The Healthnet project: extending online information resources to end users in rural hospitals*†

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The importance of easily available, high quality, and current biomedical literature within the clinical enterprise is now widely documented and accepted. Access to this information has been shown to have a direct bearing on diagnosis, choices of tests, choices of drugs, and length of hospital stay. However, many health professionals do not have adequate access to current health information, particularly those practicing in rural, isolated, or underserved hospitals. Thanks to a three-year telemedicine award from the National Library of Medicine, The University of Iowa (UI) has developed a high-speed, point-to-point telecommunications network to deliver clinical and educational applications to ten community-based Iowa hospitals. One of the services offered over the network allows health professionals from the site hospitals to access online health databases and order articles via an online document delivery service. Installation, training, and troubleshooting support are provided to the remote sites by UI project staff. To date, 1,339 health professionals from the ten networked hospitals have registered to use the Healthnet program. Despite the friendly interface on the computer workstations installed at the sites, training emerged as the key issue in maximizing health professional utilization of these programs.

INTRODUCTION

Located in Iowa City, The University of Iowa Hospitals and Clinics (UIHC) is the state's only tertiary health care center. One of the largest university-owned teaching hospitals in the nation, the UIHC has 873 inpatient beds and serves patients and families from all of Iowa's 99 counties. From July 1, 1996, to June 30, 1997, there were 41,818 patient admissions and 581,446 ambulatory clinic visits to the UIHC. The UIHC complex includes a main building and six interconnected buildings, covering approximately 4.0 million square feet.

In addition to the UIHC, The University of Iowa (UI) Health Sciences Center includes the Colleges of Medicine, Nursing, Pharmacy, Dentistry, and a number of allied health programs. The Health Science Center provides an information-rich environment for its healthcare professionals, faculty, students, and patients. Daily grand rounds and guest lectureships, a campus-wide fiber optic infrastructure, robust access to online health information resources, and an academic health sciences and patients' library are only a few of the services available to UI's faculty, students, health care providers, and patients.

Many of Iowa's rural and community health care workers, on the other hand, are geographically and

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professionally isolated from the information resources and specialty consultation services to which academic health professionals have easy, daily access. Of the state's 117 hospitals, ninety-six are classified as either rural or rural-referral and 71.1% have ninety-nine or fewer beds [1]. Recruitment and retention of health care workers in rural areas is difficult in Iowa as it is in other states with geographically dispersed populations [2]. To remain current in their respective fields, rural health providers must take time away from their patients to travel to sites where continuing education opportunities are available. Access to online information resources is also problematic because many rural health care workers lack convenient access to the Internet.

Thanks to a three-year telemedicine contract from the National Library of Medicine (NLM) that began in 1994, UI has developed a high-speed, point-to-point telecommunications network to deliver clinical and educational services to ten rural and community Iowa hospitals. This contract created the National Laboratory for the Study of Rural Telemedicine administered by the Telemedicine Resource Center and directed by Michael G. Kienzle, M.D, associate dean for Clinical Affairs and Biomedical Communications in the UI's College of Medicine [3]. With the development of this telemedicine network and other outreach services, the UI Health Sciences Center has undertaken the challenge of defining the role this institution will play in providing health services to Iowa's community health providers and their patients. UI now has the potential to eradicate the gap between the information "haves" (academic health centers) and "have nots" (underserved rural and community-based practices).

The Rural Telemedicine Laboratory includes five projects (three clinical and two educational), the Telemedicine Resource Center, and a T1 telecommunications infrastructure that connects the ten community hospitals to a hub at UIHC. UIHC's Telecommunications Service Department has supplied each of the hospitals in the network with the requisite electronics, equipment, and hardware needed to support the delivery of telemedicine applications. Circuits have been provided by the state's fiberoptic infrastructure, the Iowa Communication Network (ICN), and by local and long distance carriers in the areas served (for example, U.S. West and GTE).

Staff from the Telemedicine Resource Center, Healthnet Project, and Virtual Hospital® Laboratory provided the ongoing training, online and print documentation, and in-service (hands-on) instruction necessary to ensure that utilization of telemedicine services was maximized at the remote hospitals. To further strengthen end-user support, the resource center installed a 1/800 telephone help line and established e-mail capabilities between the rural hospitals and the UIHC.

