NetReach: A Clinical Information Infrastructure for Health-Care Teams in Ambulatory Care

Final Report
Northwestern Memorial Hospital
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INTRODUCTION

Northwestern Memorial Hospital (NMH) serves as the primary teaching hospital of Northwestern University Medical School (NUMS). There are approximately 1200 physicians, 300 residents, 1055 nurses, 3156 employees, and 750 volunteer workers who together take care of patients seen through over 36,000 admissions and 50,000 outpatient visits. Physicians on the NMH medical staff conduct approximately 800,000 outpatient visits annually.

The central campus of the hospital facilities and physician offices are currently spread over 22 buildings within a 6-block radius in downtown Chicago. The sprawling nature of the facilities and the aging buildings led to a strategic decision to build a new facility that would consolidate the patient care areas in a single, integrated facility. The Board of Directors approved a $580M building project, one of the largest building projects in the country. Named the "redevelopment project" (RDP), the new building became a symbol of the transformation or redevelopment of the hospital corporation into a health system linking health-care providers, diagnostic testing services, and acute-care facilities. The building is scheduled to open in January, 1999. Hospital operations and physician practices will occupy the building in the spring of 1999.

The common building will address many of the impediments to physical and administrative integration. In 1993, Northwestern Memorial Corporation (NMC) made a long range commitment to clinical integration and saw clinical information systems as an essential infrastructure to operate in the new health-care delivery environment. NetReach, the National Library of Medicine sponsored project, was initiated to define clinicians' information needs and to develop solutions to address those needs.

To accomplish the goals of the project, we conducted a comprehensive assessment of clinical information needs at diverse clinics, defined the functional requirements for information tools to support the clinicians, and implemented information systems solutions including a computer-based patient record system in two sites. Finally, we evaluated the impact of the systems against our initial goals, focusing extensively on the evaluation of the impact of using a computer-based patient record system (CPR).

We begin by describing the alignment of the project goals with the organizational goals.

GOALS AND OBJECTIVES

Organizational Vision and Strategic Objectives

Northwestern Memorial Hospital established the following vision for its clinical information system (CIS):

> *To continuously evolve a state-of-the-art clinical information system that provides ready access to relevant information in support of patient care, management, research, and education.*

The primary goal of the CIS initiative is to continuously improve the quality, appropriateness, and cost-effectiveness of patient care. We believe that information is a common infrastructure for patient care, research, and education. The CIS vision is aligned well with the strategic objectives of Northwestern Memorial Corporation. Of the nine NMC strategic objectives, the following four are served directly by the CIS initiative.

- Information Systems: "…we will implement information technology solutions to enhance clinical decision making, patient outcomes, and effective operations."

- Primary care physicians: “NMC will recruit formally committed primary care physicians…”
- Managing care: “…with physicians, NMC will organize our care delivery and contracting systems to manage care effectively.”
- Academic mission: “NMC, in partnership with Northwestern University Medical School, will be a preeminent academic medical center.”

A CPR system is an essential tool for managing the care of individual patients and for managing the practice of a health system. Without accurate data on the decisions made in the provision of service, a health system cannot rationally manage either the effectiveness or costs of its service.

NetReach Project Goals and Objectives

The goal of the NetReach project is:

> *To implement and evaluate information tools that facilitate the provision of high quality, cost-effective health care in ambulatory-care settings.*

In order to address the goal of the project, we concentrated on the following objectives:

- Develop a methodology to determine information needs of physicians and health-care teams in a variety of outpatient settings
- Perform needs assessment in diverse outpatient settings
- Acquire, develop, and implement information tools at test sites
- Evaluate the impact of the information solutions

The NetReach Project involves seven different clinical sites chosen to reflect the diversity of physician practices on the Northwestern campus. The sites include primary-care, specialty-care, faculty, and independent practices. One of the sites is an urban clinic whose patient population represents underserved patients. By understanding and satisfying the information needs of these diverse sites, we hoped to develop a strategy and plan for implementing a clinical information infrastructure that serves the patient care mission of the organizations and provides the data to continuously adapt to the changing health-care environment.

CLINICAL INFORMATION NEEDS ASSESSMENT

The medical staff of NMH is a mixture of community and academic primary-care and specialty-care physicians. Consequently, it is important to understand what effect the diversity of practices has on clinical information needs and what tools are necessary to address those needs. We conducted a comprehensive user information needs assessment during the first year of the project. Several business tools were used to assess the information needs of our clinicians including observational studies, time-allocation studies, semi-structured interviews, and surveys.[1]. Of the multiple methods employed in the needs assessment, the observational studies provided the most useful information.

To conduct the needs assessment and, later, to form the core of the implementation team, we created a team of clinical consultants. Clinical consultants are primarily clinicians and other health-industry professionals who have a special interest in clinical informatics. Employing clinicians as an integral part of the implementation team was an extremely important component of our overall success.

Development of Information Needs Assessment Methodology

We deliberately made comprehensive user needs assessment a central part of our program. Observational studies have shown that practitioners' perceptions of their information needs as reported in surveys or interviews quite often differ qualitatively and quantitatively from actual practice.[2] Furthermore, results from ethnographic studies can be applied to the design of computer-based clinical applications with favorable results.[3] Consequently we centered our multi-method assessment approach on observational methods, and used other assessment tools to complement our observational studies. We had anticipated that a more comprehensive information needs assessment would put us in a better position to acquire and/or develop information tools that integrate well into routine clinical practice. Fortunately, that hope turned into reality and we were richly rewarded for the time we spent doing the needs assessment.

Clinical consultants observed clinicians' use of information (e.g., when data used, with whom, how used, what data, etc.) during the patient encounter. Observations occurred in two-hour blocks, recording events at one-minute intervals. We used semi-structured interviews to: 1) validate information obtained from other data collection techniques, 2) expand on observational data or explore new data, and 3) identify potential functional requirements and measurement opportunities. Finally, we used survey instruments to assess three baseline characteristics: 1) current use and experience with computers, 2) satisfaction with available computing resources in the clinic, and 3) perceived value of various functions of a clinical information system.

Results of Information Needs Assessment

During the time allocation portion of our observational studies, we shadowed 38 clinicians (34 attending physicians, 3 nurse practitioners, and 1 physician assistant) for 2 hours each at our 7 different sites.[4] The instrument appears as Attachment A. Activities were recorded at one-minute intervals for 159 encounters, totaling 4541 observed minutes. Figure 1 shows the average distribution of information activities during the encounter across all of our sites. On average, physicians spent 60% of their time talking with the patients, 19% of the time examining the patient, 7% of the time writing, and 5% of the time conducting reading activities. Although the average time spent during an encounter varied from 11.8 minutes to 24.2 minutes, the relative distribution of the kinds of activities was approximately the same despite the diversity of practice types examined.

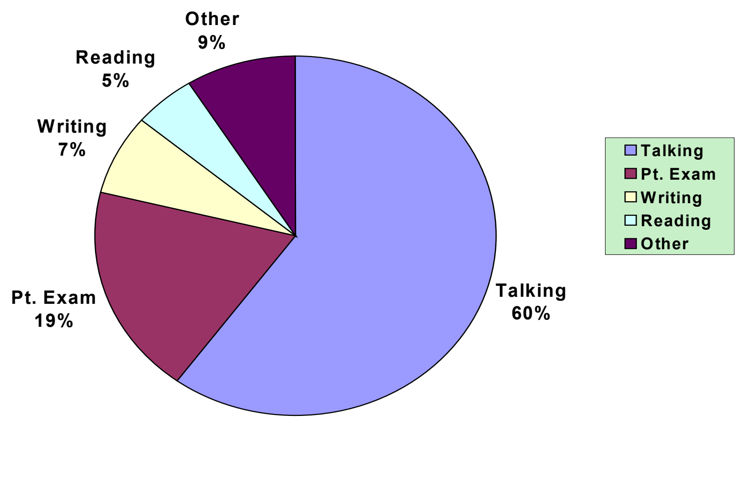


Figure 1: Average Distribution of Information Activities

When we broke out the subcategories of talking, we found that on average 37% of the time was used for patient education and instructions, shown in Figure 2. We found remarkable similarity in the proportion of talking time spent in this activity across the diverse sites, shown in Figure 3. Unfortunately, despite the fact that clinicians uniformly spent significant time on this activity, the literature shows that patient education, when conducted in the typical manner, has not been effective.[5-7] Consequently, this became a priority for us to address with our computer-based tools.

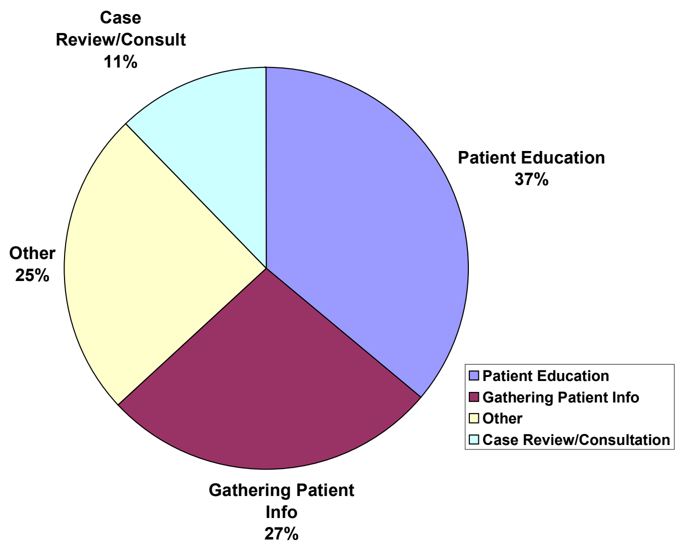


Figure 2: Summary of Talking Subcategories

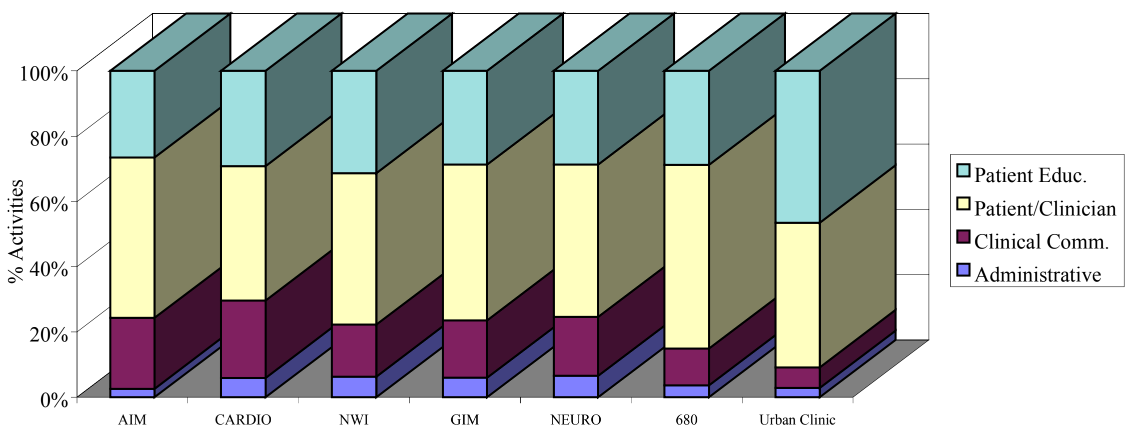


Figure 3: Subcategories of Talking by Site

We interviewed 33 attending clinicians and abstracted the interview data for functional needs. The most common needs are listed in Table 1.

Functional Requirement	Count
Access to diagnostic test results	21/33
Mechanism for communication among health-care team staff	10/33
Display medication list	10/33
Display/modify problem list	10/33
Assistance with patient education and follow-up	8/33
Remote access	8/33
Display/ modify patient appointments	7/33

Table 1: Top Functional Requirements Identified During Interviews

A computer assessment survey was mailed to the site participants asking them to rate their level of expertise with systems and their satisfaction with the computer systems available to them prior to our deployment of any new applications. The clinician respondents' self-rated computer skill levels averaged 2.97 out of 5.0 (5=expert), suggesting an intermediate level of computer expertise. The clinicians' satisfaction with the baseline computer resources, depicted in Figure 4, was relatively poor.

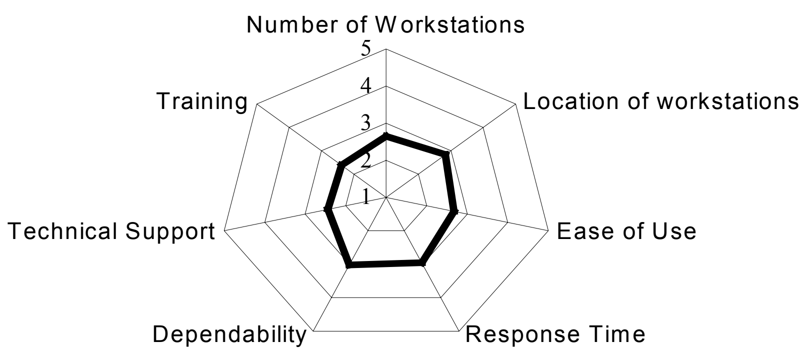


Figure 4: Clinicians' Satisfaction with Computer Resources Prior to NetReach Project

The survey also asked clinicians to rate the desirability of certain functions in a future computer system. A summary of these results is presented in Table 2.

Future System Functionality	Mean All Sites	Range Across Sites
Access diagnostic test results	4.9	4.8-5.0
Display a medication list	4.6	4.3-5.0
Obtain abnormal test result alerts	4.6	4.0-4.6
Access to patient appointment schedules	4.5	3.6-4.8
Retrieve dictated notes	4.5	4.0-4.6
Display and modify the current problem list	4.4	4.0-5.0
Obtain drug interaction alerts	4.3	3.9-4.8
Access demographic information	4.3	3.9-4.6
Generate patient care follow-up reminders	4.3	3.6-4.8
Generate patient self-care instructions	4.3	3.8-4.5
Trend diagnostic test results	4.2	3.8-4.4
Authenticate dictated notes on-line	4.1	3.7-4.4
Order diagnostic tests	4.0	3.7-4.3
Prescribe medications via on-line access to pharmacy	4.0	3.7-4.6
Access expert system to establish differential diagnosis	3.3	2.8-3.6

Table 2: Clinicians' Desired Functionality for Future Computer Systems (5.0=extremely desirable)

Conclusions of Information Needs Assessment

After analyzing the results of all our data, we summarized the major information needs of our study sites in five high level points below:

- Need for integrated access to patient information
- Need for summary information (e.g., problem list, medications, demographics)
- Need for a mechanism to communicate in a timely and efficient manner among health-care team members
- Need for effective means of providing patient instructions and education
- Need for convenient access to computer work stations with good training and technical support

Although conducting observational studies was very labor intensive, we believe there were significant benefits associated with this method. First, social science studies have shown that direct observation of cultures and processes in situ produced results that more reliably reflect actual practice than information obtained in an artificial environment such as in surveys, interviews, and focus groups.[8] Second, direct observation of everything that occurred in the actual practice environment provided a more complete understanding of the breadth of activities that take place. Third, observation of actual needs allowed us to separate the understanding of clinicians' needs from potential technology solutions. One of the limitations of focus groups is that it requires that the participants have some knowledge of the new solutions demonstrated, which in our case are technology solutions.

One of the most important benefits of the observation studies was the knowledge that was captured by the observers, who then acted as surrogate users when questions came up during development and implementation. We capitalized on this benefit continuously throughout the project. Finally, the field-presence of our clinical consultant team and their subsequent involvement in implementation created an important rapport between the user and the clinical consultant.

SITE DESCRIPTIONS

Seven clinical sites participated in the NetReach project. (We substituted one site during the course of the project.) Collectively, the sites represent primary care, specialty care, faculty group practice (Northwestern Medical Faculty Foundation, NMFF), independent private practice, and urban care. Below is a brief description of each site with the name of the project liaison.

General Internal Medicine (GIM), NMFF, Gary Martin, MD, Time Life Building, 303 E. Ohio Street

> This is a combined primary care faculty and resident group practice that is the largest of the seven clinical sites involved in the project. There are 34 attending faculty physicians, 65 residents, a nurse practitioner, registered nurses, licensed practical nurses, medical receptionists, a billing coordinator and a managed care coordinator at this site. Patient volume averages 47,000 visits annually. The majority of their lab tests are performed at NMH and the results recorded in PRIMES, the NMH hospital information system. The NMFF paper-based medical record system is centralized and supports sixteen clinical departments spread across the campus. NMFF uses the IDX registration and scheduling system. Separate administrative offices for the physicians and clinical exam rooms are located on the same floor. Patients are admitted to NMH.

Associates in Internal Medicine (AIM), Private Practice, Edward Winslow, MD, 211 E. Chicago Avenue

> This is a seven physician private practice that includes two cardiologists, one endocrinologist and four internists. (One physician left the project but is included in the control group.) They have additional support staff of 19 persons including medical assistants who have a 1:1 relationship with the physicians. Each physician has an exam table in their office and there are five additional smaller exam rooms. This practice also has a satellite office in a suburb north of the city. Patient volume is about 15,000 visits annually. Most laboratory requests are sent to a private laboratory while most diagnostic procedures (e.g., X-rays) are performed at NMH. Results are obtained via dedicated printers for outside lab results. The practice uses Medical Manager software for scheduling and billing. Patients are admitted to NMH.

General Internal Medicine, Private Practice, Henry Ruder, MD, 680 N. Lake Shore Drive

> This primary care private group practice consists of five general internists. They share physical space and support staff services, but function as individual practitioners. The physicians deliver primary care with additional expertise in endocrinology and geriatrics. The 13 support staff consist of an office manager, billing clerks, medical receptionists and lab technicians. The practice averages about 15,000 patient visits annually. Most routine blood work and cultures are collected on-site and sent to an off-site lab for analysis. X-rays and other diagnostic testing are performed at NMH. The receptionists use a manual appointment system while the billing system is automated. Patients are admitted to NMH.

Northwestern Internists, Ltd. (NWI), Private Practice, Michael Stewart, MD, 676 St. Clair

> Northwestern Internists is a private general internal medicine practice with ten full-time and two part-time internists. Both clinical exam rooms and administrative offices are located at the site. During the course of the project, the site added four physicians and expanded the clinic space from 6,000 to 10,000 square feet. Annually, the practice averages 46,000 patient visits.

Laboratory tests are drawn at the site and sent to an outside laboratory for analysis. Results are retrieved through an interface to their Medical Manager system. NMH is used for the majority of other outpatient diagnostic tests. The clinic uses Medical Manager for its scheduling and billing processes, as well as for generating referrals. Patients are primarily admitted to NMH for inpatient services. However, a few of the physicians also have admitting priviledges at Rush Presbyterian St Luke's Medical Center.

Cardiology, NMFF, Robert Hendel, MD, Time Life Building, 303 East Ohio Street

The cardiology faculty staff consists of 21 Attending Physicians, 6 Fellows, a clinical practice manager, 3 registered nurses, medical receptionists, billing staff and technical/procedural staff. During the last three years, there has been a high rate of physician and staff turnover. The use of temporary personnel has increased to cover vacant staff positions. Physicians' administrative offices are located in several buildings across the campus. The administrative area on-site includes space for the administrative and clinical support staff only. This site handles approximately 6,500 outpatient visits and 3,200 procedures per year. Sixty percent of the patients seen at cardiology are physician-referred. The practice provides a full range of cardiology services. Clinical laboratory tests are performed at NMH. Diagnostic cardiology tests are performed at the clinic. NMH's outpatient diagnostic testing center is used for more complex tests and procedures. The clinic recently began resulting PT/PTT on-site as part of the Coumadin-tracking program. Patients are admitted to NMH.

Neurology and Neurosurgical Sciences, NMFF, David Stumpf, MD, 233 East Erie Street

This specialty-care faculty group practice consists of 9 general neurologists, 6 behavioral neurologists, 4 neurosurgeons, a practice manager, 5 registered nurses, and 7 medical receptionists. The 233 East Erie office is the setting where physicians from neurology, neurosurgery, neuropsychiatry, and now anesthesiology, provide ambulatory patient care. Of the staff physicians, only two of the general neurologists have their administrative offices on-site; the rest of the administrative offices are located elsewhere on campus. The practice sees approximately 20,000 outpatient visits per year, including 12,000 neurology, 6,000 neurosurgery, and 2,000 neuropsychiatry visits. Their lab work and diagnostic tests are performed at the hospital; specialty tests are performed at the Neuro Testing Center (NTC). Results from the NTC are sent to the clinic on paper. Patients are admitted to NMH.

Erie Family Health Center (EFHC), Rupert Evans, 1701 Superior Street

Erie Family Health Center is a community-based health care clinic with strong ties to NMH. The center provides an array of primary care services, health promotion and educational services, and psychosocial services. The internal medicine staff consists of 6 doctors and 3 family practice nurse practitioners. Pediatrics has 6 doctors and 2 pediatric nurse practitioners while obstetrics consists of 1 doctor and 4 nurse midwives. The clinical support staff includes 3 community health registered nurses, 4 medical assistants, 4 lab technicians, 1 pharmacist, 1 psychiatrist, and 10 receptionists (including financial counselors, medical receptionists, and cashiers). Patient volume averages 28,000 visits per year. Patient population is approximately 85% Latino, most of whom speak Spanish. Labs are sent to an outside laboratory and results are received in a batch form nightly to a dedicated terminal. Physicians are on staff at NMH as well as several other area hospitals that support community health care.

