Costs and Benefits of Connecting Community Physicians to a Hospital WAN

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The Washington Heights-Inwood Community Health Management Information System (WHICHIS) at the Columbia-Presbyterian Medical Center (CPMC) provides 15 community physician practices with seamless networking to the CPMC Wide-Area Network. The costs and benefits of the project were evaluated. Installation costs, including hardware, office management software, cabling, network routers, ISDN connection and personnel time, averaged $22,902 per office. Maintenance and support costs averaged $6,293 per office per year. These costs represent a "best-case" scenario after a several year learning curve. Participating physicians were interviewed to assess the impact of the project. Access to the CPMC Clinical Information System (CIS) was used by 87%. Other resource usage was: non-CPMC Web-based resources, 80%; computer billing, 73%; Medline and drug information databases, 67%; and, electronic mail, 60%. The most valued feature of the system was access to the CPMC CIS. The second most important was the automatic connection provided by routed ISDN. Frequency of access to the CIS averaged 6.67 days/month. Physicians reported that the system had significantly improved their practice of medicine. We are currently exploring less expensive options to provide this functionality.

INTRODUCTION

A Community Health Information Network (CHIN) is a combination of services, products, and technology that allows unaffiliated health care entities to exchange information electronically. Their role is to improve the efficiency and delivery of health care in the community.1 The Washington Heights-Inwood Community Health Management Information System (WHICHIS) at the Columbia-Presbyterian Medical Center (CPMC) is a CHIN funded by the Hartford Foundation.2 The WHICHIS project allows CPMC to share administrative, financial, and clinical information with the community physician practices. WHICHIS provides community physicians with seamless networking to the CPMC Wide-Area Network. The basic architecture includes two PCs and a network addressable printer. The equipment in the physician's office is connected to a Local Area Network (LAN), which is, in turn, connected to CPMC via Integrated Services Digital Network (ISDN).

This paper will provide value and cost analysis for the WHICHIS project. It will address two questions: 1) How much does it cost to install and maintain ISDN linked computers in community physician offices? 2) What are the benefits from the point of view of the physicians using the system?

METHODS

The WHICHIS project can be viewed as having two phases. The first phase involved the installation of the system in the offices of 7 community physicians. During the first phase basic issues of architecture and connectivity were addressed. The first phase represented a steep learning curve for both the project staff and for the local telecommunications provider. Several man-years of experimentation were required before a stable configuration was achieved. Using the knowledge gained from the first group of physicians, a work-flow plan was developed. This plan was tested during the second phase of the project which consisted of installations in 8 physician offices.3 The two project phases differed other ways as well. During the first phase, a limited number of physicians were recruited. All those expressing interest were included in the project. The second phase incorporated a much higher entry barrier. A larger number of physicians were contacted and participation was made competitive. The physicians and their secretaries were required to attend training meetings and provide the necessary electrical wiring and cabinetry to accommodate the computers. Only the first 8 offices that had completed these tasks received computers.

Separate cost estimates were made for initial installation and continuing operating expenses. The installation costs included ordering, installing and configuring the equipment, installing the appropriate LAN cabling and ISDN lines, and training the physicians to use the applications. The yearly operating costs included the software and hardware.
maintenance, the operating fees for the ISDN lines and compensation for the support staff.

Because the installation procedure changed significantly between the two phases, installation costs were estimated only for the second phase offices. The yearly operating costs were estimated across all 15 offices. The cost of the system equipment was determined from purchase orders and billing records. Estimation of personnel cost was complicated by the fact that staff were shared across multiple projects. Individual staff members were asked to estimate the percentage of time spent on the installation and maintenance of the project. Personnel costs included salary and fringe, but did not include indirect grant related charges.

