinicians located at remote rural sites. For accurate diagnoses to be made, the same attention to detail regarding specimen preparation and examination must be ensured as if the pathologist were physically present. Fourth, rapid technical support is essential for the success of a telepathology program. Finally, in a supportive environment, telepathology serves an integration function in bringing together clinical laboratories with shared missions and goals.

Little has been written about the cost effectiveness of telepathology. Our own analysis of the existing Iron Mountain–Milwaukee telepathology testbed suggests that telepathology is more cost effective than maintaining an on-site pathologist at a remote site with limited workload.[22] However, the annual cost of telepathology is likely greater than that of transporting specimens from Iron Mountain to be processed and diagnosed in Milwaukee.[22] If, however, transportation of specimens to Milwaukee were to be implemented in lieu of using telepathology, turnaround time for cases would be increased and the ability to perform real-time frozen sections at the Iron Mountain VAMC would be eliminated.

In summary, the HDSF telepathology system provides accurate and timely clinical services to hospitals in the absence of an on-site pathologist. Generally, clinician satisfaction with telepathology services has been high. This dynamic, real-time telepathology network has been an essential tool in our health care system in which the clinical laboratories are separated by distances of up to 300 miles. Telepathology will support not only anatomic pathology but all other areas of the clinical laboratory in which analysis of either gross or microscopic specimens is essential. Thus, at least in some situations, telepathology can be cost effective[22] compared with maintaining an on-site pathologist at a remote site.

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