Winfield/Moody Health Center, Near North Health Service Corporation, Linda Murray, MD, 1276 N. Clyborn Avenue

Winfield Moody Health Center provides an array of primary care, social service support, nutrition education and outreach programs to a medically indigent population. There are 10 attending physicians on staff who provide internal medicine and child care services. The clinic averages 48,000 visits annually. Their labs are sent to an outside laboratory and diagnostic tests are performed at a variety of sites with whom they are affiliated. Many of their patients are admitted to NMH. This site participated in the project during Year 1.

ESTABLISHING AN INFORMATION FOUNDATION

This section describes our implementation of the technical and network infrastructure and the phased approach we took to implement change in their information foundation. Our first objective in establishing the information foundation was to deploy personal computers (PCs) at the participating sites and establish network connectivity.

Networking

The seven NetReach clinical sites are all connected to the NMH fiber optic backbone via T1 connection speed or wide are network connections. The topology is illustrated in Figure 5. In the upper left hand corner of the figure are the four pavilions that make up NMH (Wesley, Passavant, Olson, Prentice). The NMH enterprise network is protected behind a firewall from the Internet. The NMFF clinics (General Internal Medicine, Cardiology, Neurology) are connected to NMFF-Net which in turn is connected to the NMH firewall. By courtesy, one of the private practices is attached to the NMFF network. Three additional sites are connected via secure T1 lines to the hospital.

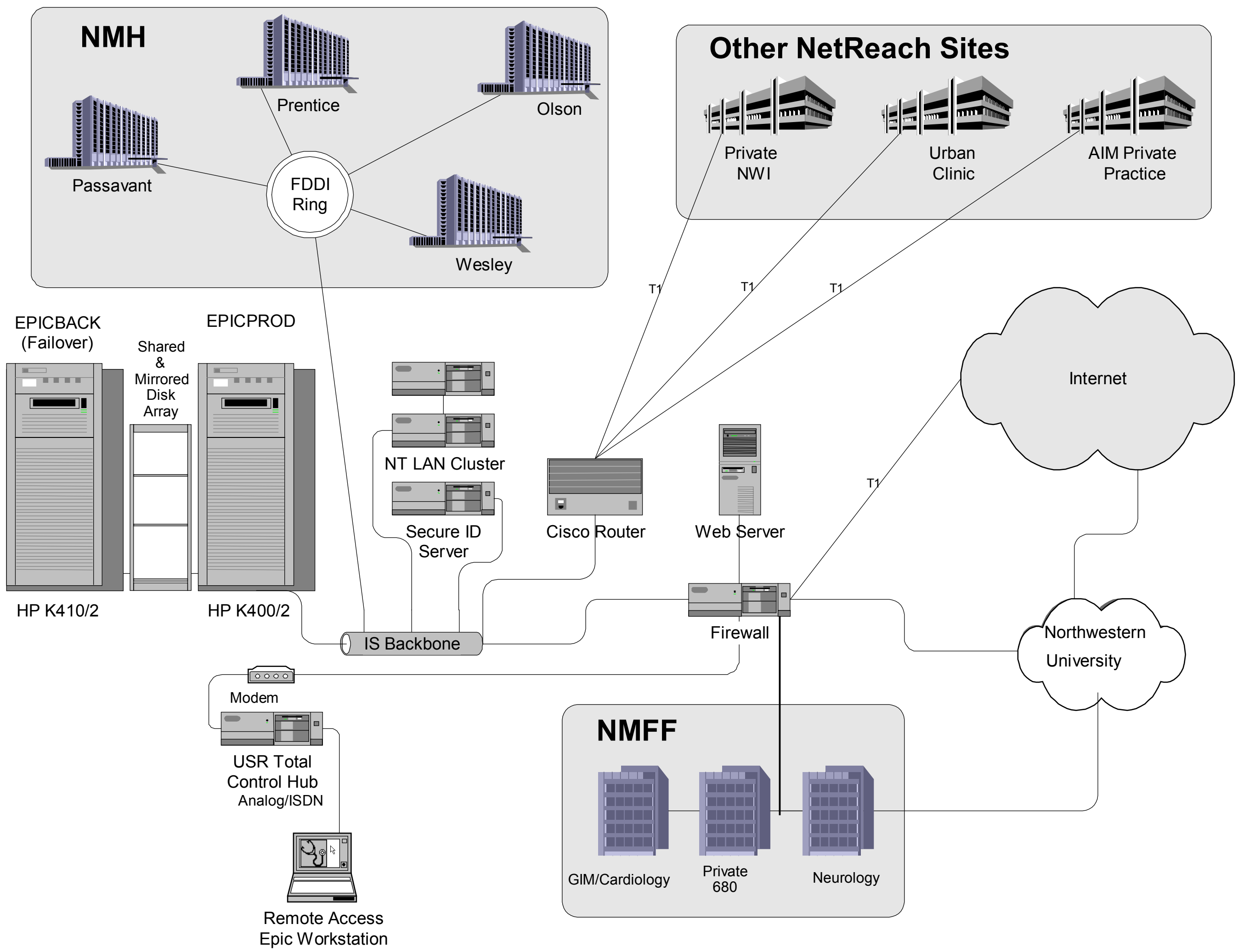


Figure 5: Northwestern Memorial Hospital Network Topology

Workstation Deployment

Site assessments, physical space and CPR participation determined the number of PCs. The deployment was carried out in stages from June through November, 1995, with the exception of EFHC which was added later in the project. Table 3, below, summarizes the total number of PCs deployed.

Site	Total number of PCs	Total number of printers	Number of attending physicians
GIM	63	9	34
AIM	16	3	7
680 LSD	2	1	4
NWI	7	1	12
Cardiology	11	3	21
Neurology	8	1	19
Erie	5	2	12

Table 3: Number and Location of Deployed NetReach Workstations

Because we were working with five different business entities, we had to reconcile hardware and software standards. Fortunately, the Pentium workstations we chose were acceptable to all parties. We initially installed Microsoft Windows 3.11 operating system on all the workstations. When we sought to upgrade the workstations to a 32-bit operating system, there was a divergence of standards. NMFF had chosen Microsoft NT operating system and NMH had chosen Windows 95. We honored the different standards and set up a support algorithm to deal with customer support issues. One of the advantages of working with different groups is that some of the alternate standards improved our ability to service our users. For example, NMFF's use of NT and Micorsoft's SMS software distribution tool increased our efficiency of performing upgrades. NT's security features also helped us avoid configuration difficulties we experienced with Windows 95 (described later). Table 4 summarizes the various technology standards employed in the project.

System/Service	Common To All Sights	**NMH** (includes NWI, AIM and common workstations)	**NMFF**
CPR Server	Hewlett Packard K400 and K410		
LAN NOS File Serving	-	MS NT 4 server - NMH Domain	MS NT 4 server - NMFF Domain
LAN NOS Print Serving	-	NetWare 4.1 – 4.11	MS NT 4 server
Network Protocols	TCP/IP	IPX/SPX (NWLINK)	
Network Topology	10BASET		
Workstation OS	-	MS Windows 95	MS NT Workstation 4
Remote Node Server	USR Total Control Hub W/ Radius		
Remote Access Security	Security Dynamics Secure ID		
Software Distribution	-	"Sneaker-Net"	MS SMS
E-mail	MSMail 3.5	Migrating to MS NT Exchange	Migrating to MS NT Exchange
Web Browser	-	Netscape Navigator	MS IE v. 3-4
HIS access	-	Reflections terminal emulator	Public Domain 3270 emulator
Productivity Software	MS Office 97		

Table 4: Technology Standards Used in NetReach Project

Cultural Change

Integrating information technology into patient-care activities requires a significant change in behavior and workflow. We designed a phased approach to our implementation of technology that included an explicit cultural adaptation phase. We describe these phases below.

We divided our implementation into three phases. During Phase 1, the "cultural enhancement" phase, our goal was to acclimate the clinicians to the computer as an integral tool in their daily professional life. Phase 2 added the notion of the computer as an information appliance through its connectivity to information resources on the network and the Internet. Phase 3 consisted of the introduction and routine use of CPR systems. All sites participated in the first two phases. Using the available resources, we could only fully implement the CPR in two of the seven sites.

The first challenge was to introduce the computer and instill comfort with, and ultimately addiction to, this new information tool. We installed networked desktop PCs in their clinical and administrative offices where appropriate. We loaded software that gave them more convenient access to their scheduling system and to their laboratory information system. In addition, we installed the MS Office suite of productivity applications. Training for Phase 1 of the deployment concentrated on orienting users to Windows, using a mouse, accessing PRIMES (our hospital based result retrieval system), accessing their practice management system in a Windows environment, and using MSMail. We shortened a typical 16-hour Windows and MSMail training class to 4 hours, split into two 2-hour sessions, to accommodate the time constraints of clinicians and clinic staff.

Electronic mail was included in the office applications and was intended to be the primary catalyst for the cultural transformation. Within approximately six months, e-mail had caught on and solidly induced a professional dependence on this communication modality. The asynchronous nature of e-mail nicely complemented the available methods of paging, telephone tag, and paper-based memos.

Access to Knowledge Resources

During Phase 2 of the project, clinicians requested on-line access to medical reference materials, patient education materials and web based clinical resources. We initially provided access to Medline via Northwestern University's licensed Ovid product. With the introduction of PubMed, we began offering Medline through the Internet. Additionally, in response to the clinicians' need for knowledge resources, we created the NetReach Home Page (http://www.nmh.org/netreach/netreach.html) providing clinicians with quick access to relevant medical resources on the Web (see Figure 6). The NetReach home page is an evolving "index page" to several resources that can help clinicians answer common questions in adult primary care.

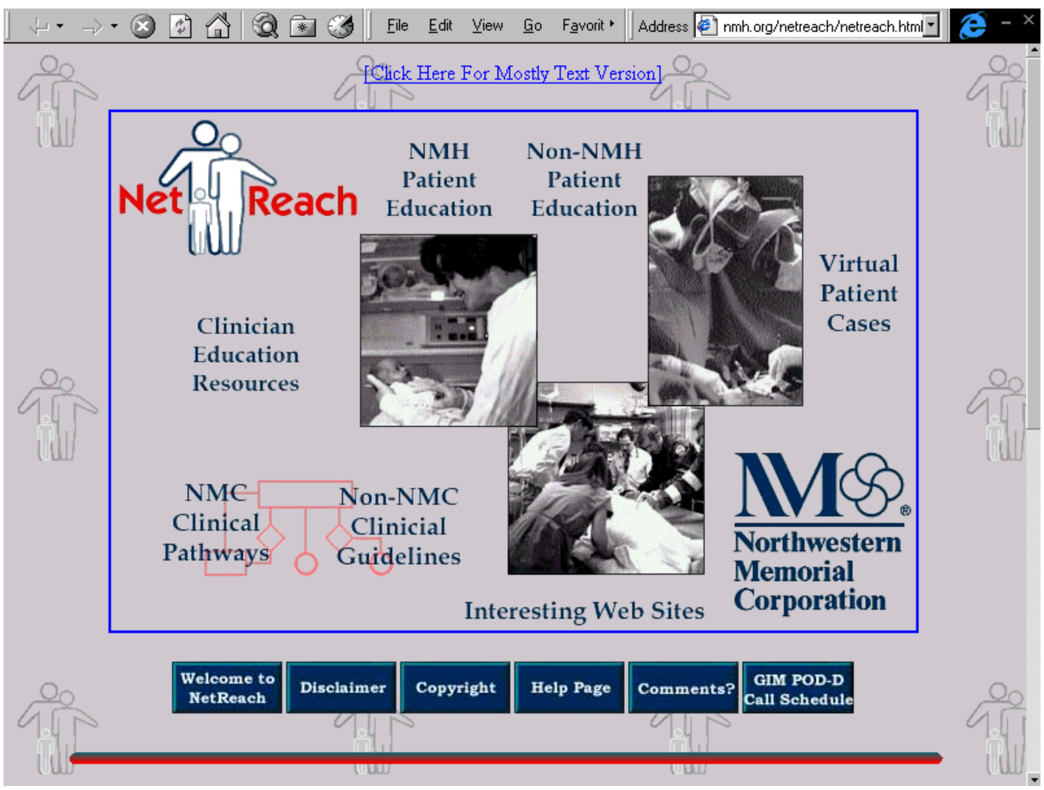


Figure 6: NetReach World Wide Web Home Page

Through the NetReach home page we have included quick access to NMH-written materials such as the following:

Northwestern Memorial Hospital patient education materials on:

- Diagnostic Procedures
- Wellness Information
- Medication Instruction
- Patient Pathways

Northwestern Memorial Corporation Clinical Pathways and Guidelines:

- Antibiotic Guidelines, Bacterial and Yeast Susceptibility
- Antiemetic Guidelines
- Blood Transfusion Guidelines
- Health Care Surrogate Act Guidelines
- Infection Control Guidelines
- Clinical Pathways

In addition, we have provided hyperlinks to some other useful sites on the Internet, as shown in Figure 7.

Figure 7: Home Page for Clinician Resources on the Internet

By the time we were ready to deploy our CPR system, the physicians were familiar with the computer as both a data-entry and data-retrieval tool.

IMPLEMENTATION OF THE CPR

The final phase of our project was to implement a computer-based patient record system in selected sites. This section describes the organization of our implementation teams, the technology and functionality of our CPR system, and our support approach.

Organization

The implementation project team was divided into two groups: clinical consultant and technical. The clinical consultant team had the major responsibility for being the liaisons for clinicians and engaging their involvement in the build process and use of the system. The technical team was responsible for the hardware, networking, software installation, and operation of the system. The size of the technical team flexed considerably depending on the tasks at hand. Approximately half of the technical team was directly responsible to the implementation project and half were participants from other groups in the Information Systems division. The total number on the CPR implementation team varied between 10 – 20 people throughout the project.

Computer-based Patient Record System

System Selection

The research team used the results of the comprehensive user information needs assessment studies to produce a list of functional requirements of a system that would address our users' needs. The team explored existing products as well as the possibility of developing applications internally. The following factors were considered in the decision making process:

- Availability of commercial products satisfying clinicians' needs
- Internal development capabilities
- Timeline of research project
- Budgetary constraints

We explored commercial solutions to the information needs identified. Because of the specific objectives and timeline of the research project, we did not have time to invoke the typical user-based committee process for this project. Instead, the research team, which included clinical consultants who together had spent over 150 hours observing the clinicians in their native practice site, became the selection team. The clinical consultants' in-depth understanding of the clinical sites served us very well in representing their needs. In addition, the relationships they had established during the observational study gave the site participants confidence that we could and would represent their interest during the selection process. The team unanimously agreed that EpicCare, a CPR system developed by Epic Systems in Madison, Wisconsin, addressed the major requirements established in our information needs studies. The contract with the vendor acknowledged the research nature of the project and included provisions for a co-development relationship wherein NMH would participate in the development of enhanced functionality according to the needs identified in our information needs assessment

Site Selection

Since the medical staff of NMH is approximately equally divided between full-time faculty physicians and independent private practice physicians, we decided to pilot the project in a faculty practice and an independent practice. We chose the General Internal Medicine (GIM) clinic of NMFF and the Associates in Internal Medicine (AIM) clinic as our pilot sites. Because of the research nature of the project, within each practice we divided the practitioners into intervention and control groups. The numbers and method of assignment are described in the Evaluation section.

Technology

CPR Architecture

Epic employs a "split logic model" for client/server applications (see Figure 8) where the application logic is split between the client and the server. In this model, commonly referred to as the Transaction Server Model, a transaction is a logical unit of work that the client requests the server to perform. The transaction may be a simple request for a data value, such as a patient's birth date, or it may be a complex request for relevant health maintenance recommendations for a patient. This model enables developers to make intelligent decisions about defining transactions and where application functions should reside that optimize performance and scalability.

Distributed-processing options also exist from the client perspective to allow for increased performance of these applications. An optional local server can be configured to support remotely replicated data files such as code lists, preference lists and rules (e.g., drug interactions and contraindications). The replicates of these static files are maintained by the systems themselves and require no ongoing intervention from operations staff. These local file servers prove cost effective by reducing Wide Area Network (WAN) bandwidth requirements.

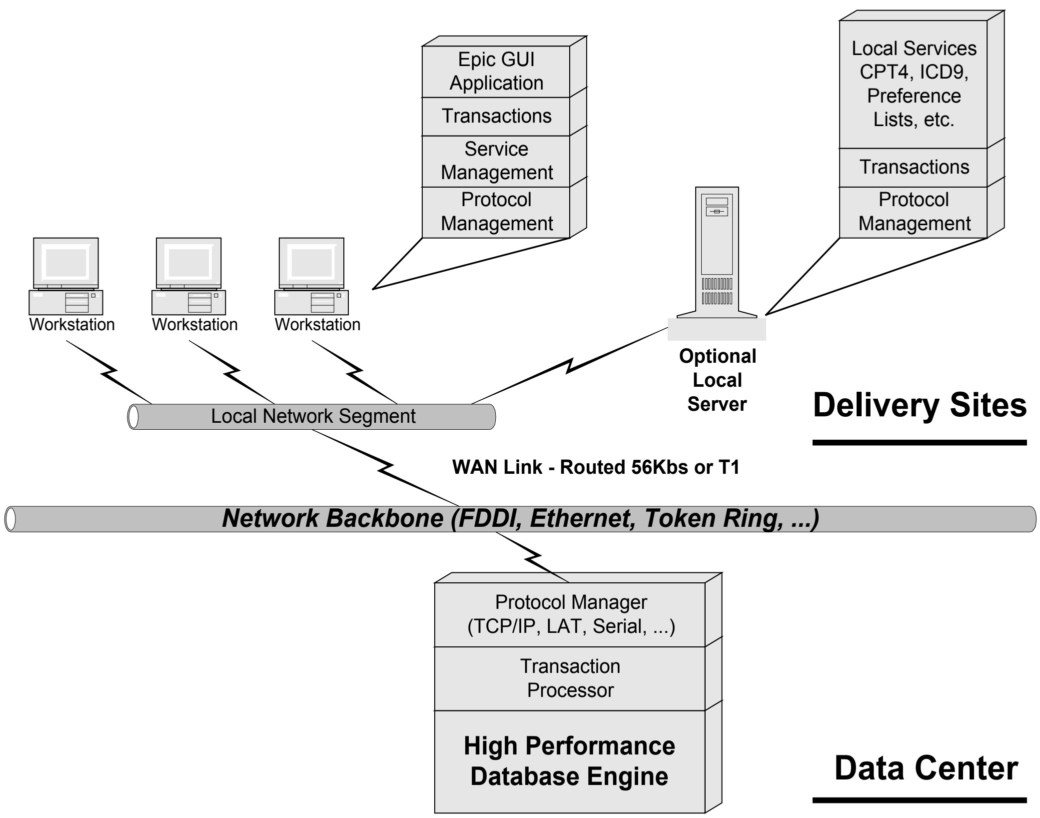


Figure 8: EpicCare Architecture – Transaction Server Model

Integration

We integrated data from nine different sources, using HL-7 messages where applicable. Figure 9 shows the various sources and messaging standards.

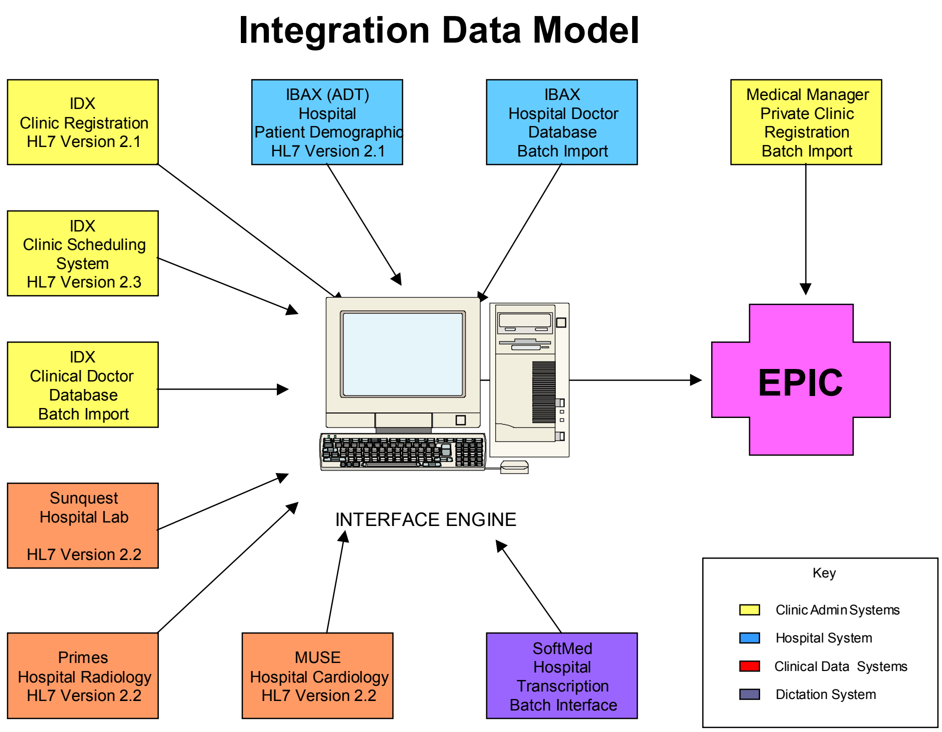


Figure 9: Integration Model

High Availability

Because a CPR system is a mission-critical system, we have redundant central processing units (CPUs) and disk arrays to enhance the availability of our CPR system, as shown in Figure 10. Single system hardware or operating system failures should not bring the system down. The current configuration of the network is not duplicated, but in the new building there will be redundant networks and routers.