Evaluation of the system began with user group meetings. At these meetings, users discussed operating issues, problems, and requests for improvement. The issues raised in the group meetings were used to develop a questionnaire for a more in depth evaluation. The questionnaire addressed prior computer knowledge, computer use, computer functionality, goals for future improvement, system drawbacks, and problems encountered. The questions were designed to gain an understanding of whether the resource was working as expected, how it could be improved and whether it was actually beneficial to the physicians. Both numeric rating and open-ended questions were included. Answers to the questionnaire were collected in interviews with the community physicians. An independent measure of usage of clinical information was obtained.

Computer-audit logs of the CPMC clinical information system (CIS) were analyzed and data were obtained for four months (Nov. 97 to Feb. 98).

RESULTS

ESTIMATED COSTS

The installation and yearly operating costs are summarized in Table 1. As noted before, installation costs are reported for the second phase offices only. Operating costs were calculated on a per year basis for all of the offices. Costs were divided into five categories: office equipment, central equipment, services, software, and personnel. Each of the categories is discussed in detail below.

Office Equipment

The basic equipment in the community physicians offices, which includes 2 PC P100s with 1.2GB hard drive, 16MB of RAM, an ethernet card, a 17" monitor, a network addressable laser printer, a hub and a CISCO 1004 router, cost $7,414.50.

The annual maintenance cost of the router is $300. The maintenance costs of the office equipment are covered under the hospital's umbrella contract. This includes outside hardware support vendors, support staff, and hospital help desk personnel. This amortizes to $525 per office.

Table 1
Costs per office

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Installation Cost</th>
<th>Operating Cost</th>
<th>First Year Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>$7,414.50</td>
<td>$825.00</td>
<td>$8,239.50</td>
</tr>
<tr>
<td>Central</td>
<td>$1,795.30</td>
<td>$80.00</td>
<td>$1,875.30</td>
</tr>
<tr>
<td>Services</td>
<td>$1,119.82</td>
<td>$988.53</td>
<td>$2,108.35</td>
</tr>
<tr>
<td>Software</td>
<td>$7,080.00</td>
<td>$1,900.00</td>
<td>$8,980.00</td>
</tr>
<tr>
<td>Personnel</td>
<td>$5,492.19</td>
<td>$2,499.67</td>
<td>$7,991.86</td>
</tr>
<tr>
<td>Total</td>
<td>$22,901.81</td>
<td>$6,293.20</td>
<td>$29,195.01</td>
</tr>
</tbody>
</table>

*Per year

Central Equipment

A CISCO 4005 router equipped with a BRI interface and 8 incoming ISDN lines was sufficient to support 15 offices. This equipment cost $26,930, or $1,795.30 per office. Annual maintenance for the central router is $1,200, or $80 per office. The installation fees and the annual operating costs of the central ISDN lines are included in the "services" category.

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Software

The computers were purchased with Windows95 operating system. Additional software included licences for PCTCP (network connectivity) at $90.
The physicians were given the option of installing a commercial physician's office management system, which allowed for electronic billing. A single license for this system cost $6500. Each office required 4 Internet Protocol (IP) addresses, $100 each. Operating costs applied only to the office management system software, $1900 per year.

**Personnel**

The installation required a full-time project coordinator for nine months. This person acted as the community liaison, task coordinator and computer trainer. In addition, a network engineer from CPMC was responsible for configuring the routers and establishing network connectivity. The network engineer contributed ten days per month for six months. After the installation was complete, ongoing support required half-time effort from the project coordinator and four days per month for the network engineer.

**QUALITATIVE EVALUATION**

The value of a system to the user is as important as the cost of the system. Before joining the project, the community physicians had a wide range of computer expertise: 3/15 were experts, 7/15 had some computer experience, and 5/15 had never used computers before. Even though many of the physicians had used computers, most of their offices were not automated. Two thirds used manual billing. Nearly all, 13/15, were telephoning the hospital to get patient information and reports. They described long waits and frustration with this approach. The remaining two had essentially given up trying to retrieve hospital information.