SERVICES‡

The projects and services involved in UI's program include:

The Telemedicine Resource Center. The resource center is an integral component of the NLM project and the Rural Telemedicine Laboratory. Goals of the center include contract administration, project coordination, remote hospital oversight, and support for the development of future telemedicine and tele-education applications. Resource center staff and advisors provide expertise in the areas of telecommunications, outcomes analysis, and computer training for community providers. The Telemedicine Resource Center facility in the Hardin Library for the Health Sciences includes a full-motion, interactive video classroom. Staff from the center have developed a training program for UI faculty who use interactive television (ITV) to deliver continuing education to rural health providers.

Teleradiology. Only about half the hospitals in Iowa have a radiologist on staff and many hospitals depend on "circuit-riding" radiologists who read films at remote hospitals on an interval schedule. Being able to digitize a radiograph and send it over a network to be read by a specialist in a matter of minutes may represent major cost and time savings for rural hospitals. Although teleradiology is not an uncommon application in telemedicine networks, many questions remain regarding these services. Specific issues that are being investigated include: standardization of sending and receiving units for networked hospitals, resolution and quality of images using teleradiology versus plain films, value-added teleradiology reports utilizing interpretation by tertiary care subspecialists, and the time and accuracy of report delivery using teleradiology as opposed to traditional circuit-riding approaches.

Three-dimensional image analysis. Using conventional (low-end) CT scanners available to all participating hospitals (one via a mobile unit), physicians and technicians from the community hospitals have access to enhanced, three-dimensional images of heart and lung via a sophisticated, computer-based image analysis system called VIDA. Data are currently being collected to assess levels of technical, educational, and clinical training necessary for health providers and to

‡ Relevant Web sites that contain additional information on the University of Iowa's program include: http://telemed.medicine.uiowa.edu (Telemedicine Resource Center); http://everest.radiology.uiowa.edu/ (Three-dimensional Image Analysis Project); http://www.pmeh.uiowa.edu/edcats/ (Trauma Care Project); http://vh.org (Virtual Hospital); http://www.lib.uiowa.edu/rtm/hl/inhnet.htm/ (Healthnet Project).

determine the extent to which patient diagnosis and care are enhanced by this capability.

Trauma care. Traumatic injury is the most common cause of death in Iowans under the age of forty-four, causing over 1,500 deaths annually [4]. Yet only 9.4% of Iowa hospitals have a trauma center (12 of 117). Many traumatic injuries in the state are caused by the use of heavy farm machinery and equipment as well as exposure to toxic chemicals and pesticides. The third clinical project supports the use of real-time computer-based information exchange between community and referral hospitals. Linked to medical image transfer methodologies, the project director has developed an algorithm for community hospitals to use in determining the triage, treatment, and transfer of rural trauma patients.

Virtual Hospital. Many community hospitals cannot afford to develop and staff a full-service medical library to serve their health care professionals and patients. An electronic medical library is an effective way for rural and remotely based health care providers to stay current with recent advances in clinical medicine [5]. The Virtual Hospital is a multimedia digital library that offers the most current medical information in a variety of formats that include, text, graphics, and compressed video with sound. This online library includes electronic textbooks, patient simulations, current diagnostic algorithms, continuing education materials, physician and hospital directories, links to online journals, radiographic teaching files, government documents, material from UI faculty and guest lectures, and a large patient information component.

Healthnet enhanced access to information services. Access to library and information services has been shown to influence medical decision-making in such areas as diagnosis, treatment, follow-up care, and length of hospital stay [6, 7]. The Healthnet project offers community hospitals the ability to (1) search a variety of health related databases via Healthnet (the Hardin Library's online database system) to identify relevant literature, and (2) order articles from the Hardin Library via the Internet without additional mediation.

GOALS OF THE HEALTHNET PROJECT

The remainder of this paper will describe the Healthnet project in detail, including efforts to evaluate its success. Overall project goals for the Healthnet project were to:

- offer health professionals access to a wide variety of electronic indexes and databases;
- provide an effective, online document delivery service that allows the end-user to initiate a document request during the online search;
- train local health professionals in the use of these resources and services and measure the effectiveness of this training;
- measure utilization of these resources and services; and
- collect anecdotal information from health professionals on the effect of these resources and services on patient care.