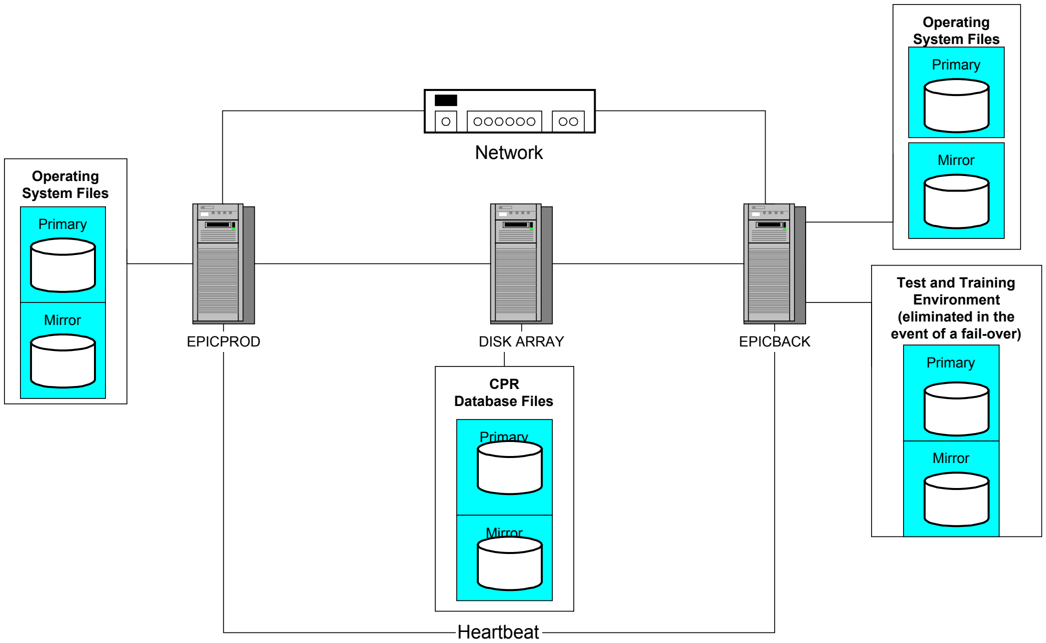


Figure 10: High Availability Configuration with Redundant Processors and Storage

Security

One of the most important aspects of the operation of a CPR system is preserving the privacy of patient data through confidentiality policies and application security. During the intensive training program, the importance of protecting the privacy of patient data was stressed repeatedly. Before receiving a log-on ID, each user was required to sign a confidentiality agreement, which included provisions for terminating an employee if confidentiality policies were violated.

Security in the CPR software is controlled at multiple levels, which include the following provisions:

- Each user has a unique login ID and password with rules governing the minimum frequency of changing the password and the number of characters and numbers that must be present in the password.
- Access to functions and viewing privileges are restricted by user class (e.g., physician, nurse practitioner, nurse, clerk, administrator).
- A second-level password entry is required at certain points of authentication (e.g. “signing a progress note”).
- Access to patient information is restricted by service area (e.g. defined business entity). If a patient transfers care from one business entity to another, the new provider must insure that a release of information consent form is signed, analogous to the transfer-of-records form for paper-based records.
- An audit log is maintained of all view and update activities to sections of a patient record.
- Sensitive lab test orders and results (e.g., HIV) can be hidden from view except by the ordering provider or his/her proxies.

- Sensitive department encounters (e.g., psychiatry) can be hidden from view except by providers in that department.
- An individual record can be flagged as a VIP and only visible to selected individuals.
- A specific encounter can be flagged as sensitive and hidden from view except to the authorized provider and his/her proxies.

In our institution, HIV results are not entered into the lab system, hence these also do not appear in the CPR. Although we have hidden psychiatry events on our system, we have not implemented the sensitive encounter class or VIP class since there are currently no provisions for "break-the-glass" access to all encounters.

All workstations loaded with the CPR software are stationed in clinical settings where physical security contributes to application security. When accessing the CPR from remote sites that are not in physically secure areas (e.g., home), we require strong authentication using SecurID, a physical token-based authentication mechanism discussed below.

Remote Access

Access outside of the network is controlled by a US Robotics Total Control Hub. A valid password is required in order to access the network. In addition, the CPR server requires an additional authentication step using a SecurID card. The SecurID card, developed by Security Dynamics, is a smart card that displays a six digit number that changes every 60 seconds and remains in synchrony with the SecurID server. The user must enter a private personal identification number and the number displayed on the SecurID card in order to gain access to the CPR through the modem pool. Upon gaining access to the CPR server, the user must still enter a normal CPR login ID and password to log into the application. This strong authentication scheme provides a high probability that only authorized CPR users can gain access to the CPR from remote sites.

Functionality of the CPR System

Patient Data Content

Although primarily an ambulatory-care patient record, we store all electronically available inpatient data from NMH in our CPR as well. Over time, the CPR will serve as the common longitudinal patient record for outpatient care across the Northwestern enterprise. The data included in our CPR are summarized in Table 5.

CLINIC DATA	HOSPITAL DATA
Demographics	Demographics
Lab test results	Lab test results
Radiology reports	Radiology reports
Progress notes	Discharge summaries
Schedules	Operative reports
	Pathology reports
	Dictated H & Ps
	ECG interpretations

Table 5: Comprehensive Patient Data in the CPR

Since go-live, clinicians have entered over 73,000 problems on 11,000 patients during 30,000 encounters. They have ordered over 41,000 prescriptions and 36,000 laboratory tests through the system. However, because we store information on all transactions from NMH and NMFF, we have processed over 10 million transactions and store data on 900,000 patients in the system.

Overall Functionality

We worked with our vendor, Epic, to enhance a number of functions and co-developed a new decision-support system with them. We summarize major functionality of the system below:

Chart Review: The Review module addresses the "integrated view of patient data" need identified in our information needs assessment by providing views of any patient information. It includes data from encounters, referrals, procedures, test results, health histories, problem list, and health maintenance records. By searching or filtering encounters by a problem, diagnosis, test or medication ordered, or other criteria, clinicians can get an overview or quickly zero in on a specific detail in the patient's chart. The filtering mechanisms assist the clinicians navigating through large volumes of data, such as lab results. Results can also be viewed in a flowsheet of related items (e.g., lab test results, medications, vital signs).

Patient SnapShot: Addressing the need for "quick access to summary information" requirement, SnapShot is a summary view of a patient's problem list, medications, allergies, immunizations, health maintenance status, alerts, and other important history items (see Figure 11).

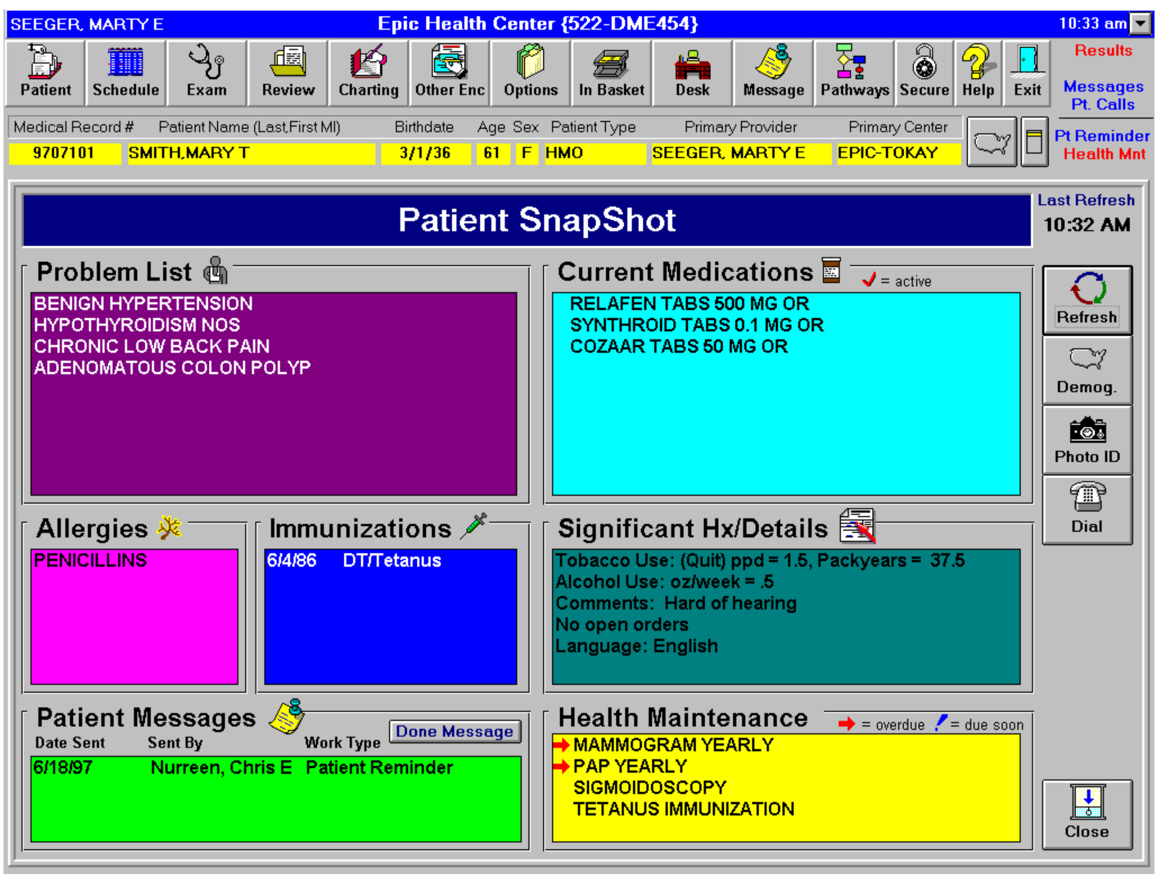


Figure 11: The Patient Snapshot Provides a Summary View of Important Patient Information

Charting Tools: Documentation of histories, vital signs, physical exam, and progress notes, is done in the Charting and Exam module. This module can be tailored at many levels to accommodate individual preferences. Templates of text (see Figure 12) for common patient conditions can be created and can include variables that retrieve patient-specific information from the patient database, such as patient name, age, problems, medications, etc. In addition, macros for phrases can be created "on the fly" as abbreviations for common phrases or sections of text. These phrases are specific to an individual user, or can be shared with other users. Pull-down menus of text help provide common choices of text phrases.

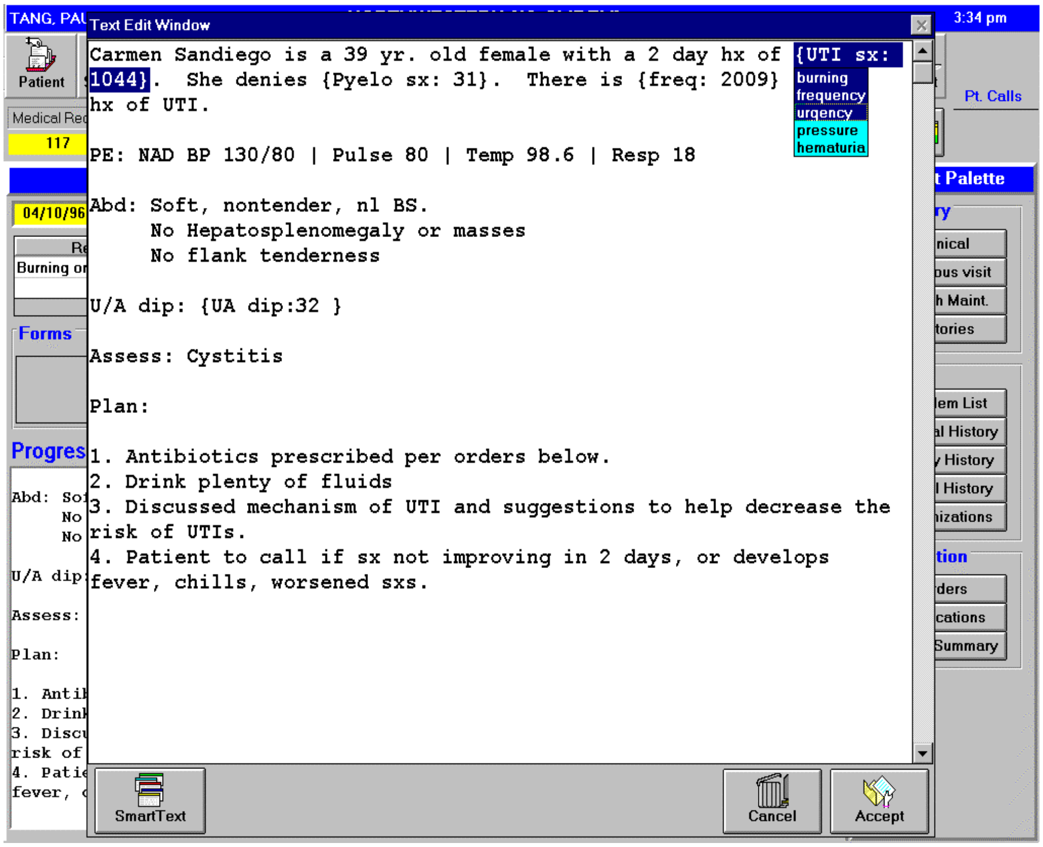


Figure 12: Use of Templates to Create Progress Notes

Patient Histories: Clinicians enter problems and family, social, surgical, medical, pediatric and obstetric histories. These items are coded and can be used in aggregate data analysis.

In Basket: The In Basket module functions as an internal basic e-mail system to the CPR. In Basket nicely addresses the need for "integrated communications" and "health-care team communications" within a CPR system. All patient-related communications in the CPR system are linked to a patient chart. Clicking on the Review button instantly brings up the patient's chart so that the clinician can review the context of any message or lab test result. Clinicians receive different types of messages in their In Basket, including the following:

- Lab test results (received automatically for all tests ordered by the provider or any results that are carbon copied to the provider)
- Progress notes that are carbon copied to a provider by another provider (e.g., an acute care visit is forwarded to the PCP by another provider who saw the patient)

- Messages from other providers or clinic staff
- Phone messages from patients (tools are provided to efficiently handle common call topics such as medication refills)
- Overdue results (tests that were ordered, but the patient has not completed the procedure by a set time)
- Patient reminders (reminders regarding a specific patient for a future date)

Health Maintenance: Health Maintenance rules determine when reminders are issued about preventive health interventions that are due. Special modifiers can tailor a reminder for a specific patient.

Order Entry: All test and medication orders are automatically included in the progress note and can be either printed or transmitted electronically. When clinicians order medications, the system can automatically suggest alternative medications based on a clinic's guideline or formulary restrictions. Other rules can also be implemented, as described below under Clinical Decision Support. Required linkages between orders and diagnosis indications not only ensure proper billing, but also provide the necessary associations for outcomes reporting and analysis.

Drug Interactions: Clinicians are warned of potential drug-allergy, drug-food, and drug-drug conflicts when they order medications.

Patient Education and Instructions: An AVS is printed at the end of a patient encounter. The ÀVS contains details of the encounter including vital signs, active medications, allergies, new lab test orders, new prescriptions, tailored patient instructions, and graphical printouts of relevant data (e.g., blood pressure, weight, cholesterol). This has been an excellent means of providing patient instructions and patient education in a way that patients can take with them. In focus group studies, we have found that the ÀVS satisfies most of the patients' need for information surrounding an encounter and improves patient satisfaction and their confidence in their physician.[9]

Clinical Decision Support

In addition to the drug allergy and interaction checking that is incorporated in the medication ordering function and the alternative medication alerts, we co-developed rules-based decision support functionality with Epic. The new decision-support function has been incorporated into the product. This functionality served as the main intervention for our evaluation studies. It allowed us to write rules that consider a patient's problems, medications, allergies, health maintenance status, age, sex, and past orders. When the clinician pulls up a patient's record, the CPR system examines all the rules to determine whether the patient qualifies for any reminders. If the antecedent of any rule is satisfied, then a reminder box appears, as shown in Figure 13. If the user chooses to act on any of the reminders, a simple checklist (see Figure 14) of common orders is presented to facilitate compliance with any of the guidelines (and simultaneously offer "preferred" choices). Table 6 illustrates some of the decision-support rules that we have implemented in our CPR system.