In spite of our previously reported installation challenges, the system performed well once installed. All physicians reported that the system was fast enough most or all of the time. The system was also quite stable and up time was good. Overall 7/15 users reported that the system was never down, 6/15 reported that the system had been down twice since they started using it (over four months). One user said that the system was down weekly but this user was again referring to the inability to access certain web sites. Finally one user commented that the windows operating system was down monthly.

WHICHIS provided community physicians with seamless access to the Integrated Advanced Information Management System (IAIMS) resources at CPMC. Reported usage is shown in Table 2. Clearly, physicians used most, but not all, of the resources available. When asked the reasons for not using some of the applications most of the physicians said that they don’t know how to use them and are too busy to invest the time to learn.

**Table 2**

**Reported Application Usage**

<table>
<thead>
<tr>
<th>Application</th>
<th>Phase I (n=7)</th>
<th>Phase II (n=8)</th>
<th>Total (n=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web-based CIS</td>
<td>4</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Text-based CIS</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Non-CPMC WWW resources</td>
<td>5</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>Drug Databases</td>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>MEDLINE</td>
<td>3</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Electronic mail</td>
<td>4</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Office Management</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Word Processing</td>
<td>7</td>
<td>8</td>
<td>15</td>
</tr>
</tbody>
</table>

All accesses to the CPMC data repository were logged. The logs were analyzed to provide an independent measure of usage (Table 3). Audited usage of the web-based CIS matched reported usage. Although the audit logs showed more use of the text-based CIS than was reported by the physicians, this represented infrequent use. All but one of the physicians used the text-based CIS less than once per month.

**Table 3**

**Audit Log Application Usage**

<table>
<thead>
<tr>
<th>Application</th>
<th>Phase I (n=7)</th>
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<td>7</td>
</tr>
</tbody>
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Overall, CIS usage by the physicians increased over the study period from 4.27 days/month to 6.67 days/month average usage. However, there was a wide range in usage, from 0 to 24 days per month in any given month. Figure 1 shows the average usage of CIS for the 4 month period.

**Figure 1**
Usage differed with the phase in which the physicians joined the project. The first phase physicians averaged 2.35 days/month while the second phase physicians averaged 8.69 days/month. Because usage did not have a Gaussian distribution, the two groups were compared using a 2-tailed Mann-Whitney U statistic. This shows a significant difference, p<0.036. Possible reasons for this difference will be discussed later.

When asked to evaluate the usefulness of the system, all physicians spoke enthusiastically. All rated the system as very useful. When asked if it made things worse in any way, all answered no. Benefits mentioned included a large time saving and improvement in the way they practiced medicine. Several specifically mentioned that their secretaries no longer spent time on the phone trying to get patient information. Overall office organization was improved by having all the information ready available in the computer and by saving paper. Many stated that the Web offers a great resource for medical and office information. Another benefit mentioned was improvement of communication among physicians.

The feature that the community physicians rated as the most important was the access to the clinical information system at the hospital. Second was ease and speed of connection that ISDN offers. They mentioned that not having to deal with dial in time, busy lines and downtime involved with connecting through a standard modem, made the system more convenient.

The physicians reported that they sent more patients to CPMC for clinical tests because they could review the results on line. They mentioned that having the system made practicing medicine less frustrating. They felt that access to the patient medical record allows physicians to offer better medical advice and better care. Several physicians noted instances when patients did not inform them of all prior hospitalization and tests. Having access to the electronic medical record minimized ambiguities and allowed the physician to give a better-informed medical advice and avoid duplication of services.

The standard configuration for the project included one computer for physician use and one for secretarial use. When questioned about relative benefit, 8/15 reported that both physician and secretary benefited equally. In 6/15 cases, the doctor benefited more than the secretary and in only one case the secretary benefited more than the doctor.

When the doctors were asked to choose an ideal number of computers in their offices, their responses varied according to the size of their practice. Most physicians were in solo practice and felt that two computers were enough. Physicians in larger practices with two or more partners said that they would like to have one computer in each examination room.