METHODOLOGY

Equipment

A total of thirty-nine Macintosh 7100 computers and Apple Laser Printers were configured and deployed to the networked hospitals. These computers served as multi-user workstations from which health professionals at the remote hospitals could access a variety of online resources. The decision to purchase Macintosh computers was made in 1994 when that platform was deemed most appropriate for graphical user interfaces and the multimedia format of the Virtual Hospital. All computers were equipped with Netscape browsers and a software program called At Ease, which was loaded on each of the computers to protect the hard drives from overzealous downloaders and potential hackers.

A document delivery workstation (486 Intel/Windows 3.11) was configured and installed in each of the ten hospitals. These workstations were equipped with Ariel software and were used almost exclusively as a central site repository for receiving and printing documents received via the Ariel document delivery system. The document delivery service was enabled in late January of 1996 through the creation of a special Web site that allowed individual users to request articles from the Hardin Library where interlibrary loan staff retrieved, scanned, and sent the articles via the Internet to a central printer at each site. In some cases, these workstations were equipped with Netscape software and did double-duty as search stations.

DATABASES

Healthnet is mounted on a Unix server at the Hardin Library for the Health Sciences. Healthnet uses the OVID search interface and includes the following databases:

- MEDLINE and the Backfiles (1966–current year)
- CINAHL (1982–current year)
- CancerLit (1983–current year)
- AIDSLINE (1980–current year)
- Current Contents, all categories (11/18/96–current year)
- Core Biomedical Collection (15 full-text journals)

All the databases include abstracts and easy access (a

Table 1
Telemedicine registrants by profession

Profession	Number of staff	Number of registrants	Percentage
Administration	202	159	78.71%
Allied Health	1,370	321	23.43%
Information Systems	41	22	53.66%
Librarian	3	3	100.00%
Nurse	1,828	588	32.17%
Physician	481	246	51.14%
Total	3,925	1,339	34.11%

Table 2
Healthnet sessions by user category (excluding librarians) July 1, 1996 to May 31, 1997

User category	MED LINE	CINAHL	Health-Star	CurCont	Cancer-Lit	Total
Administration	43	2	12	5	1	63
Allied Health	74	1	3	3	0	81
Nurse	399	146	53	37	18	653
Physician	380	0	6	1	4	391
Total	896	149	74	46	23	1,188

single mouse click) to a Web-based document request form. Appropriate licensing agreements with OVID to provide searching software to the remote sites were arranged before the contract was finalized. Additionally, users could telnet to Micromedex, a computerized clinical information system that provided information in the areas of toxicology, poisons, drugs, and emergency medicine. UI's online book catalog, OASIS, was also available to rural end-users.

LOCAL SUPPORT

Hospital chief executive officers were asked to appoint a "telemedicine liaison" from their hospital personnel to facilitate communication with UI telemedicine staff. These individuals included four directors of education and information services, two librarians, two administrative assistants, one radiology director, and one emergency room supervisor.

It should be noted that only three of the ten hospitals had a medical librarian in their facility. One librarian (not represented in the group described above) was a backup telemedicine contact for her hospital. Telemedicine liaisons at each hospital decided where the workstations would be located in their facility to optimize utilization by their staff. Typically, locations selected were physicians' lounges, nurses' stations, administrative offices, and emergency rooms.

USER INTERFACE

End-users first logged in to the project's default home page. A successful login brought up the Virtual Hospital, which served as the front end and allowed health professionals to search the Virtual Hospital and access the Healthnet databases, the online document delivery request forms, VIDA Physiologic Imaging tutorials, Informm (the UI's mainframe-based online patient record system), Micromedex, and other health resources on the Web. All applications were timed-out to return to the startup login screen after ten minutes of nonuse.

DATA COLLECTION

Staff from the Telemedicine Resource Center coordinated the registration, data collection, and data analysis for these workstations. Data from the Healthnet server were captured and entered into a relational database. Scripts were written in order to produce reports on a variety of parameters and queries. Usage data entered into the database included registration and end-user information, Healthnet utilization, and records of document delivery requests. Using the scripts and report functions, identification cards with each registrant's login codes for various programs were generated and mailed to each end-user.