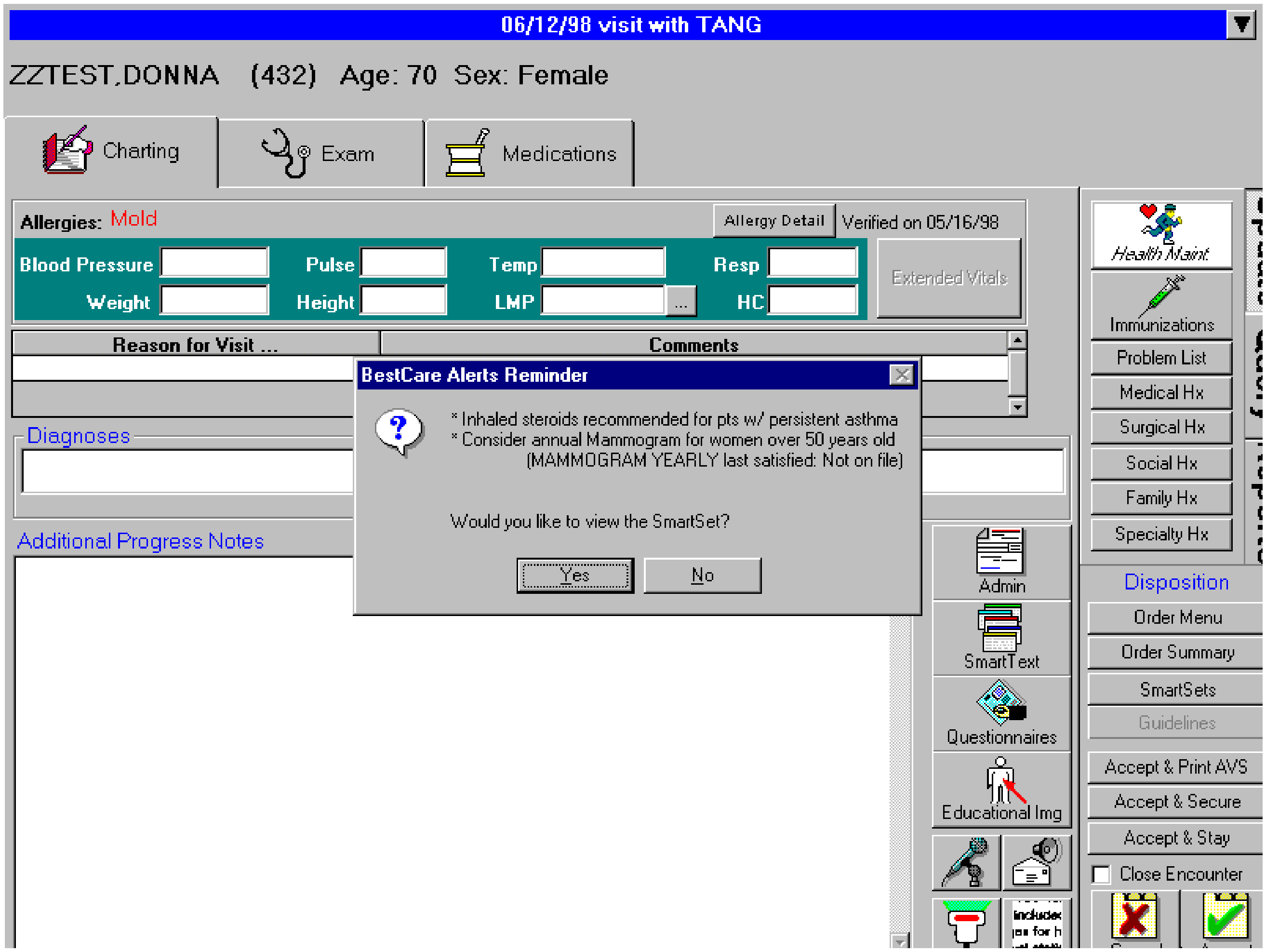


Figure 13: Patient-Specific Decision Support Reminders

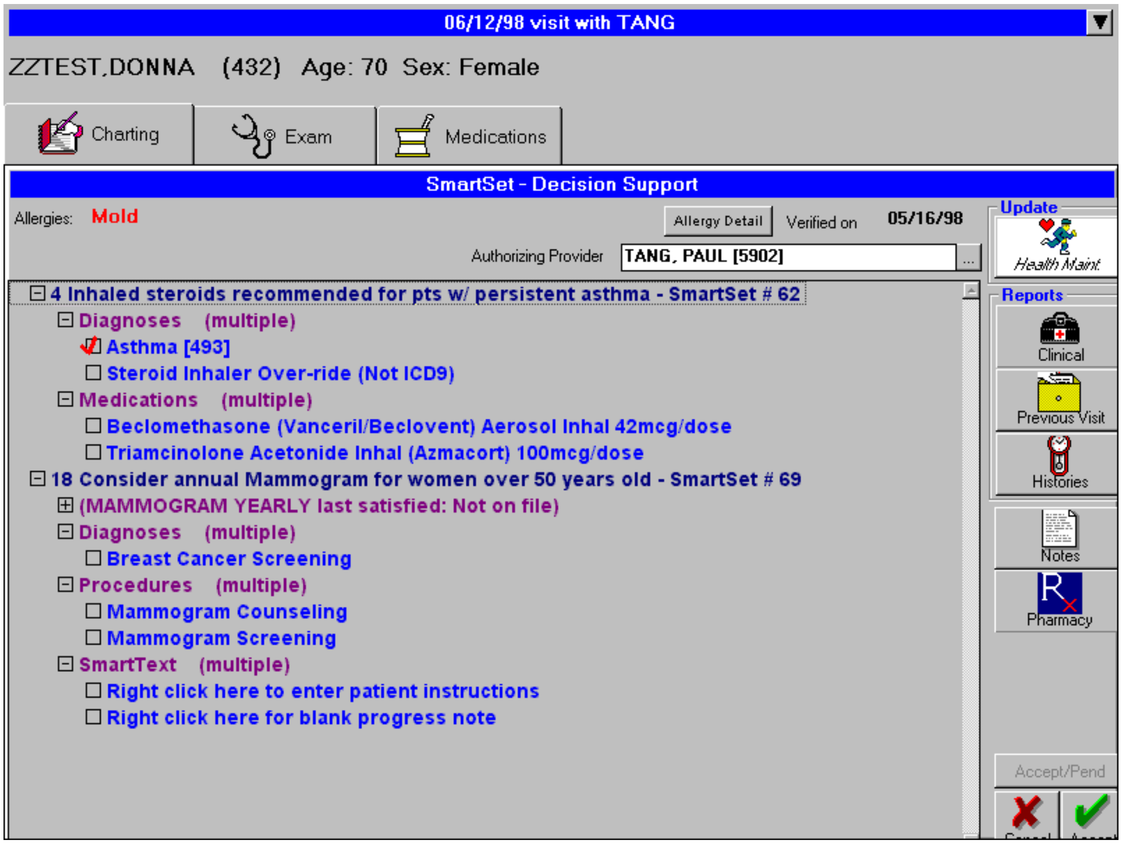


Figure 14: Order Sets to Facilitate Compliance with Guidelines

Topic	Rule	Rationale
Coronary Artery Disease	• IF Problem {CAD, MI} THEN Beta Blockers • IF Problem {CAD, MI} THEN Aspirin • IF Problem {CAD, MI} THEN Coronary Risk Panel	• Non-ISA beta blockers reduce cardiac events & deaths post-MI • ASA decreases mortality in post-MI patients • Lowering LDL <125 decreases cardiac events and deaths in CAD
Diabetes – Monitoring	• IF Problem {DM} THEN HbA1c • IF Problem {DM} THEN UA • IF Problem {DM} THEN Coronary Risk Panel	• ADA recommends HbA1c for diabetics q 6months • ADA recommends UA for diabetics q year • ADA recommends coronary risk panel q year in DM
Diabetes – Screening	• IF Problem {DM} THEN Ophthalmology Consult	• ADA recommends annual ophthalmology consults in DM
Asthma	• IF Problem {Asthma} THEN Inhaled Steroid	• Inhaled steroids are recommended for patients with persistent asthma
Atrial Fibrillation	• IF Problem {AF} THEN Coumadin	• Consider anticoagulation to reduce CVA risk in AF
Cancer Screening	• IF Age > 18 THEN Pap Smear • IF Age > 50 THEN Mammogram	• Consider annual Pap for women over 18 years old • Consider annual Mammogram for women over 50 years old
Health Maintenance	• IF Age > 65 or Problem {Asthma, COPD, CHF} THEN Flu Vaccine	• Annual flu vaccine recommended for patients 65 years or older • Annual flu vaccine advised for patients with chronic medical problems
Congestive Heart Failure	• IF Problem {CHF} THEN ACE Inhibitor	• ACE Inhibitors decrease mortality in CHF

Table 6: Decision Support Rules

Implementing Clinical Decision Support

Developing the decision-support rules is a process that must involve the local care group in its development, review, and approval. Figure 15 shows the decision support development and feedback process that we employ. We work with a small core group within a clinic to decide on clinically important rules and reminders. The core group then researches the literature and presents a draft set of rules for discussion by other members of the core group. Once the core group agrees, they present the draft rules to all of the clinicians in the division for discussion. The core group then uses the feedback obtained from this broader discussion to define the rules, which are presented for final approval to the entire group. Once approved, the rules are implemented within the CPR system. These rules represent the intent of the clinicians to behave in a specific manner. We then provide the clinicians with feedback on their behavior prior to the rules being implemented and give them comparison compliance statistics periodically after the decision support rules have been implemented. We believe that providing ongoing feedback in the form of compliance reports combined with reminders that appear during relevant encounters will improve clinicians' compliance with their own intentions. It is important to note that the goal of compliance is not 100%, since guidelines are merely general guidelines for a group of patients. Naturally, not all patients fit a given guideline.

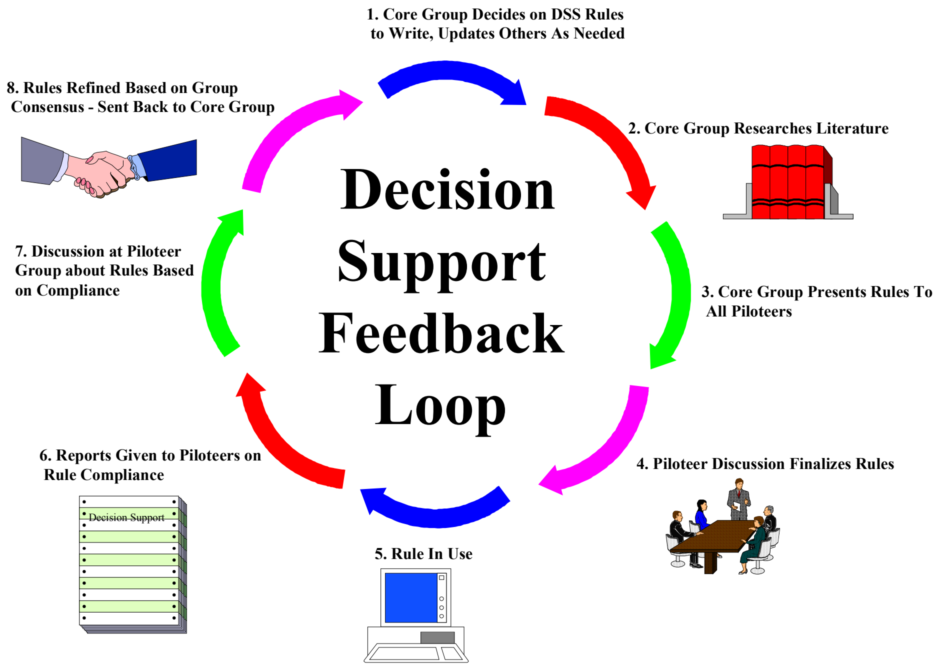


Figure 15: Process of Developing Decision-Support Rules

We found that our CPR system solidly addressed the clinicians' information needs identified in our assessments:

- Need for integrated access to patient information
- Need for summary information (e.g., problem list, medications, demographics)
- Need for a mechanism to communicate in a timely and efficient manner among health-care team members
- Need for effective means of providing patient instructions and education

Combined with the new decision-support function, we believe that the CPR provides the information basis for continuously improving patient care and managing the delivery of health care.

Training Providers to Use a CPR

General Internal Medicine Clinic Training

Preparation for Phase 3 (implementation of the CPR system) began months before go-live. We involved designated physician liaisons from each clinic in building the customized parts of the system (e.g., preference lists for diagnoses, procedures, medication formularies) and in the development of policies for its use. They presented their work to the larger pilot group of physicians for feedback to ensure buy-in among the entire group. Among the many lists defined were common encounter diagnoses, reasons for visit, common medications (including default instructions), and frequently used medical and surgical history diagnoses and procedures. They defined synonyms for terms to assist users in finding diagnoses and procedures more quickly. The liaison physicians also created charting templates for specific diseases.

A natural experiment occurred because we were not given the same access to the nursing and ancillary support staff ahead of our go-live date at the first clinic that we had with the physicians. The lack of nursing involvement in the system-build process resulted in greater anxiety and fear among the nurses during go-live. Some of the impact on current processes was overlooked without their prior involvement.

A policy task force developed new policies to address procedures related to the use of a CPR system in the clinic. The task force consisted of the office practice manager, the nursing supervisor, the physician champion, the clinical practice director, and a project team member. Twenty-one new policies were developed covering a variety of topics, including the roles and responsibilities of the rooming nurses, physicians, and medical receptionists. Administrative policies described responsibilities of password use, report printing and handling, and downtime procedures.

Formal training on the CPR system began four weeks before our go-live date. The clinical consultants attended "train the trainer" classes at Epic, and subsequently conducted the training of our users. Pop quizzes, food, and humor kept the pace going and held the clinicians' attention. Physicians and nurse practitioners attended 3 four-hour classes which relied heavily on the use of scenario-based exercises. Two weeks before go-live, physicians were given charts of patients who were scheduled for upcoming visits and asked to abstract the problems and medications from those charts. This helpful exercise not only reinforced the training, but also loaded the system with some useful data for their initial patients. The Health Information Management (HIM)department continued pulling charts a few days before each clinic session for the first month. A few days prior to go-live we staged a dress rehearsal with Information Systems personnel acting as the patients. The clinical consultant team observed the interaction and provided helpful pointers during the debriefing. Other benefits of this exercise were the exposure of behind-the-scenes Information Systems staff to the impact of this system on the physicians and patients. We found that the amount of training and preparation for go-live paid off handsomely during the actual week of go-live. The go-live week went so smoothly that we sent the vendor's support team home early. During go-live, clinicians started at 50% productivity and by six weeks returned to full productivity in managing patient encounters.

Because the clinic was divided into intervention (CPR users) and control groups, we had to design the output of our CPR-based process to flow seamlessly into the paper-based administrative process (e.g., checkout and billing). Consequently, we programmed the system to print test requisitions and billing sheets to merge into the clinic's routine paper-based process handling test requests and billing. Similarly, each night progress notes were printed directly in the HIM department for filing into the paper-based patient record. Naturally, our CPR users rely on the CPR as the patient record.

It is interesting to note that although paper is used as the "interface" to the existing paper-based record system, the CPR printouts have made the existing paper-based processes more efficient. The paper-based printouts that automatically print in the HIM department not only reached the HIM department more quickly and reliably, they were filed into the paper-based record more quickly than the hand-written progress notes. This is because the computer printouts reliably had legible patient identifiers in the same location on the page and always included a time and date stamp. Similarly, the CPR-based printouts of test requisitions and billing sheets were always 100% complete (eg., billable diagnosis, level of service, diagnosis-linked orders), legible, and timely. Hence, there was no rework for the front desk or billing clerk. In short, not only were the administrative overhead requirements derived as a by-product of clinical care using the CPR system, the paper-based output of the CPR system actually improved the efficiency, timeliness, and accuracy of the existing paper-based processes that were not directly involved with the intervention.

Associates in Internal Medicine Training

About three years into the NetReach project AIM became one of our CPR sites. A new version of the CPR was scheduled for release in September 1997. Rather than training the users on all the functions of the CPR and then retraining on a different version, we chose to train in phases. We began by training on use of the Review function to retrieve laboratory-test results and messages in In Basket. Test results were automatically sent to the ordering provider's In Basket. This interim period gave the users time to become familiar with part of the CPR and provide a new avenue to access test results. During the July-October time period meetings were held regularly with the physician champion to customize choices for the CPR's preference lists and site profile information.

In October, 1997, we began training the users to enter information into the CPR. Two of the three intervention physicians had extensive computer experience, having created their own mini-record in Excel. Because of the diversity of backgrounds in this small practice, we trained the three physicians separately. The physicians took time out from their patient schedule for training. A checklist was used to make sure all physicians completed training on all functions.

After the physicians were trained, their individual medical assistants were also trained to use the CPR for rooming patients, entering medical histories, and communicating patient phone calls with the physicians ensuring all patient data is included in the CPR. The office RN was trained so that she could enter immunizations and nursing visit encounters further completing the patient's CPR.

A schedule for the eight-week training period was posted at the AIM offices. Information included the trainee and trainer, scheduled time, and also which clinical consultant would be at the site for any needed support while using the newly taught procedures. We spent approximately 12 hours training each physician and 6 hours for each of three assistants and one RN. We provided full time on-site support during the phased training for approximately 6 weeks. Thereafter, we provided at least 8 hours of support on a weekly basis for three weeks. Many of the support hours were not used by the CPR users as they quickly became proficient at using the CPR. The extra time was used by the clinical consultants for adaptation of patient education materials and development of personal time saving shortcuts provided by the CPR. The piloteers initially reduced their scheduled patient load to 60% of usual during the first week of go-live. By the third week they were up to 90-100%.

Weekly meetings have been held with the physicians since implementing the CPR. This time is used for information exchange, discussion of issues, and teaching innovations in the use of the CPR. The meetings are well attended by the three physicians. Scheduling constraints have made it difficult to hold meetings with the medical assistants so we have individual meetings with them as the need arises. All users have made remarkable progress in the six months since training began. They seek ways to use the computer and CPR to enhance their workflow and efficiency.

Work Flow Using a CPR

Just as in the paper-based process, physicians vary in the way they incorporate a CPR in their encounter process. Figure 16 shows the prototypical steps in an encounter. The first step may be to review the schedule, which is imported from the local scheduling system. The physician may then review the patient's problem list, medications, and past progress notes on a patient before entering the exam room. After taking the history and examining the patient, the clinician enters medications and orders into the system. Throughout the encounter, the system provides reminders and alerts relevant to this patient's care. At the end of the encounter process, the system prints out an ÀVS. Finally, the clinician completes the progress note documentation.

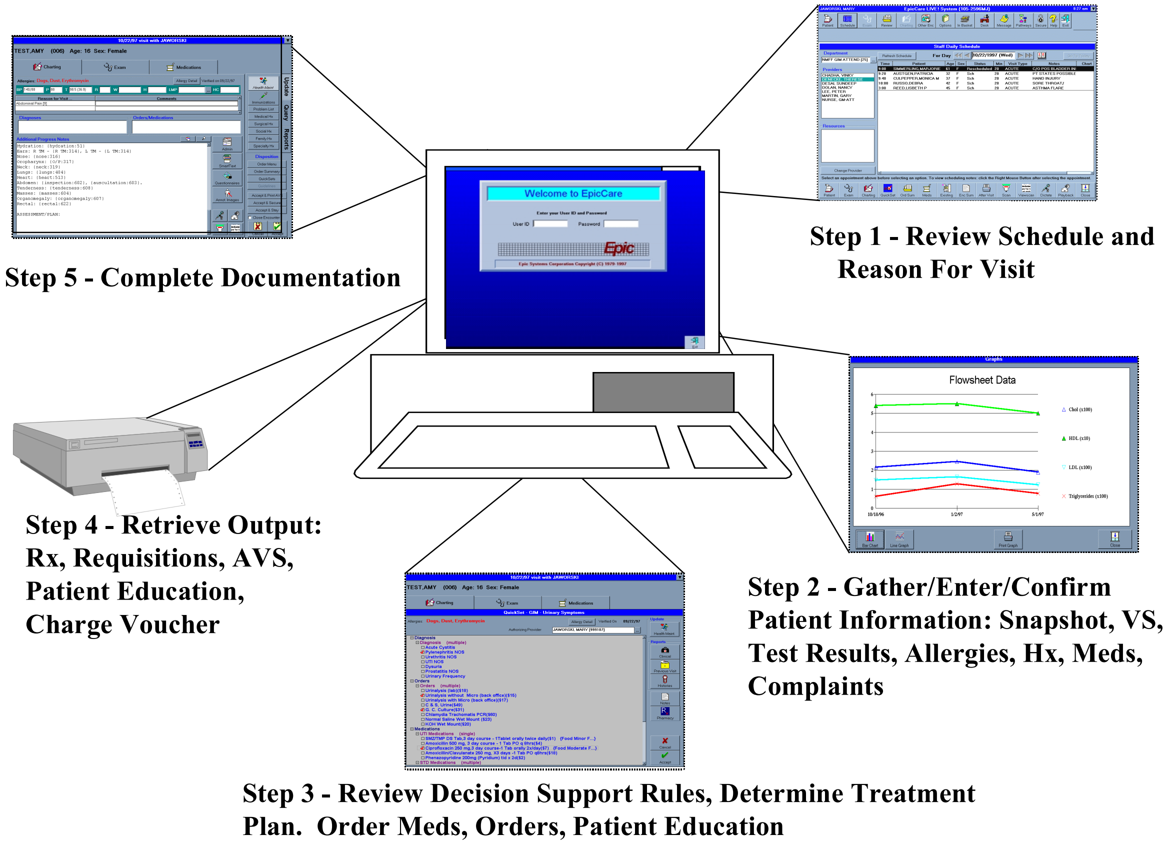


Figure 16: Work Flow Using a CPR

Given our goal of providing access to patient information anywhere and any time that clinicians need it, we deployed workstations in all the common settings where physicians access patient records. Figure 17 depicts the settings in which the clinicians can access the system. Workstations with the CPR software installed are located in the exam room and at the nursing stations in the clinical areas. We find that clinicians complete their daily work as well as return phone calls in their administrative offices. In the hospital, access to the CPR allows physicians to look up outpatient records and also enter notes on a hospital admission, complete an inpatient discharge summary or chart a progress note. Finally, we provided remote access to the system from home. Physicians use it at home in a variety of ways. They may complete some of their work at home, they may answer calls or follow-up on lab test results, or they can use it while on call. The more accustomed to information they become, the greater the need for access to the system. In fact, the availability of remote access from home has motivated most of our CPR users to purchase home computers. Seven out of ten physicians at GIM purchased home PCs and all three physicians at AIM purchased PCs as well.

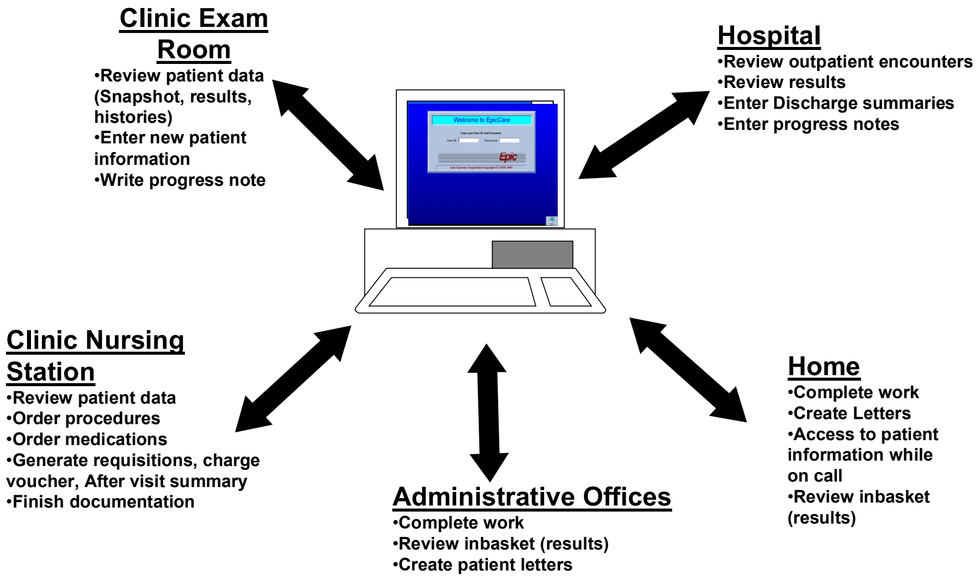


Figure 17: Ubiquitous Access to the CPR

Legal Documents and Confidentiality Policies

Our CPR system is currently installed at two sites that are independent business entities affiliated with NMH. Consequently, our project involves three independent business entities.

Legal issues surrounding ownership of data and transfer of patient information between different business entities were addressed in a legal contract among all users of the CPR system. A Legal Issues Task Force composed of lawyers representing the organizations using and operating the CPR system developed documents which include the following:

- Site Participation Contract. This contract defines the data ownership rights and confidentiality agreements among the participating organizations. It segregates the individual clinics' data from other clinics and defines the permissible uses of aggregate data. It defines the operations, data integrity, and data security responsibilities of NMH.
- Enterprise Patient Consent Form. This form informs the patient that data may be accessible by other health-care providers, but only on a need to know basis.
- Letter of Understanding and Provider Confidentiality Agreements. This letter is signed by all project team members who are exposed to identifiable patient data in the course of performing work on the project. It reinforces the importance of confidentiality as a condition of project participation.