The physicians had many suggestions for improvements to the system. All said that they would like to be able to order procedures and schedule appointments at the hospital with on-line order forms. To our surprise they also wanted to share more information with the hospital. Specifically, they would like to have an in-office electronic patient record that the hospital could access electronically. CPMC is the primary provider of hospital services in the Northern Manhattan. Physicians felt that increasing the communication between the community physicians and hospital physicians would result in better patient care. If communication between the hospital and community physicians could be increased, they indicated that they would send more patients to the hospital. Lastly, the community physicians requested an on-line directory of specialists for each department so that they could contact specialists directly.

The computers for the project were provided at no charge. Physicians were asked whether they would use their own money to replace the system, were it to disappear, and if so, what they would purchase. All said they would pay for the system. Interestingly, they indicated that they would purchase cheap computers but would pay a premium to have an automatic connection versus a modem connection. Although we asked the physicians to give a dollar estimate of the value of the system, all declined. Most stated that they had too little computer knowledge to make a valid estimate.

DISCUSSION

We believe that this paper provides a realistic picture of the costs and benefits of giving WAN access to community physicians. It is important to remember that the costs cited represent a complete hardware, software, and support implementation. This was necessary because of the low level of computer penetration in Northern Manhattan. We were pleased to find that the costs for each office were in line with the commonly cited value of $6,000 per year to support one networked PC. Of course, connecting physicians who are already computerized would be less expensive. However, a large percentage of the installation costs represented the well-known difficulties of ISDN. Therefore personnel costs would not decrease as much as hardware. Equally important is the realization that the costs cited represented a "best-case" scenario after over 3 years
The physicians' opinion of the system was overwhelmingly positive. Physicians reported that the system resulted in increased referrals to CPMC. We are currently attempting to quantify this. We are also exploring with several ancillary departments at CPMC ways to implement some of the requested improvements to the system.

Physicians' attitudes towards the hospital were correlated with computer usage. The heavy use of the system resulted in physicians sending more patients to the hospital for tests so that they can review the data in the computer. They were also the most vocal in requesting on-line order forms, referral directories, and hospital access to private office's patient records. The easier the communication with a hospital becomes, the more willing the physicians are to use it as their primary referral center. We had assumed that they would fear that hospital specialists would steal their patients. In contrast, the community physicians repeatedly stated that the benefit to the patient and the increased convenience for them outweighed this possible risk.

The differences between the phase one and phase two physicians were significant. Making participation to the project more competitive and requiring initial training prior to installation increased the physicians' emotional commitment to the project. This resulted in over three fold higher use of the CIS, the only resource that could be quantified.

ISDN was a major source of difficulty. Even with experience, configuration of the routers was consistently problematic. Incorrect configuration resulted in some ISDN lines being connected around the clock. Prior to the move to flat rate pricing, usage charges resulted in some extremely large ISDN bills of approximately $500/month/office. In addition, the local telecommunications provider had difficulty configuring the ISDN correctly for flat rates. Fortunately, once configured, the ISDN has been quite stable. The ability to connect automatically to the network was seen as a major advantage by the physicians. When this project began, this feature was only available with ISDN. We are now exploring newer options, such as WAN Bridges over 56K modems, and digital services, such as ADSL, that will allow us to provide automatic connection more simply and inexpensively.

There is considerable interest at CPMC in expanding the system. What has not been determined is how much of the cost of the system should be financed on a fee-for-service basis by the offices themselves, and how much should be financed through increased revenue from referrals. It is also not clear whether an all-inclusive model or a "connection only" package (where the physicians buy and maintain the computers) would be best.

Installing and supporting computers in remote offices is neither easy, nor cheap. In spite of this, the WHICHIS project has been positively received. It has benefited both CPMC and the community physicians. The information gained is allowing us to explore new services and connecting options.

Acknowledgment

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Reference List