RESULTS

Project registrants

As of October 1997, 1,339 health and allied health professionals from the ten networked hospitals have registered to use the Virtual Hospital workstations. To gather usage statistics based on site and profession, individual registration of each user was necessary. Table 1 shows the number of staff and registrants at all sites across professions.

Healthnet database searching

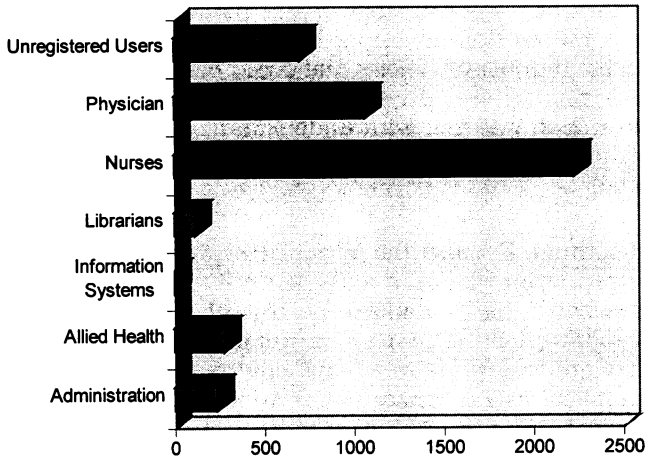
Table 2 shows the use of the Healthnet databases by each profession for the eleven month period from July 1996 through May 1997.

Electronic document delivery

Electronic document delivery was enabled in late January of 1996 through the creation of a special Web page that allowed individual users to request articles from the Hardin Library where interlibrary loan staff retrieved, scanned, and sent the article via the Internet to a central printer at each site. Ariel software was used for this function.

The Hardin Library interlibrary loan staff has achieved a "fill rate" for requested articles of approximately 90%. For purposes of this study, requests that could not be filled through the Hardin collection were not referred to other libraries. Because the Healthnet

Figure 1
Document requests by user category



databases were coded by Hardin Library staff members to indicate which articles were held at the Hardin Library, some filtering was performed by the requesters who also had the option of limiting their Healthnet database retrieval to only those journals held at the Hardin Library.

A total of 4,620 requests were made by personnel at all of the sites from January 1996 through August 1997, resulting in 4,150 document transmissions. Although Davenport (712 requests) was the largest of the ten institutions, the highest number of requests were generated by Ottumwa (2,161 requests) where document delivery was heavily promoted and supported by the site librarian. It should also be noted that Davenport used the electronic document delivery program primarily to supplement its established interlibrary loan program: therefore, a much smaller fraction of their requests were generated via the electronic document delivery program.

Figure 1 shows the total number of requests generated by each of the user categories. A total of 249 registered users generated 4,620 requests (or an average of 15.75 requests per actual user). Also shown is the number of requests from unregistered users (i.e., those who did not formally register as telemedicine users but who used the Web site to request articles). Because no registration data were available for these users, categorizing them by profession was not possible. Nurses accounted for the greatest number of document delivery requests with over half (56.8%) of all requests coming from this end-user category.

BENEFIT OF SERVICES

Site coordinators (n = 10) were surveyed on a number of parameters including their perceptions of who received the greatest benefit from the programs available through the Virtual Hospital workstations. For the end-user categories in Table 3, site coordinators were asked to rate the benefits from one to six with six receiving the most benefit and one receiving the least benefit. Average scores for each group are listed below and take into account that not all hospitals have a librarian or computer support personnel.

DISCUSSION

Lessons learned

Training. The importance of on-site, end-user training cannot be overemphasized [8]. UI's experience indicates that on-site training in site navigation, search methodologies, and document ordering procedures not only provides a much-needed introduction to the services but, perhaps more importantly, stimulates interest in these services on the part of the participants. The extent to which training was completely "voluntary" or "strongly encouraged" at each of the sites varied. However, once hands-on training began, participants showed a marked interest in the project and in using the available services. Unfortunately, owing to busy and varied schedules on the part of hospital staff, providing systematic training to all personnel or even to all of the registrants was impossible. For this reason, training was made as flexible as possible with UI telemedicine project staff traveling to the sites and making themselves available at workstations throughout the hospital so that instruction could take place as end-users had a break in their schedules.