Customer Support Process

Supporting our customers is a continuous process that begins with training and never ends. Because NMH is the owner and operator of the CPR system and the clinics in which the system is deployed are separate business units, we have formed a cooperative working relationship among the organizations to provide 24 hour x 7 day support to all our users. As part of NMFF, GIM has access to the NMFF customer support service, which operates during a normal business weekday (8am to 5pm). The NMFF customer support group answers workstation setup, networking, and PC operation questions. NMH's customer support organization provides support for CPR system applications, as well as provides after-hours and weekend support. NMH provides all customer support for AIM, the independent clinic.

Figure 18 depicts the algorithm used to triage support calls from GIM physicians. The call begins at the NMFF help desk during daytime business hours.

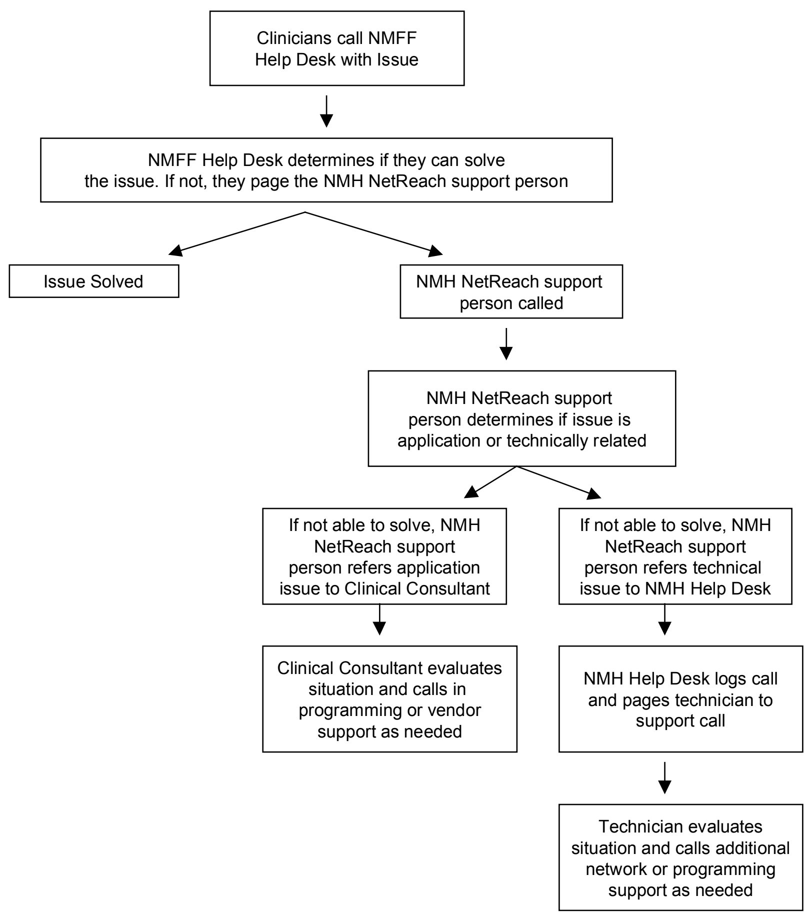


Figure 18: Customer Support Triage Algorithm for GIM

NMH uses an issue-tracking system to log support calls. Management can review trends and analyze issues reported. In our experience, the traditional help desk model for support (Figure 18) has not completely met clinicians' needs. Clinicians in the outpatient setting have limited time for each patient encounter. Since the clinicians have come to rely on having the information instantly when they need it, any problems that they encounter with the CPR hinders the patient care process and shortens the time available for patient care. Consequently, clinicians require immediate response to any workstation or application related issues in a way that minimally impinges on their time. Busy clinicians need to talk with a support person that understands the clinical workflow and processes yet has the technical knowledge to reach quick resolution on such issues. The clinical consultants initially functioned in such a role but as the implementation phase drew to an end, we tried to turn over support using the traditional "Help Desk" model. The clinicians, however, were used to interacting with the clinical consultants and getting quick results, so they often bypassed the help desk by contacting the clinical consultants directly. Although this remains a challenge from a resource point of view, it also represents a new opportunity for clinicians with interest in clinical information systems. We are using this information to refine our support model for clinical applications.

Management of a CPR system implementation project requires a clear vision, top-level executive commitment, deliberate planning, and determined skill in implementation. We have found that working with clinicians as the primary user and beneficiary of the system also requires significant clinician involvement on the information systems team as well as at the implementation-site. Creation of the clinical consultant team has been instrumental to the success of the project. We found that our comprehensive evaluation of clinicians' information needs was a tremendous asset both in terms of the understanding it produced as well as the lasting relationships we developed with our clinical sites. By deliberately addressing the cultural aspects of the introduction of information technology, we believe we have nurtured a lasting adoption of information technology in general and CPRs in specific as essential professional tools. Clearly, management of the human side of the project was as important as the technology.

Post-Implementation Support

Continuous Development and Training

One of the key features of operating a CPR system is the continuous nature of development and training. Unlike a typical departmental system whose support can be turned over to a customer support function once the implementation is completed, a CPR system is an emerging technology and a constantly evolving set of applications. Consequently, implementation is an ongoing process of use, feedback, and enhancement. We applied a well-tested method of engaging users in the constant development process using nutritional support as exemplified by Regenstrief Institute. We hold weekly pizza-induced "piloteer" meetings to solicit their feedback on the system, share user tips, train them on new functionality, and develop consensus-based clinical content or rules to be implemented in the system. Often, a physician at the meeting solves issues raised by another physician. This type of interaction increases support within the user group. The meetings give the physicians scheduled time to interact with each other about both system and practice issues, creating a sense of community. Attendance averages 72%. Meeting minutes are published within a couple days of each meeting and are not only distributed to the CPR users, but also the entire CPR system support team and the vendor. The Medical Director works closely with the vendor to enhance current functionality according to responses from our clinicians and works on developing new functionality for the product. Enhancements are released every 2-3 months. The Decision Support functionality (discussed in the Functionality section) is an example of a major enhancement that was developed at NMH, incorporated into the product, and consequently available to any EpicCare customer.

LESSONS LEARNED

Implementing an emerging information technology in a multi-organizational environment presented many challenges. In some areas, we served as trailblazers for implementation teams to follow. In others, we were able to resolve issues and provide standards for future projects. Below, we describe some of our important lessons learned during the execution of this project.

Differing Technology Standards

Electronic Mail

Because convenient communication was an important feature of the project, we attempted to provide all the participants with access to e-mail from anywhere on campus. Unfortunately, the lack of consistent e-mail standards prevented that from happening. NMH and NMFF selected MSMail as their e-mail standard. Unfortunately, due to technical limitations of the product (including limited number of users on a single post office), we were unable to host all our users on a single post office. Consequently, we needed to create multiple mail icons on each workstation. As the number of e-mail users grew on campus, we could not keep up with the number of active post offices of our users. Over the project time frame, the organizations also decided to migrate to MS Exchange. This process is still ongoing. So, although everyone has access to e-mail and can communicate with everyone else, we were not able to make each individual's e-mail accessible at every workstation on campus.

Network Infrastructure

The stability and reliability of the network infrastructure for any information service project is vital to the system. Stability and reliability includes the ability to handle the traffic volume, provision of fail-over and redundant connections, and maintaining knowledgeable staff to support the structure and respond immediately to problems. Problems in the network infrastructure were responsible for the majority of outages for our users. Different networking standards and the complexity of network maintenance led to unexplained problems and outages. For example, NMH uses Novell NetWare network operating system and NMFF uses MS NT. Introduction of new technology (e.g., firewall, modem pools, authentication services) required time to gain expertise with the new equipment and services.

Support of Workstations in the Hospital

To provide NetReach participants with access to the same information tools in the hospital, we installed 12 workstations loaded with the project software, including the CPR application. We did not place any specific restrictions on who used the computers in the hospital. The accessible location in the hospital attracted significant use by other people working in the hospital, including hospital employees, residents and medical students. Soon after their installation, new issues arose that did not occur at the clinic sites. The problems included the following:

- Technical Tampering – Users altered the workstation setup configuration in ways that disrupted access to the CPR and other NetReach applications.
- Policy Concerns – Physicians in training used the computers to generate computer-based signout lists. This raised the issue of whether confidential patient data was being adequately protected.

- Professional Misconduct - In addition to using the workstations to support patient care, some users made use of the computers for their own personal interests. For example, pornographic or offensive material was downloaded to the PC.

We found that reacting to these problems by making a service request to our customer service department was both draining and expensive. Earlier this year, we convened an ad hoc PC task force to address these problems. We assembled representatives from the hospital, physician groups, training programs, and university. Upon review of the hospital policies covering use of PCs on hospital property, we found that the policies were comprehensive enough to cover the objectionable behavior. The task force recommended the following:

- Hire a security officer
- Prepare educational materials for housestaff for orientation manual and orientation meetings
- Apply technical procedures to disable access to CD ROM and floppy drives (to prevent loading unapproved programs and materials)

The technical procedure appears to have markedly reduced the problem of loading unauthorized software on the NetReach machines. A review of hospital policy has been included in the housestaff manual. We have communicated the recommendation to hire a Security Officer to the hospital CIO.

Strength of Strategic Commitment

Northwestern Internists

Originally, Northwestern Internists, Ltd. was selected to be the second site where the CPR would be implemented in the fall of 1996. Prior to making that decision, we had many discussions with the site where they indicated their commitment to training and using the system. However, after the project-sponsored computers were installed and the users trained, they felt they could not spend the time learning to use the system, and they withdrew as participants of the CPR project.

The physician champion was initially very interested and committed to participating in the project. However, we soon recognized that site leadership was not committed to the project as a strategic project. In the participants' eyes, they had agreed to 'try' the system rather than make it a priority for their practice. They were interested in participating as long as it did not impact clinic activities and processes. This prevented individuals from going through the learning period. Without leadership commitment and creating an expectation of full participation, the volunteers did not feel fully committed to the project.

The key lesson learned was to ensure a firm strategic commitment from a potential site. Strategic commitment includes the willingness to absorb short-term costs and contribute personal time for longer term sustained benefits. Without a willingness on the part of the clinic to persevere in the first few months, successful implementation of such a CPR system is less likely.

Winfield Moody

Winfield Moody was one of the original NetReach sites. They participated in all of the early assessment stages of the project during Year 1. When results, specifically time allocation measurements, were presented to the physician and nursing staff they seemed interested and committed to the project at that time. However, after carefully planning the number and placement location for each computer to serve the clinicians' needs, the site changed the location of the computers to serve the computer needs of the administrative clerks. This made it unlikely that we would accomplish the goals of the project to facilitate clinicians' need for information. Again, without strategic commitment to assist us in reaching our goals, we were not going to be successful at this site. Consequently, we had to seek another clinic of a similar type to substitute for this site.

Operational Issues with CPR Implementation

Implementation of a CPR requires process changes in order to take full advantage of the benefits. Unfortunately, at GIM, there were other parallel process changes which did not incorporate use of the information technology put in place at the site. For example, the site's decision not to include telephone reception in the CPR project meant that phone messages were recorded on paper. Initiating the message process on paper rather than in the computer defeats the potential advantage of using the CPR system to handle patient phone requests. Similarly, the site's decision not to allow rooming nurses to be trained to use the CPR prevented integrated communication and documentation of nursing vital signs with the CPR. Late in the project, at the repeated request of the triage and message nurses, the clinic did allow us to train selected nurses. They have been very appreciative and report that the instant access to the patient's record helps a great deal in answering patient questions, especially if the physician is one of the intervention group using the CPR.

Information technology, such as a CPR, is just an enabler to change. To realize the full benefits of a CPR, clinicians need to reexamine existing processes and be open to incorporating the new tool in ways that enhance the efficiency and effectiveness of the practice.

In the next section, we describe our evaluation studies and the results.

Evaluation

We originally studied the information needs of seven diverse clinical sites to understand the differences in information practices. Finding that clinical practice sites were more similar than different, we focused our efforts on implementing and enhancing the functionality of an integrated CPR system. We chose two internal medicine clinics as our pilots – one a faculty practice and the other an independent private practice. During the timeframe of this project, evaluation studies were primarily undertaken at the GIM clinic of NMFF, since that site has been using a CPR for almost two years continuously. The second site, Associates in Internal Medicine, has been using the CPR for six months.

This section of the report is divided into two general sub-sections – evaluation of the impact of the CPR at GIM and, to a lesser extent, AIM, and the evaluation of the impact of general information tools at the sites without a CPR.

Clinical Sites Using a Computer-based Patient Record

The GIM clinic at NMFF is a group practice of 34 internists on the faculty of Northwestern University Medical School. Although there is an associated resident practice in the clinic, we included only the attending physicians in our study. Of the 29 clinicians eligible at the time of selection, 15 clinicians (14 physicians and 1 nurse practitioner) volunteered to participate as users of the CPR. We informally called our intervention-group participants "piloteers." The remainder of the practice served as our control group. Because participation required significant investment of personal time to learn and master the use of a CPR, we did not randomly select the participants. The piloteers use the CPR to retrieve information, write orders, and document all encounters. Past information contained in the paper-based record is available using the same processes as the control group. Since the implementation of the CPR system, four of the original piloteers have left the practice for unrelated reasons. The demographics of the participants appear in Table 7.

General Internal Medicine Clinicians	Female	Male	Years of Practice (Mean)
Pilot Group (n = 15)	4	11	4.9
Control Group (n = 14)	8	6	4.8

Table 7: Demographics of Clinicians at GIM

AIM is a private group practice originally comprised of seven internal medicine physicians. In addition to their internal medicine practices, two physicians also practice cardiology and one physician practices endocrinology. Of the six AIM clinicians eligible, three volunteered to pilot the use of a CPR in a private-practice environment with the remaining physicians serving as a control group for this implementation.

In addition to their central office on the NMH campus, AIM also maintains a smaller satellite office located approximately 30 miles north of Chicago. Access to the CPR system was recently made available to piloteers at the satellite office. The demographics of the AIM clinicians appear in Table 8.

Associates in Internal Medicine Clinicians	Female	Male	Years of Practice (Mean)
Pilot Group (n = 3)	1	2	10.17
Control Group (n = 4)	1	3	15.94

Table 8: Demographics Of Clinicians at AIM

In the following sections, we organize our discussion of how the CPR addresses clinicians' information needs according to the high-level goals from our needs assessment studies.

Integrated Access to Patient Data

According to the Institute of Medicine report on CPR systems, the CPR should be available 24 hours a day without downtime, without data loss and with the ability to accommodate multiple, simultaneous requestors.[10] Clearly, a paper-based record keeping system cannot meet this stringent requirement. This point can be illustrated by considering the logistical issues associated with most ambulatory care facilities. Clinical data requests require that the patient record be located, transported to the requestor, reviewed by the clinician, transported back to HIM and then returned to the appropriate location within the file room. Along this process chain is the potential for delay and data loss.

To quantify the availability of the patient's record following its use during an ambulatory-care visit, we measured the availability of completed encounter documentation in the CPR and the paper-based patient record for a six-month period (July 1996 through December 1996). Figure 19 shows the number of encounter documtents completed and filed in the patient chart versus the number of days following the date of the encounter. The completed encounter documentation was present in the CPR sooner (1.3 days vs. 5.2 days; $p<.001$) than when the paper chart which was returned to the HIM department. Of note, the availability time for the CPR measures the time from the date of the encounter date to the date the entry is authenticated. The availability time for the paper record measures the time from the date of the encounter to the date when the paper record (with or without the encounter documentation) is logged back in the HIM department. However, the paper record often arrives in the HIM department without the completed encounter document, which is sent later and then filed. In a random one-day sampling of the loose notes filing in the HIM department for GIM, it took an average of 15 days for a loose document to be filed in the patient's paper-based record.

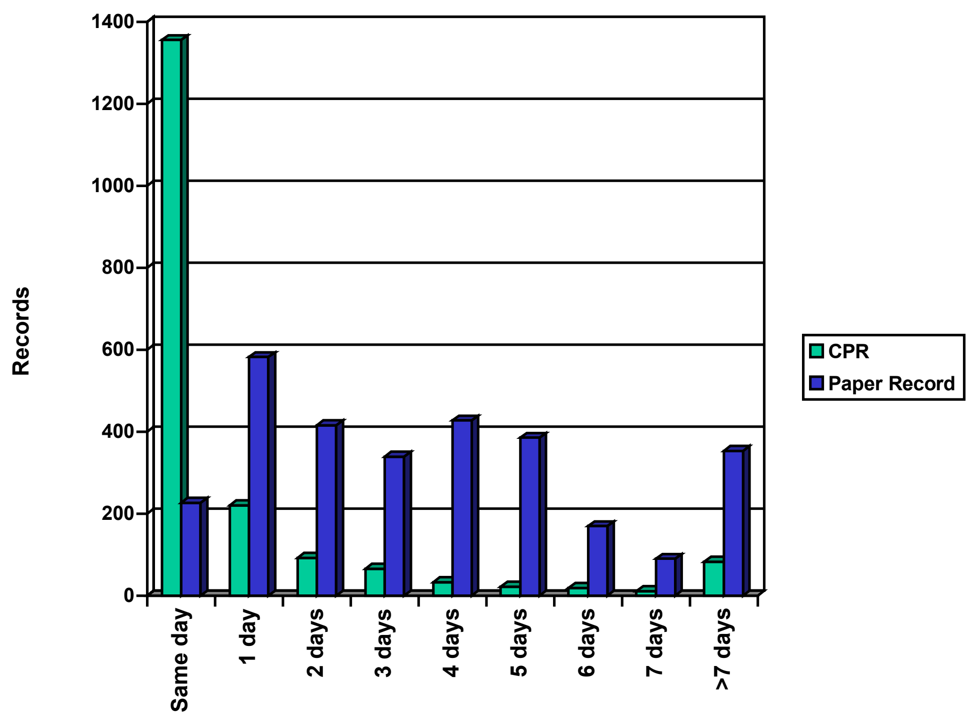


Figure 19: Availability of Authenticated Encounter Documentation Following a Patient Encounter (July-December 1996)

The availability of patient records also affects the timeliness with which providers can respond to patient telephone calls. We conducted serial surveys of physicians asking what percentage of the time they have "easy access (within one hour) to the information they needed" to respond to telephone-based patient requests on various clinical issues. Figure 20 shows that the availability of information was significantly better for the CPR users than the control physicians when refilling prescriptions, discussing a patient case with clinicians in the Emergency Department, answering a question about a laboratory-test result, and responding to a call for medical advice.

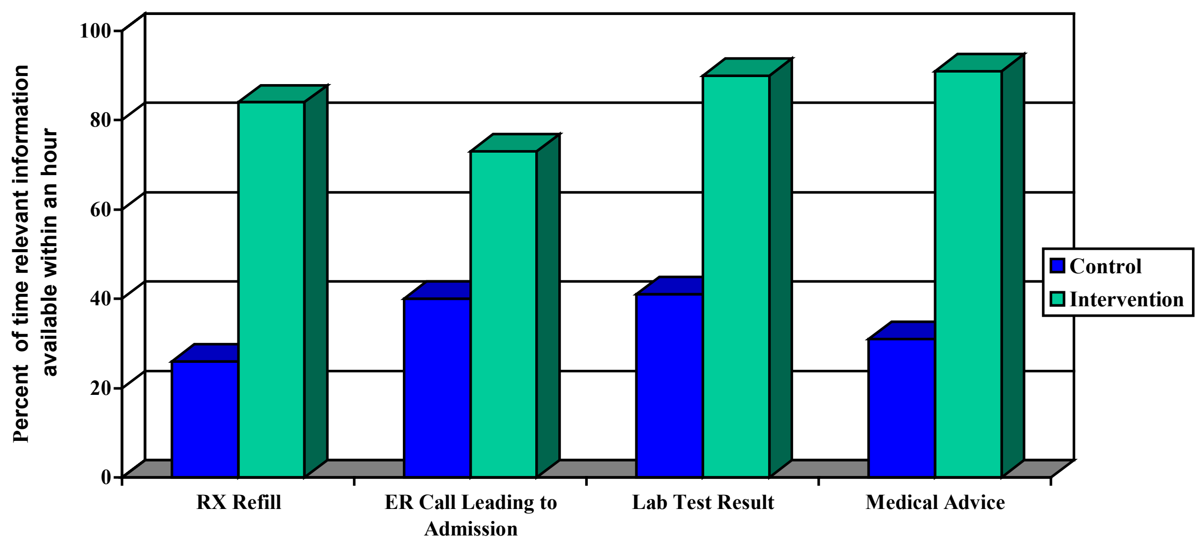


Figure 20: Availability of Relevant Information within an Hour

Ready Access to Summary Information

Information contained in the traditional patient record is frequently incomplete, illegible, inadequate or entirely missing. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and the National Committee on Quality Assurance (NCQA) have defined regulations pertaining to the ambulatory care record. Specifically, JCAHO's ambulatory care standards state that "for patients receiving continuing ambulatory care services, the medical record contains a summary list of all significant diagnoses, procedures, drug allergies, and medications" (Information Management Standards, IM.7.4.). Furthermore, "the list is initiated for each patient by the third visit and maintained thereafter" (IM.7.4.1).

We examined patient records before and after we implemented the CPR to assess the availability of summary information (i.e., problem list, medication list and allergy list). Administrative data sets were used to identify patient visits associated with one or more chronic medical conditions. The criteria included a diagnosis of asthma, congestive heart failure, coronary artery disease, diabetes, hypertension, hypercholesterolemia, hypothyroidism or rheumatoid arthritis. From these lists, random selections of a statistically valid sample of cases were selected. We reviewed encounter documentation associated with 368 patient visits for the intervention group and 364 patient visits of the control group before the implementation of the CPR. We then reviewed records of both groups three months or more after the CPR system was implemented.

For each randomly selected record, we looked for the presence of a progress note as well as the explicit documentation of a problem list and medication list. Allergy history was abstracted from three sources in the chart: the cover (looking for the presence of an "allergy label"), the progress notes and the "face sheet" (a summary form placed at the front of the paper record or the "SnapShot" in the CPR). We also recorded the instances where allergies documented on the face sheet were inconsistent with those recorded within the progress note.

The members of the intervention group demonstrated a statistically significant improvement (pre-post analysis) in the completeness and consistency of their documentation of problems, medications, and allergy histories (Figure 21). Documentation of a problem list in the progress note improved from 36% to 88% (p<.005), documentation of a medication list improved from 61% to 95% (p<.005) and documentation of an allergy history improved from 27% to 67% (p<.005). During the same period, the documentation habits of the control group did not change significantly for problem lists (22% vs. 14%) and medication lists (48% vs. 42%). However, the control group's documentation of allergy histories actually declined during this period (28% vs. 18%; p<.005).

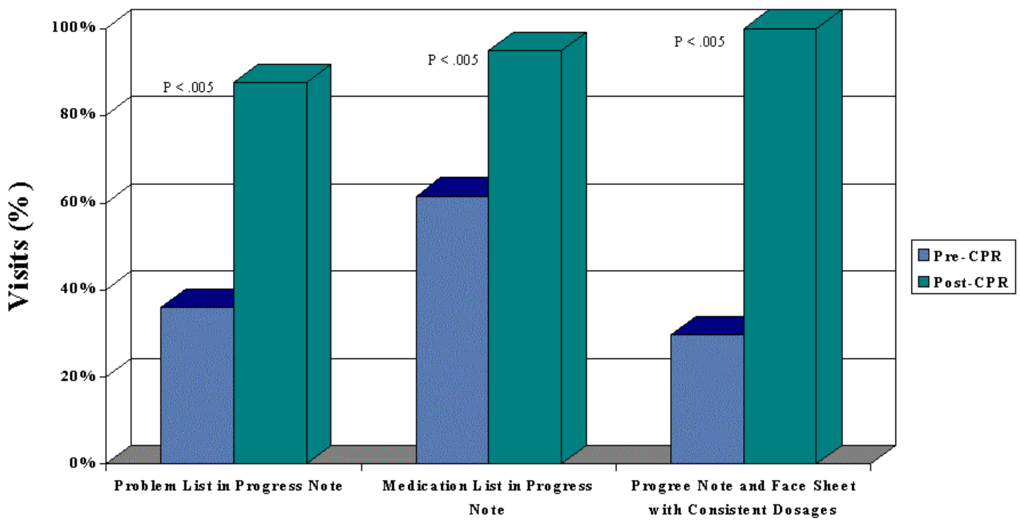


Figure 21: Percent of Visit Documentation with Complete Information

Health-Care Team Communication

We initially attempted to evaluate the results of our intervention on health-care communication by comparing the completeness and timeliness of the communication between the intervention and control groups. However, despite multiple attempts, we were not able to reliably determine either what information was communicated or when communication took place for the control group using paper-based documentation. Thus, we relied on before and after interviews of the intervention group to determine whether a change in their communication methods occurred.

We repeated our semi-structured interviews about information processing near the end of the project at each site. Of the 24 interviews conducted, all respondents described one or more improvements to health care team communication. In 21 of 24 interviews, electronic mail was described as a facilitator to these improvements. In addition, 3 respondents cited CPR documentation and messaging as important clinical communication tools. The following quotes typify respondent comments.

I think with e-mail, a terminal in every physician's office along with enough terminals in the clinical area (nursing station and so forth), communication among the physician staff has definitely improved immensely. I think, if nothing else, the benefit of having computers is definitely the communication aspect.

Nurses and triage nurses e-mail the events of the day to the physician. The physician e-mails orders or how to handle certain situations and it is a nice, formal way of summarizing a day or an incident.

There are almost no pink slips [telephone messages] anymore. It used to be that you'd have to go pick up pink slips and review them and then I would make the decision and do things with them. Pink slips are only personal messages at this point.

I personally think documentation is very important…probably ninety-five percent of my [telephone] messages are given to me through the computer. A call comes to my assistant, she logs it on the computer and the message is sent to me. When I read my messages I will either call the patient directly or I'll send a response back to my assistant to call the patient. If it is really urgent my assistant may still put a manual note on my door just so that it strikes me. If there are a lot of calls that are coming in really fast, I may get a manual note but then, eventually, either she or I put them in the computer. Some days are just wild and we've logged thirty calls and each one, in some manner, needs to be responded to.

Clinical communication is not limited to the health professional staff. Some of the physicians, by mutual agreement with their patients, communicate with their patients by electronic mail. The CPR facilitates electronic communication by making available patient information remotely. One patient likened it to an "electronic housecall" in a Chicago Tribune article containing an interview with a patient whose provider uses the CPR appears.[11]

Patient Education Support

We used the focus group technique to get direct feedback from patients on their need for information pertaining to their health and their reaction to specific information provided at the CPR sites. In the first focus group, session time was spent on four general discussion topics: 1) opinions about patient education materials they had received in the past, 2) reactions to sample patient education handouts on two common health issues (lower back pain and asthma in adults), 3) reactions to a summary document about a patient encounter (including the provider's name, patient's vital signs, active medications, medication allergies, new medications prescribed, new lab tests ordered, new consults requested, graphed lab test results, printed instructions from the visit, and follow-up appointments and phone numbers), and 4) desired attributes of patient education material. [9]

The following major themes emerged from the first focus group:

- Patients Need for Information. Patients seek information. Patients want more information about their illness and treatment plan than they typically receive during physician visits. After an outpatient visit, patients sought information from a variety of information sources including friends, relatives, pharmacies, public libraries, and the World Wide Web. Patients also used the information to explain the outcome of the encounter to their family members or friends.
- Custom-Tailored Information. Patients prefer to receive information that is tailored to their own situation. For example, patients with high cholesterol would like to see their cholesterol results and an explanation of how it compares to the normal range, what the consequences are, and how they can take steps to favorably affect the results.

- Timing of Questions. Patients seek answers to their questions at the time they formulate their questions, which was generally *not* during the encounter. Patients rarely had time to formulate their questions in the exam room during an encounter. The relevant time to satisfy patients' need for information was not during the encounter, but rather after they left the clinic, when they formulated their questions.
- Need for Physician Endorsement. Although there are a variety of sources from which to get information (e.g., drug store, library, magazines), patients prefer to receive material that their physician has endorsed as credible and applicable to their specific problem.
- Access to More Information. Patients would like their physicians to recommend other sources of information as well. Journal articles, URL addresses, or resource telephone numbers are all helpful. These resources give patients additional comfort and confidence that they have ways to access information for future questions.
- Personal Medical Record. Patients would like to accumulate as much information as possible about their own health and health problems. Some patients who had received printed summaries of their encounter, which included personal data, saved them as their own personal medical record.

Based on the results of the first focus group on patient education, we developed enhancements to the AVS. The AVS contains details of the encounter including vital signs, active medications, allergies, new lab test orders, new prescriptions, tailored patient instructions, and graphical printouts of relevant data (e.g., blood pressure, weight, cholesterol). This has been an excellent means of providing patient instructions and patient education in a way that patients can take with them. A sample output of the AVS is shown in Figure 22. The accompanying graphical trend, automatically printed for patients with hypertension, is shown in Figure 23, with the explanatory text.

After Visit Summary:
Summary of Your Visit Today

Patient
TEST,JACK — HR # 182955 — DOB 06/28/22 M

Date	Time	Clinician Seen Today	Clinic/Dept
03/15/98	12:22 PM	Tang MD, Paul	NMH/ATT

During your visit today, we recorded the following information about you:

Temperature	Pulse	Respiration	Blood pressure
98.6 degrees	66/minute	18/minute	130/75

Weight
195 lbs

Our records show the following allergies:

Allergy Agents	Noted	Allergy Reaction
PENICILLINS	3/14/98	Shortness of breath

Date verified: 3/14/98

ORDERS/MEDICATIONS

Medications Ordered Today
SEPTRA DS TABS 800-160 MG OR — 1 TABLET EVERY 12 HOURS
Refills: 0

CURRENT MEDICATIONS (PRIOR TO TODAY'S ENCOUNTER)

FLUVASTATIN SODIUM CAPS 20 MG	1 tablet every day
ATENOLOL TABS 50 MG	1 tablet every day
ASPIRIN TABS 325 MG	1 tablet every day

Instructions related to today's visit

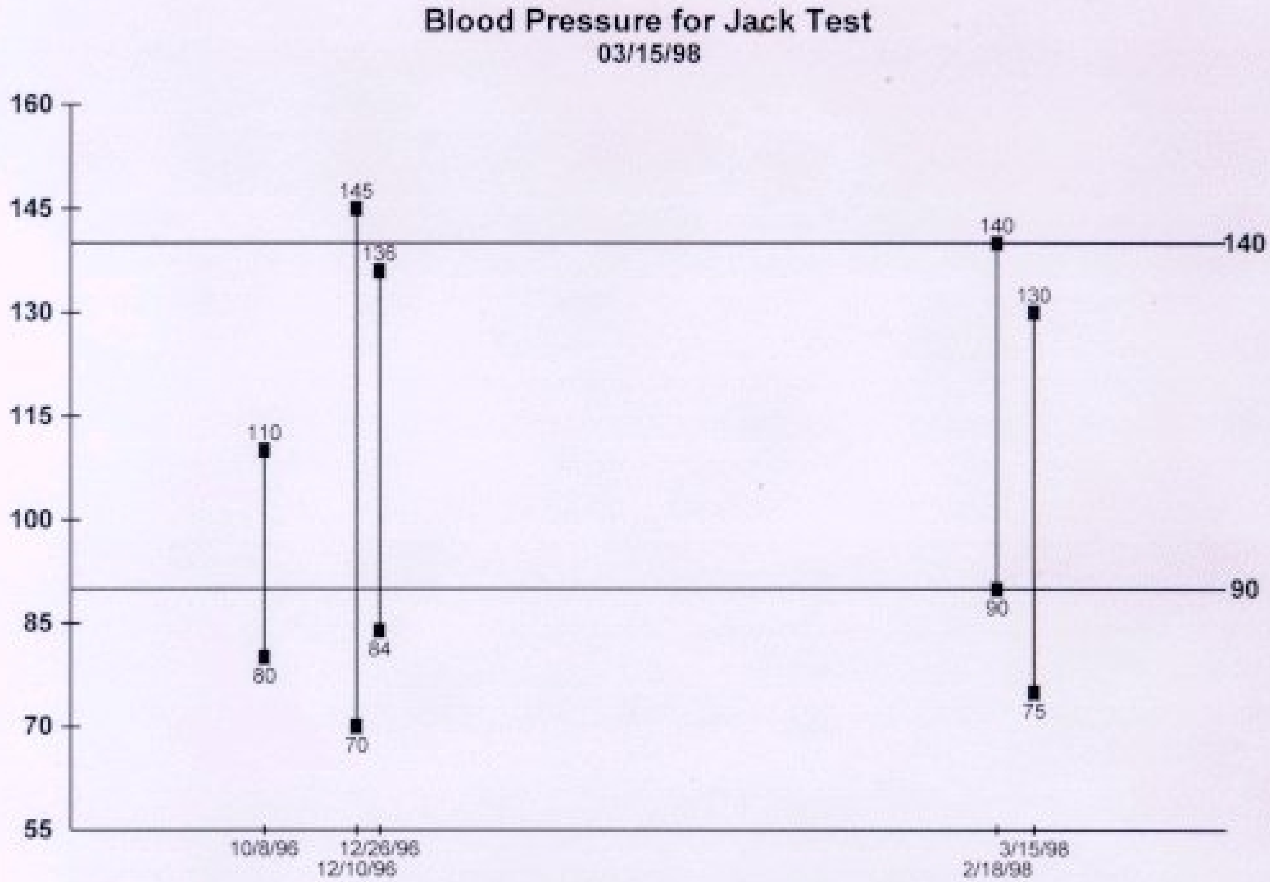
--Bronchitis Information--

Bronchitis is an infection in the air passages in your lungs. It commonly develops as a complication of a "cold." Although the bacterial infection generally responds well to antibiotics, the underlying viral infection (your cold) will run its usual course despite taking antibiotics. Hence, not all of your symptoms will disappear with the antibiotic.

Although there are no medications to cure your cold, there are a number of medications available over the counter (OTC) that can help treat the symptoms:

Page 1

Figure 22: The After Visit Summary Provides Important Information for Patients to Keep



Date	Blood Pressure
10/8/96	110 / 80
12/10/96	145 / 70
12/26/96	136 / 84
2/18/98	140 / 90
3/15/98	130 / 75

Blood pressure normally changes with activity and stress. If a person is sitting relaxed their blood pressure is usually less than 140mmHg for the first number (systolic) and less than 90mmHg for the second number (diastolic). When someone's blood pressure is consistently above these numbers we call it high blood pressure or hypertension. Salt restriction and exercise, if appropriate for the individual, are the foundation of treatment.

Figure 23: Graphical Plot Enhancement to the After Visit Summary

We conducted a second focus group after we developed and implemented the enhanced version of the AVS.[12] Participants in the second group had been seen by one of our piloteers. Patients were selected from a pool of those with acute and chronic disorders (e.g., hypertension, diabetes, coronary artery disease). The focus group session time was spent on five general discussion topics: 1) educational materials received during an office visit, 2) satisfaction with the materials, 3) use of the materials, 4) suggestions for improvement, and 5) reactions about physicians using computers during the visit.

When asked about information they had received during a recent clinic visit, patients were quick to focus on the AVS. Some of the patients had not received an AVS and were quite interested in the descriptions of those who had received them. The patients who had received an AVS were uniformly positive about the value of the material. All of the recipients agreed that it was a desirable component of the patient care experience in the clinic. Several common themes emerged during the discussion, which are summarized below. Many of the comments validated our findings from the previous focus groups on patient education, either by reiterating the points or by emphasizing how the AVS addressed their information needs. Comments from the second focus group coalesced around the following themes:

- Permanent Personal Record. Patients wanted more information about their health. They appreciated receiving their personal information as a printout they could take home with them and file, which most of them did. Participants reiterated the finding from our previous focus group that being able to take home the AVS allowed them to deal with the information at a time when questions arose – *after* the encounter.
- Health Information. Patients sought information about their health condition and methods to improve their health. Providing custom-tailored information about a disease or instructions to speed their recovery from an acute illness was perceived as valuable.
- Relationship with Providers and Customer Satisfaction. Although the relationship of providers and patients has always been an important aspect of care, it is assuming a rising importance as providers seek ways to retain patients in a managed care environment. The positive impact of the AVS on the patient-provider relationships and customer satisfaction was pronounced.
- Adherence with Therapy. The ultimate clinical goal for providing more information to patients is to engage the patient in shared decision making and improve the adherence with jointly agreed-upon treatment plans. Although the health outcome of efforts to improve patient compliance are difficult to measure, we posed the question of how receiving the AVS would affect their adherence with therapeutic plans. The participants felt that the graphical printouts of trends and identified goals were particularly helpful in motivating them to adhere to prescribed therapy.

  Many chronic diseases (e.g., hypertension, hypercholesterolemia, diabetes, obesity) do not have daily symptoms. Patients typically have a conceptual understanding of their disease, but without external cues, such as a graphical plot of trends, it may be difficult to motivate a patient to comply with a proven treatment plan. Patients' responses at the focus groups indicate that the graphical trends plotted with the AVS may provide some motivation. Some of the patients had received an AVS before the graphical capability was developed. It was interesting to find that those who had not received a graphical AVS were among the most enthusiastic about the value of the trend plots and their potential impact on their motivation to adhere to effective treatment plans.
- Information in a Computer. Despite the fact that entering information into a CPR may cause some concern about maintaining confidentiality of patient data, when the topic was deliberately raised, the participants in our focus groups were more focused on the potential benefits to their care.

Computer Resources, Training, and Support

We designed a survey instrument to measure: 1) the amount of time the site participants spent using a computer; 2) the extent to which computers were used to perform patient care related tasks; 3) the users' self-reported skill level with different applications and systems; 4) their satisfaction with the systems provided; and 5) the desired functionality of future computer systems. The respondents evaluated their computer skills and their satisfaction with computer resources using a Likert scale. Respondents were also asked to describe (1=never, 4=always) their use of computer systems in performing patient care related tasks.

The survey was first conducted in 1995, prior to the delivery of computer workstations at the NetReach sites, and was repeated annually throughout the duration of the project. The survey was sent to the entire staff, clinical and clerical, at each site. A second mailing was sent to each non-respondent two weeks later. The surveys were coded to determine the respondent's site and job classification. The response rates varied from 45% to 52%.

We compared the responses of the intervention and control groups before and after the CPR was implemented. While the control group did not change significantly, the intervention group had a significant increase in clinical uses of computers for the following activities: documentation of patient information; accession of clinical data; communication with other health care staff; securing advice on patient diagnoses or therapies; accession of patient appointments; word processing; and searching medical literature (see Figure 24).

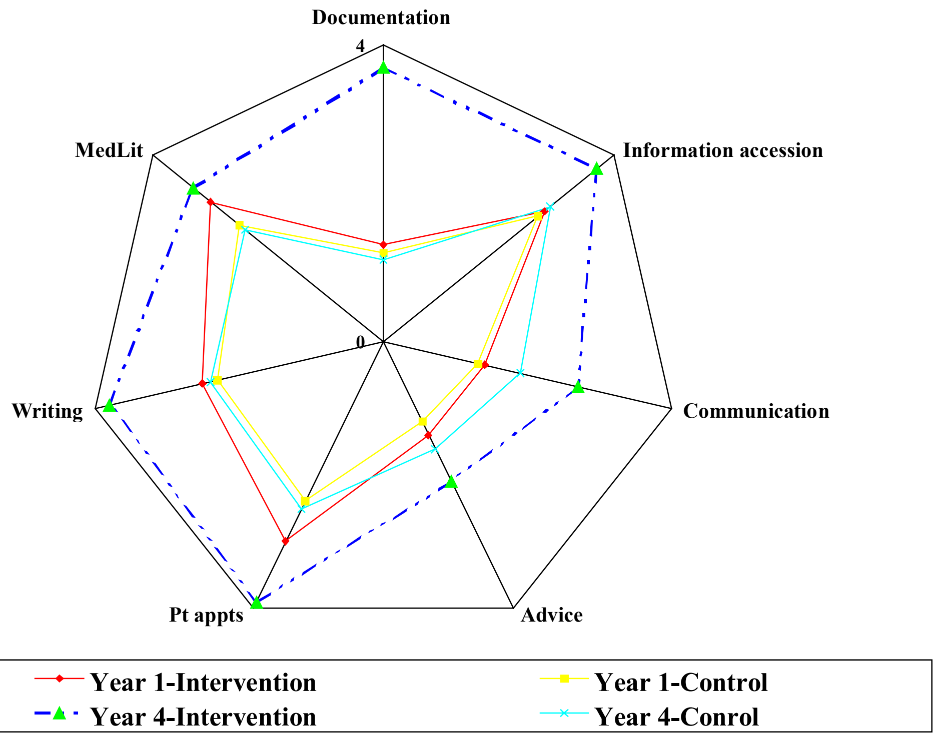


Figure 24: Clinician Use of Computers for Patient Care Tasks

Time Allocation Studies

We repeated our time allocation studies at the end of the project using methods described previously. A total of 39 study subjects were evaluated at our seven sites producing 4680 minutes of clinical activities. The mean time spent during an encounter in the exam room was shorter in 1998 (15.4 in 1998 vs. 17.3 minutes in 1995; p=.26), but not statistically significant. The mean clinician/patient encounter times by site are summarized in Figure 25. Although there were rather large differences in the mean encounter times at GIM and Cardiology, because of the small sample size, the differences were not statistically significant.