In future training efforts, consideration will be given to providing greater uniformity in training publicity across the sites. The production of a Healthnet or document delivery training video is also planned, and copies of the video could be made available for checkout at each of the sites. This video would allow users to learn or review material at their convenience.

Shortly before a training visit, the Telemedicine Resource Center staff provided posters and flyers to the site coordinators at each hospital who were then responsible for publicizing the event locally. There seemed to be considerable variation, however, in the

Table 3
Information workstations: site coordinators' perception of benefits

Group	Score	Minimum	Maximum
Library staff	5.7	4	6
Physicians	4.9	3	6
Nurses	4.0	1	6
Allied Health	3.6	3	6
Administrators	2.4	2	4
Computer support staff	1.8	1	5

6 = Most beneficial; 1 = least beneficial.

extent to which the visits were publicized and, in retrospect, ensuring that these training visits were publicized more aggressively might have been useful.

Although special workshops on Healthnet were held for the site coordinators, with the exception of the two librarians, whether any of them ever attained what might be termed, "expert status" is doubtful. For this reason, and because their roles were not publicized as such, the site coordinators were sometimes not sought out by the users, in contrast to the two librarians who had already assumed the role of information expert at their institutions. In retrospect, providing more in-depth database training for the site coordinators to help reinforce this role might have been appropriate.

A great deal of effort was expended by project staff in creating colorful, printed manuals, which were then placed by each of the workstations. As services were added and modified, revising this tool was necessary to ensure accuracy. In addition, several of the workstation manuals were lost or misplaced despite the fact that they were marked with their location. In the future, "on-screen" electronic resources in the form of Web pages or other "pop-up" screens which can be modified centrally and with greater flexibility and security will be relied on. In cases where printed material is deemed necessary, printing and distributing multiple short handouts rather than producing a limited number of larger manuals may be best.

Troubleshooting. A one-year analysis of the troubleshooting log (February 2, 1996 to February 26, 1997) revealed that the 220 incoming calls to the 1/800 help line during that timeframe could be divided into thirteen categories based on the reason for the call. The top three problem categories related to (1) Informm, the mainframe-based online patient record system, which has a relatively complex security access structure (n = 69); (2) system and server errors (n = 26); and (3) technical problems relating to hardware and networking issues (n = 23). Specific questions about Healthnet were fourth out of thirteen in frequency, with twenty-one calls being placed via the help line during the one-year troubleshooting study period.

Document delivery. The special Web form used by participants to request article delivery appears to have worked quite successfully. The form did require, however, that the user click on a different Web page to complete the form. Ideally, article delivery request capability would be linked directly to database searching so that articles could be selected from within the Healthnet database. The project team had hoped to incorporate this feature into the Healthnet software but were unable to do so in the time allotted to the contract period.

On the whole, the document delivery component worked very well. Thanks to an extremely efficient Interlibrary Loan Department at the Hardin Library for the Health Sciences, nearly all articles were delivered within one working day of the request. Six months into the service, an upper limit needed to be placed on the number of articles that could be requested from a single user on a given day to avoid bottlenecks. This restriction was met with understanding by the site coordinators and end-users at each of the remote hospitals.

Healthnet. Because the Virtual Hospital workstations were Macintosh-based and the OVID search software was not initially available on this platform, database searching for the first six hospitals connected to the network took place in a telnet environment. This nongraphical user interface (GUI), while more difficult to navigate than the Web or Windows client version, did not seem to pose as great an obstacle as was originally supposed. However, toward the end of the study (June, 1997) when OVID Web software was made available at the sites, the project team received favorable feedback from users with regard to this "friendlier" interface. Unfortunately, the statistical package that was put into place for the telnet version was not compatible with the Web version, so the team was not able to compare usage figures before and after this change.

CONCLUSION

The Healthnet project was an attempt to replicate the "information-rich" environment of a large academic health sciences center within the community hospital setting. It included not only access to health-related databases, but also an efficient means by which source documents could be sent within a matter of hours to the end-user, thus completing the information "loop." The heavy use of the system together with the enthusiastic response by users attest to the viability of such a model. Moreover, the successful integration of library-related services into a larger telemedicine effort reinforces the concept that libraries and librarians are essential players in this burgeoning field.

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