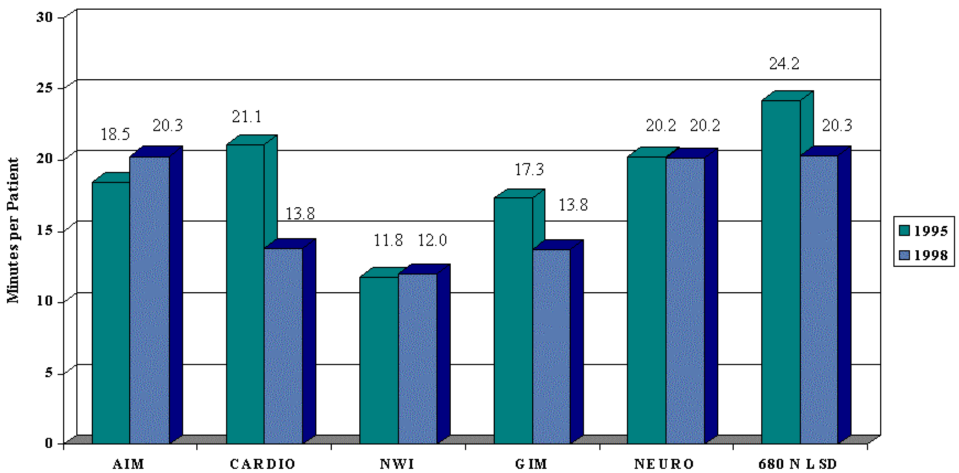


Figure 25: Comparison of 1995 and 1998 Mean Clinician/Patient Time

We stratified the direct patient-clinician interaction time into five general categories – talking, writing, reading, exam and other. The category "Other" was comprised of several subcategories describing clinician activities related to searching for equipment, supplies, forms and requisitions; and any idle or personal time. The amount of time spent in all subcategories of "Other" significantly declined (p<.001). Changes in categories of activities from 1995 to 1998 are summarized in Figure 26.

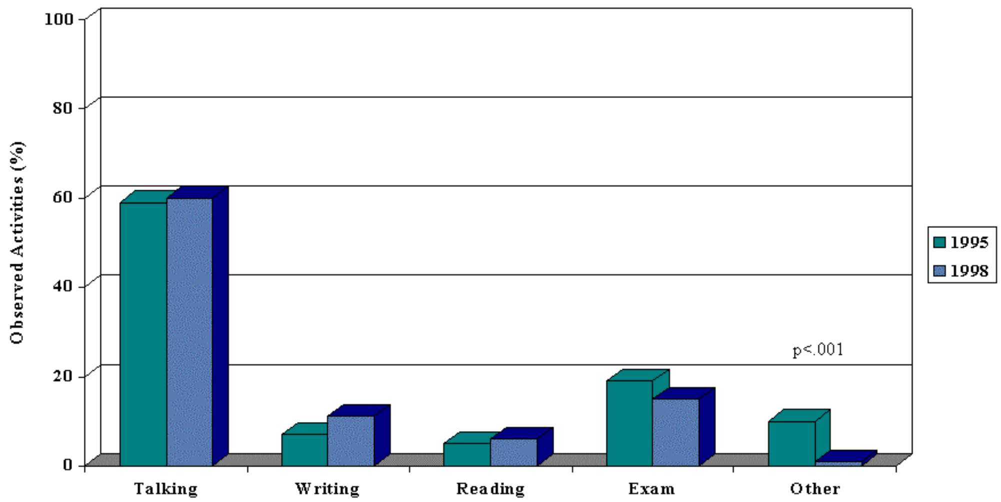


Figure 26: Comparison of 1995 and 1998 Direct Patient Activities for All Sites

We performed additional data analyses on the data from the sites where the CPR was implemented, GIM and AIM. There were no statistically significant differences between the intervention and control groups at GIM initially (22.2 vs. 17.2 min, respectively; p=.34) or after the CPR was implemented (13.7 vs. 15.2 min; p=.47). Similarly, prior to implementation of the CPR, there were no statistically significant differences between the mean patient/clinician encounter times for the intervention and control groups at AIM (19.2 vs. 18.6; p=.95). After the CPR was implemented, the mean encounter times were also similar (23.9 vs. 18.1; p=.49). The before and after mean encounter times are shown in Figure 27.

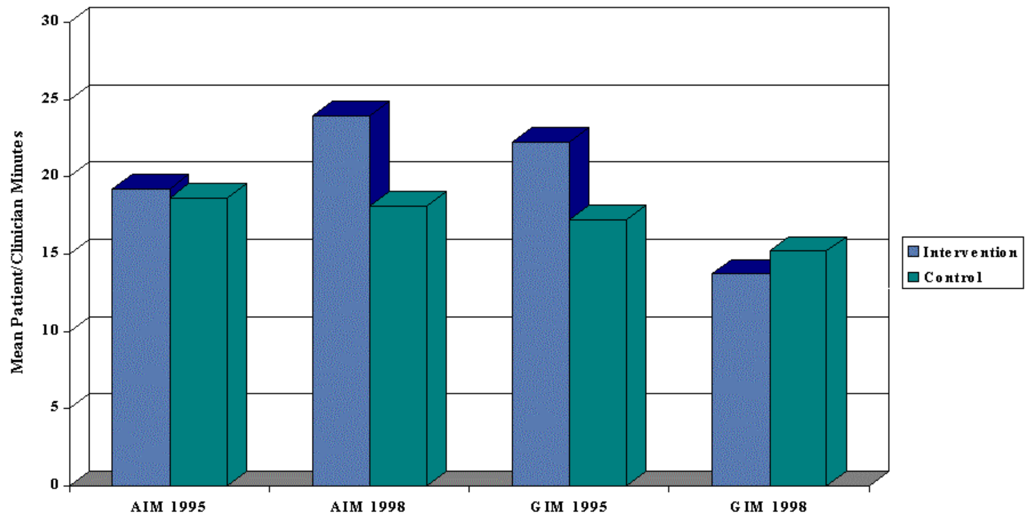


Figure 27: Mean Patient/Clinician Time at CPR Sites

Video Ethnography Study

We contracted with the Northwestern University Medical School Program in Communication and Medicine to examine physician-patient communication patterns associated with the use of CPRs or paper-based records using video ethnography. The investigators taped three physicians who use a CPR system and three who used only a paper record ("control physicians"). A total of 204 patient visits were included in the analysis (mean = 34 for each physician). Content analysis of the video tapes was performed. Both intervention and control physicians demonstrated considerable variability in style of interaction with patients. Two of the three physicians in each group directed their attention to the patient record during the initial minutes of the encounter. The intervention physicians appeared to spend more attention on information tasks – gathering, clarifying, and providing information during patient visits. Qualitatively, the computer appeared to draw physicians' attention away from patient-physician communication tasks more than the paper record did. While there were differences between CPR and control physicians in some aspects of their communication with patients, CPR physicians' communication behaviors might well reflect styles established before they began using an electronic medical record.

Clinical Impact Studies

In addition to our evaluation studies under each functional goal established by our initial information needs assessment, we also studied how using a CPR in routine practice affects clinical care. In this report we present the results of studies completed. We are continuing to add new studies to measure the clinical benefits of using CPR systems.

Appropriateness of Clinical Decision Making in Ambulatory Care

Deficiencies of the medical record as a repository of patient information have been well documented.[13-16]. A CPR overcomes many of the limitations of a paper-based record. However, none of the studies documenting the deficiencies of the current medical record was designed to measure whether or how lack of relevant information affected clinical decisions made during the encounter. We therefore investigated whether using a CPR affects the appropriateness of medical decisions made during ambulatory-care encounters. Providers who used the CPR had more complete documentation of the clinical encounter and made more appropriate decisions compared to providers who used paper charts, as judged by a blinded expert physician panel.[17]

Methods

A panel of four expert physicians analyzed medical records from an academic internal medicine practice. The panel members were board-certified in internal medicine and had been in practice for an average of 28 years. No expert was involved in the computer-based patient-record project or was a member of the practice studied. We included in the pool of eligible records those of patients who had chronic diseases (e.g., asthma, hypertension, diabetes, congestive heart failure, hypothyroidism, chronic renal failure, or rheumatoid arthritis) and were seen at GIM four or more times between September 1996 and August 1997. The pool of eligible records covered 491 patients of physicians who used the CPR and 435 patients of physicians who used the traditional paper-based record. We randomly selected records from the pool and transcribed progress notes into a standard format so that any differences between the formats of the original records were minimized. A transcribed version of the ambulatory-care medical-record face sheet (containing the problem, medication, and allergy lists, when available), four consecutive internal-medicine-clinic progress notes, and the results of diagnostic tests ordered during the covered encounters were assembled as a “mini-record” for the expert panel.

Each expert reviewed an identical set of 56 mini-records. Twenty-five mini-records represented those of providers using a CPR; 25 represented those of providers using paper-based records. Six duplicate records — three from each group — were added to the study sets so that we could assess intracoder reliability. The study records were mixed between the two groups, and the experts were blinded to whether a note was recorded by a provider using a CPR or a paper-based record. All reviewers evaluated five aspects of each of the 56 medical records. They were instructed to rate the completeness of the problem list (on a scale of 0 = “does not exist” to 2 = “itemizes most major problems for this patient”) and medication list (on a scale of 0 to 2 = “itemizes most active medications and instructions”) in the most recent progress note, using information in the mini-record. Reviewers rated the completeness of allergy documentation in the mini-record (on a scale of 0 to 2 = “itemizes most allergies”). Reviewers rated the degree to which relevant patient factors were considered in the assessment and plan portion of the most recent progress note (on a scale of 0 = “considered none of the relevant patient factors” to 2 = “considered most of the relevant patient factors”). The final question on the scoring sheet asked the reviewer to rate the clinical appropriateness of the assessment and diagnostic and treatment decisions made during that visit (on a scale of 0 = “completely inappropriate” to 5 = “completely appropriate”), given the information available in the mini-record.

Results

Each reviewer completed his review of 56 mini-records. We evaluated intracoder reliability using a test-retest reliability model. The calculated intraclass correlation coefficient was 0.94.

We compared the experts’ ratings of medical records from the two groups of providers in each of the five aspects evaluated (Table 9). The expert reviewers rated the problem lists and medication lists in the CPR as significantly more complete than those maintained in the paper-based record (1.79/2.00 vs. 0.93/2.00; $p<0.001$ and 1.75/2.00 vs. 0.91/2.00; $p<0.001$, respectively). The allergy lists in the two types of records were similar (1.97/2.00 vs. 1.85/2.00; $p=0.07$). Physicians who used a CPR provided more evidence in their assessment that they had considered relevant patient factors in making their decisions (1.53/2.00 vs. 1.07/2.00; $p<0.001$) and made more appropriate decisions (3.63/5.00 vs. 2.50/5.00; $p<0.001$) than did those who used traditional paper-based patient records.

Rating Dimension	N	Computer-Record Users (Mean)	Paper-Record Users (Mean)	Significance
Major problems documented in problem list	169	1.79/2.00	0.93/2.00	< 0.001
Medications documented in medication list	171	1.75/2.00	0.91/2.00	< 0.001
Allergies documented in mini-record	169	1.97/2.00	1.85/2.00	0.07
Relevant clinical factors considered in assessment and plan	172	1.53/2.00	1.07/2.00	< 0.001
Appropriateness of assessment and plan	172	3.63/5.00	2.50/5.00	< 0.001

Table 9: Comparison of Completeness of Documentation and Appropriateness of Medical Decisions Making

More thorough consideration of relevant patient factors was independently and significantly correlated with a more complete problem list ($p<0.01$) and with a more complete medication list ($p<0.01$), as revealed by our two-tailed Kendall's tau-b analysis. Furthermore, there was a statistically significant correlation between consideration of relevant factors in the assessment and plans and the appropriateness of the medical decisions made ($p<0.01$), as judged by the expert panel.

Discussion

To our knowledge, no studies have evaluated whether the deficiencies of the record-keeping system affect the appropriateness of patient-care decisions made during an encounter. Our study links the deficiencies of the paper-based medical record to a decreased appropriateness of medical decisions. These results raise a concern over whether decisions made without available information have an adverse influence on patient outcomes. Although we did not assess long-term outcomes, the significant differences in appropriateness of decisions between the two groups is serious enough to call for further study, if not for immediate action to improve the medical record system.

Other studies have demonstrated that computer-based reminders can change physician behavior.[18-23]During the study period, our CPR system did not employ a rules-driven reminder system. Consequently, we were able to isolate the effect of using a CPR from the possible additional positive effects of computer-based decision support in the form of reminders and alerts.

At least three possibilities could explain the difference in appropriateness of decisions made when physicians used a CPR. First, having complete information available during patient encounters may have directly improved the decisions made. Second, the CPR is legible and organized, and thus increased the ability of physicians to find information. Third, physician use of a CPR may have affected documentation habits. Physicians who used CPRs had more complete documentation of the patients' problems and medications and of their assessment and plans in the progress notes. A possible explanation for better documentation among users of the CPR stems from the highly legible output; knowing that documentation in the CPR is legible may have influenced providers to exercise greater care in preparing their notes.

We conclude that ready access to patient data, such as those made available by CPR, facilitates better clinical decision making.

Timely Follow-up for Underprivileged Patients Following Delivery of Newborn

Erie Family Health Center (EFHC), a community health center serving the predominantly Hispanic West Town neighborhood of Chicago, provides pre- and post-natal care within its Obstetrics Division. Patients are followed through their prenatal course by a multidisciplinary team of case managers and clinicians. Perinatal care (labor and birthing) is provided at the Prentice Pavilion of NMH, located 2.5 miles from the clinic. Follow-up care for both mother and newborn is provided at EFHC. When we interviewed the clinical staff during our initial needs assessment, the clinicians expressed concern over the lack of timely follow-up of mothers and newborns after delivery. The primary reason for this was the lack of reliable notification about the delivery at NMH. Without knowledge of the delivery date and any complications, ensuring timely follow-up visits for the mother and infant was a challenge. The nurse midwives also wanted to be able to contact moms who planned to breastfeed before they left the hospital to set up a support system. Because many of their patients are indigent, the patients were difficult to contact after they left the hospital for a variety of reasons.

As a result of this need, we met with the nurse manager of Labor & Delivery (L&D) who agreed with our plan to automate the Prentice labor and delivery log and store the data in a networked database, giving EFHC 'read-only' access to their patients' information. The database was maintained by the Labor and Delivery Department staff at NMH and was made available over the enterprise network to EFHC staff with appropriate authorization.

To evaluate the impact of our intervention, we used a pre-post quasi-experimental methodology to measure the time from delivery to first post-partum clinic visit. Study populations for the pre- and post-implementation groups were identified through the use of a computer-based patient database, maintained by EFHC clinicians, to track patients enrolled in prenatal care.

We reviewed 99 pre- and 106 post-implementation cases. The time from delivery to the first post-partum visit was significantly reduced (58.5 versus 45.3 days; p=0.002). In addition, there were fewer patients lost to follow-up care (28 at baseline versus 14 post-implementation; p=.004).

However, in addition to implementing the L&D Log, there was a significant process change that occurred during our intervention period that confounds our results. In January, 1997, nurse midwives at EFHC were given admitting privileges at NMH so that they were able to visit their own patients and provide follow-up instructions. Consequently, we cannot attribute the change in follow-up times solely to our intervention.

The L&D Log has contributed to improvements beyond those sought at its inception. Other clinicians needing information about the mother and infant also use the L&D Log. In addition, the log is utilized as a case-finding tool by AmeriCorps volunteers working to encourage breast-feeding as the primary source of neonatal nutrition. Other programs taking advantage of on-line data include the Healthy Women Program as well as use by the case managers to meet state reporting mandates of the Cornerstone Program. Figure 28 illustrates the uses of the L&D log.

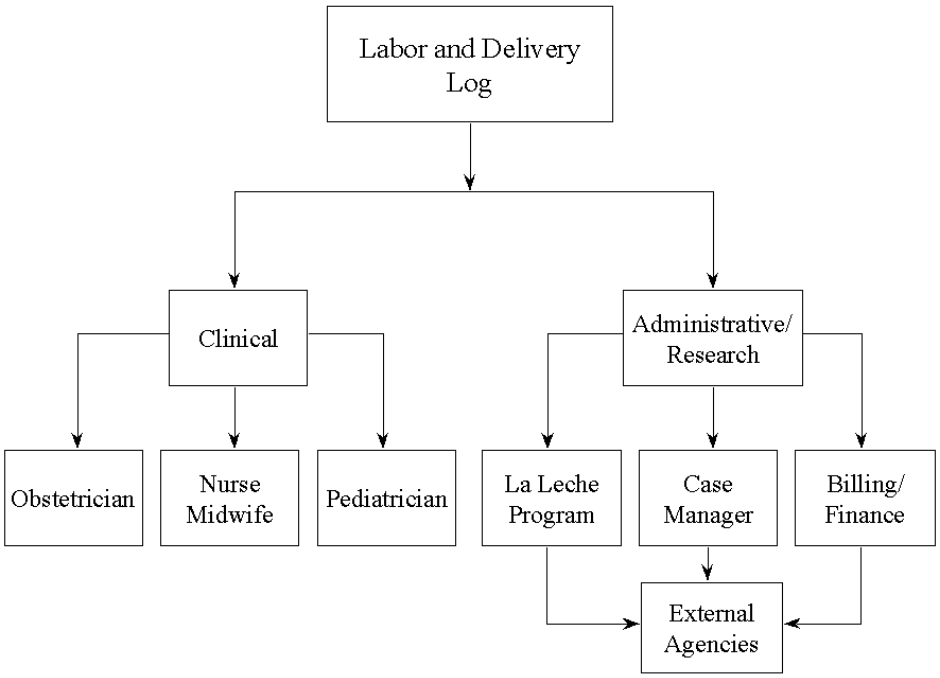


Figure 28: Flow of Information from the Labor and Delivery Log

Compliance with Clinical Guidelines: Influenza Immunization Example

The benefits of timely influenza vaccination in older adults have been clearly demonstrated.[22] Immunizing eligible patients reduces their morbidity and mortality due to pneumonia and other acute respiratory illnesses.[24;25] The U.S. Preventive Services Task Force recommended that at least 60% of the older adult population receive influenza vaccinations annually by the year 2000. However, in order for this goal and related benefits to be realized, the population at risk must be inoculated at the appropriate time and in sufficient numbers. Adequate processes must exist to inform the population at risk that these services are available, but equally important is a reminder/support system for clinicians.

Below, we report on survey results of the clinicians' intent for a specific intervention, their perceived use of the intervention, and finally, their measured compliance with their intentions.

Intent: Clinician survey responses (mean 4.91 on 5-point scale) indicated that both the intervention group and the control group clearly endorsed influenza vaccination of older adults (see Figure 29).

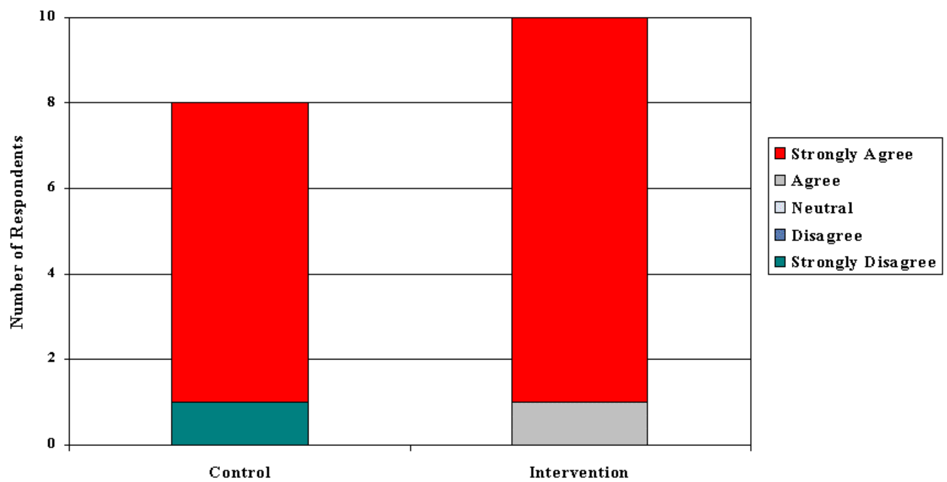


Figure 29: Clinicians' Agreement with Influenza Vaccination Guidelines for >64 Year Olds

Perceived Use: Of eight intervention group respondents , six (75%) believed that they provided influenza vaccinations at least 75% of the time for their patients. The seven control group respondents perceived themselves as being even more compliant with all stating they provided influenza inoculations at least 75% of the time. See Figure 30.

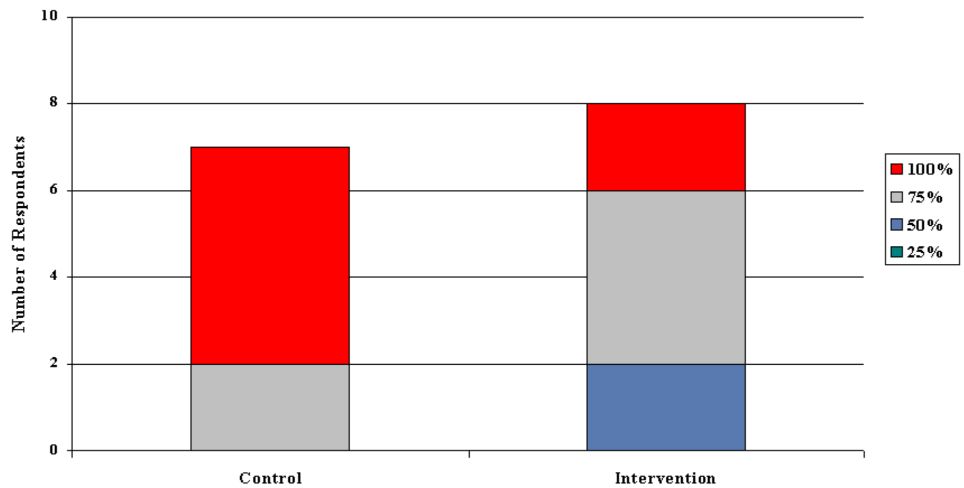


Figure 30: Clinicians' Perceived Use of Flu Vaccination in Elderly

Methods: Typically, influenza vaccination rates are ascertained by surveying patients. This method was recommended by the National Committee on Quality Assurance after pilot testing of a similar measure and is currently used in HEDIS, Version 3.0. Improving compliance with immunization guidelines can be accomplished through a combination of methods involving the provider, provider organization, and patient. We focused our intervention on changing the behavior of the provider by reminding them to consider immunization in eligible patients as well as providing clinicians with periodic feedback on their individual rates. Consequently, to measure the effectiveness of our intervention, we developed a methodology where the unit of analysis is the individual provider. We measured the compliance with the influenza vaccination guidelines for each eligible patient seen during the influenza season (October 1 through January 31). Patients with a contraindication to influenza vaccine (e.g., allergy to egg products) and those who have previously received the vaccination were not part of the eligible population. Each patient visit was considered an opportunity for the clinician to document influenza inoculation counseling and/or to document an order for the influenza vaccine. Documentation of influenza inoculation counseling included a clinician note that the influenza vaccine was offered to the patient and declined or that the influenza vaccine had been administered at a location other than the internal medicine clinic.

During data abstraction of qualifying patient visits, evidence of influenza administration was also sought for the purpose of calculating influenza vaccination rates. For these calculations, the unit of analysis included all patients whose age was 65 years or greater and was seen at least once during the study period. This methodology was repeated for each influenza year reviewed.

Results: Statistical analysis of the qualifying patient visits yielded the following results in Table 10 and Figure 31:

	Intervention Group			**Control Group**		
Study Year	Total Eligible Patient Visits	Visits With Counseling or Immunization (Intervention Group)	% of Visits with Counseling	Total Eligible Patient Visits	Visits With Counseling or Immunization (Control Group)	% of Visits with Counseling
1995	167	67	40.1	147	41	27.9
1996	217	84	38.7	151	43	28.5
1997	233	142	60.9	200	74	37.0
1998	242	165	68.2	268	82	30.6

Table 10: Counseling and Vaccination Rates

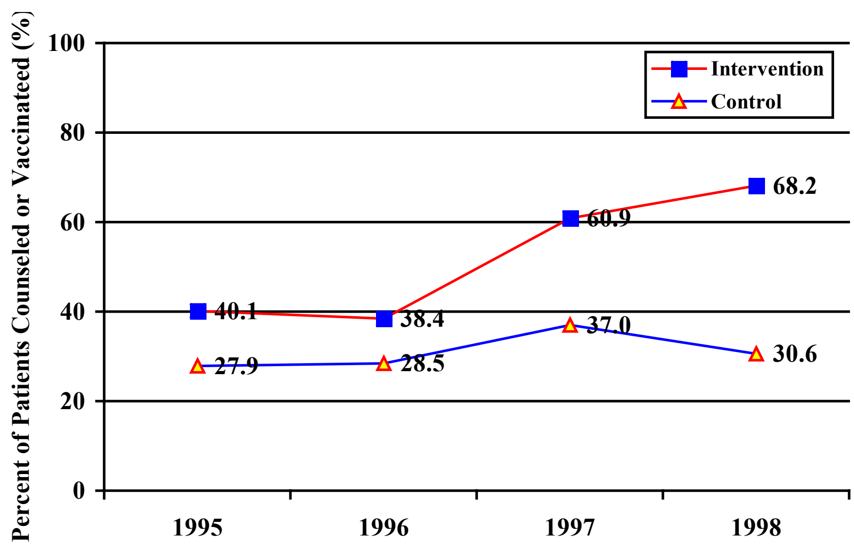


Figure 31: Percent of Eligible Patients Counseled or Vaccinated

Analysis of the immunization rates from 1995 to 1998 indicate that the intervention group demonstrated statistically significant (p<.001 by Kruskal-Wallis Test) improvement in performance while the control group showed no change.

We also analyzed the actual immunization rates of patients regardless of how they received the immunization (e.g., during a study provider visit, during a nurse visit, during a visit with non-study provider). Evaluation of actual influenza inoculation rates for the study groups showed the following results as shown in Table 11 and Figure 32:

	Intervention Group			Control Group		
Study Year	Total Eligible Patients	Patients Receiving Immunization (Intervention Group)	% of Patients Immunized	Total Eligible Patients	Patients Receiving Immunization (Control Group)	% of Patients Immunized
1995	120	60	50.0	104	38	36.5
1996	166	74	44.6	117	51	43.6
1997	188	123	65.4	156	72	46.2
1998	189	132	69.8	178	78	43.8

Table 11: Influenza Inoculation Rates

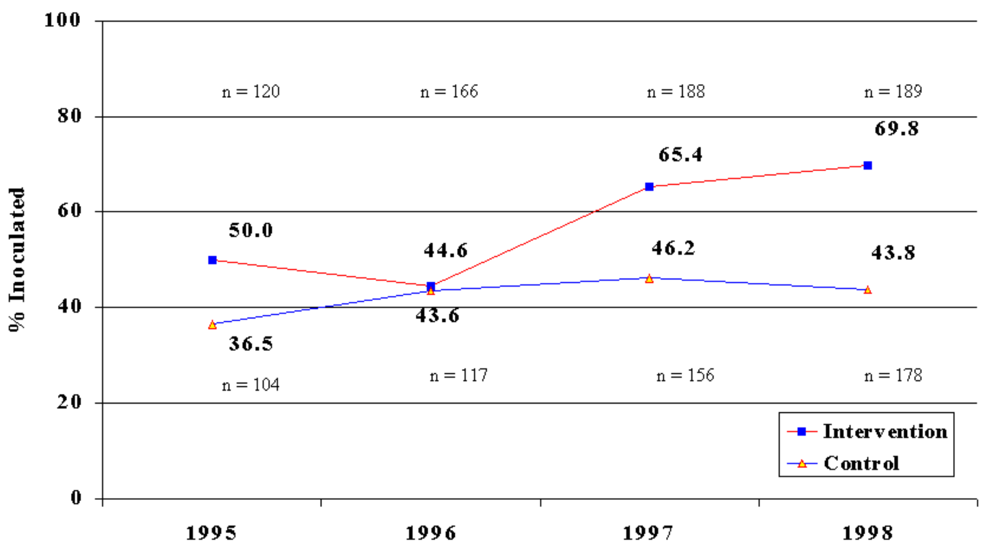


Figure 32: Percent of Eligible Patients Receiving Influenza Immunization

The inoculation rates for CPR patients increased significantly from 1995 to 1998 (p<.001 by Kruskal-Wallis Test). Inoculation rates for the control group failed to show significant change over the same study period.

Use of Aggregate Data in Disease Management

Disease management is an approach for managing chronic diseases to improve the overall health status of a patient and reduce the number of acute exacerbations. Because the intervention typically involves close follow-up by trained health professionals, it would be useful to identify the patients who need the more intensive follow-up.

We reviewed the consumption of resources of asthma patients seen in GIM over the past year and found that 9% of the 458 patients seen consumed a disproportionate amount of clinic resources (32% of clinic visits) and hospital-based services (71% of hospital-based charges) compared to the whole asthma patient population (see Figure 33). Interventions focused on the population of patients who consume the most resources are likely to produce the most benefit.

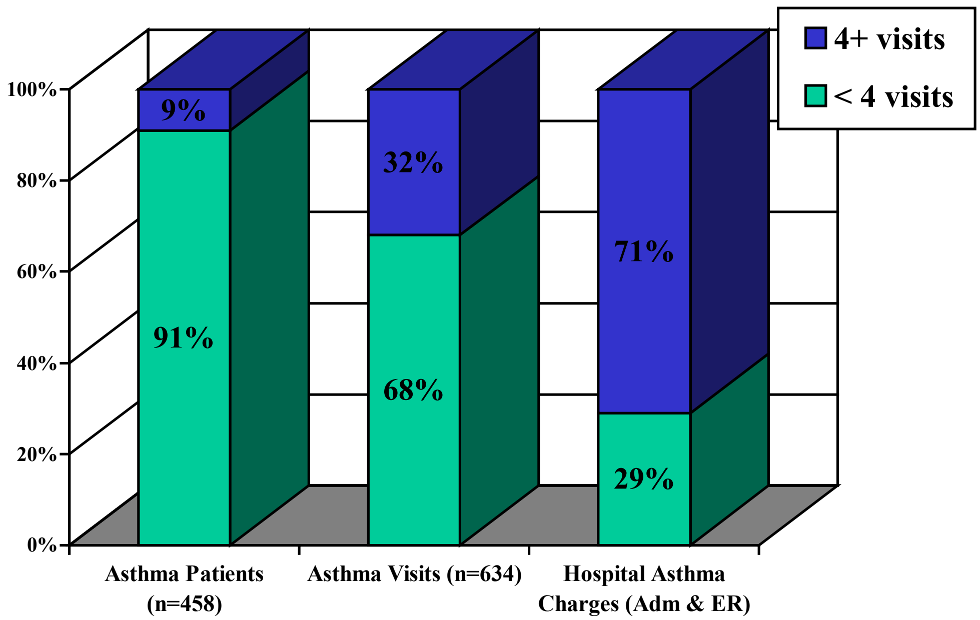


Figure 33: Relative Resource Consumption by More Severe Asthma Patients

Clinical Discoveries Using a CPR

Not only can the CPR facilitate the conduct of clinical research, the instant availability of individual patient data and the capability to follow-up on unexpected findings can be combined to facilitate discovery of new knowledge, which can pose new clinical research questions. In this capacity, the CPR acts as an efficient tool to conduct clinical research. We illustrate this capability with the following example.

A clinician noted a possible change in the resistance pattern of typical organisms responsible for urinary tract infections (UTI). Whereas in the past, uncomplicated UTIs were almost exclusively caused by Escherichia coli (E. coli) sensitive to trimethoprim/sulfamethoxazole, recently an increased number of patients have presented with persistent symptoms. The resultant treatment failures required return clinic visits for further diagnostic evaluation and the administration of a secondary course of antimicrobial therapy.

Because the frequency of antimicrobial resistance of E. coli causing UTIs was unknown in our ambulatory general medicine population, we analyzed patients in our clinical database. We identified a study population consisting of clinic visits for women 18 to 65 years of age treated for urinary tract infection (ICD-9-CM code 599.0). We excluded patient visits associated with significant neurologic disorders (e.g., multiple sclerosis, neurogenic bladder) that would indicate a complicated UTI. Using these search criteria 843 clinic visits were retrieved. During the 843 UTI clinic visits, 135 (16.0%) urine cultures were performed. E. coli was isolated as the principal organism in a total of 82 (60.7%) of the 135 urine cultures. A total of 43 (52.4%) of the E.coli cultures were subsequently noted to be resistant to either ampicillin or trimethoprim/sulfamethoxizole or both.

Preliminary record review shows that more than half (23 of 43) of the resistant E. coli UTIs were initially treated with trimethoprim/sulfamethoxizole or ampicillin. These cases required one or more return clinic visits because of persistent or worsening symptoms and resulted in changes to antimicrobial therapy.

To our knowledge, this change in antibiotic resistance pattern for E coli in uncomplicated UTIs has not been reported. A 1994 study published by Beunders noted increasing E. coli resistance to trimethoprim/sulfamethoxizole (28%) and amoxicillin (34%) in their review of culture isolates from seven clinical laboratories.[26] Importantly, however, these isolates included cultures from inpatients, which are not representative of uncomplicated outpatient infections in young women.

We use the above case to illustrate the value of CPRs for discovering new knowledge. We are currently studying the incidence of antibiotic resistance in a formal epidemiological study.

CPR User Survey

We developed a user satisfaction survey to measure clinicians' perceived value of our CPR system and its effect on patient care. We surveyed the piloteers three times since implementing our CPR system. The questionnaire was initially administered in November of 1996, four months after CPR deployment. The instrument was re-administered at six months and one year following initial polling. The survey consisted of 22 questions using a Likert-scale format. Sixteen of these questions specifically addressed clinician impressions of their ability to provide patient care following the introduction of the CPR. An additional six questions focused on the clinician's ability to manage other aspects of clinical work. Finally, four multiple choice questions were included to elicit information concerning general satisfaction.

We administered the first survey to 15 clinicians and 100% responded. In April of 1997, 14 clinicians polled (1 physician had left the clinic) and 11 (78.6%) responded. In October of 1997, we distributed 12 surveys (an additional two clinicians had left the clinic) and 11 responded (91.7%).

On analysis of survey responses related to the ability to provide patient care (see Figure 34), responses to twelve of sixteen questions showed increases in positive impact from November 1996 to October 1997. One question, "Making informed decisions on your patients" demonstrated a statistically significant increase ($p < .024$) reflecting the ability of the CPR to integrate and present clinical data in a relevant and timely fashion.

One of the changes that occurred between the two surveys is a decrease in the number of nurses using the system. Originally, half of the piloteers had nurses who used the system. When nursing attrition caused a temporary decrease in nursing staff, clinic administration decided not to train new nurses on the system. Responses to four survey questions that addressed functions that involved nursing (e.g., related to telephone calls and follow-up) showed slight decreases in respondent ratings. The decrease in use of available communication tools may have caused the small decreases in ratings observed in areas where nurses had previously participated.

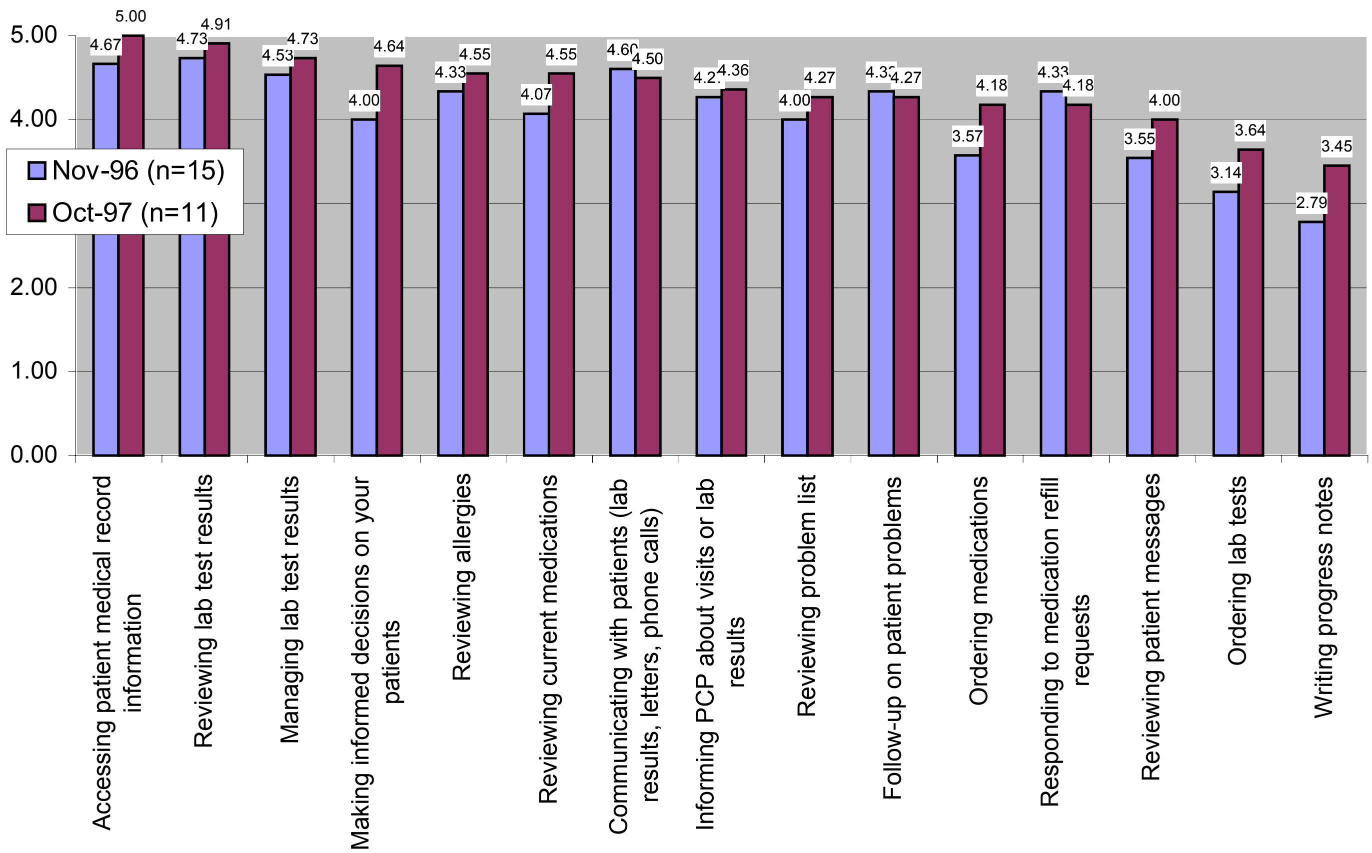


Figure 34: Survey of CPR's Impact on Patient Care Functions

We asked clinicians to rate the overall impact of the CPR system on their ability to function in the clinic. Three areas showed statistically significant improvements from November 1996 to October 1997 (see Figure 35). Respondents concluded that ability to manage medical records ($p < .009$), impact clinical outcomes ($p < .047$) and practice cost-effectively ($p < .04$) had all improved with a CPR.

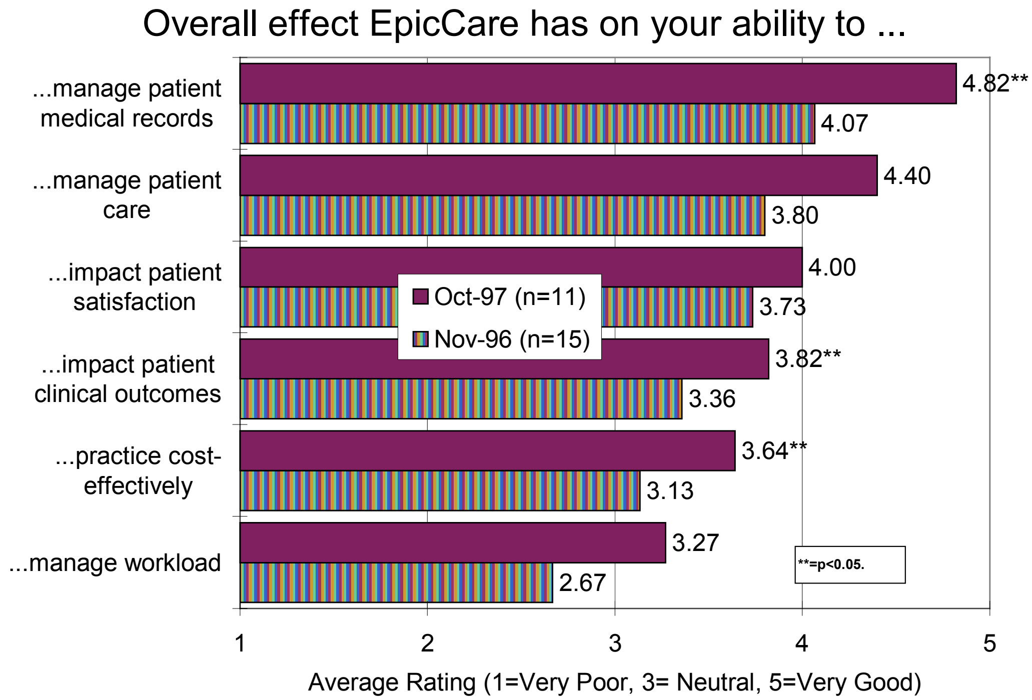


Figure 35: Impact of CPR System on Clinician Function

Analysis of the remaining multiple choice questions indicated that clinician respondents (9 of 11) favor the use of a CPR for all patient records. In addition, 6 of 7 respondents stated that there was benefit or significant benefit associated with documentation in a CPR as compared with the level of effort involved. Because documentation of the progress note was the most labor-intensive activity, we were particularly gratified that, after the initial learning curve, physicians felt that the benefit of capturing the notes was worth the level of effort involved. When asked to estimate the monetary value of a CPR per year, compared to the cost to maintain a paper-based record, the clinicians' average perceived value of a CPR was $10,000 per clinician per year.

Clinician assessment of the availability, training and technical support of available computer-based tools has improved from baseline assessments (see Figure 36). Wilcoxan match-pairs analysis of the first and current year respondent data reveals statistically significant improvements in satisfaction with computer-based resources. Number, location, ease of use, training, and technical support all reflect improvements as additional workstations and functionality have been made available.

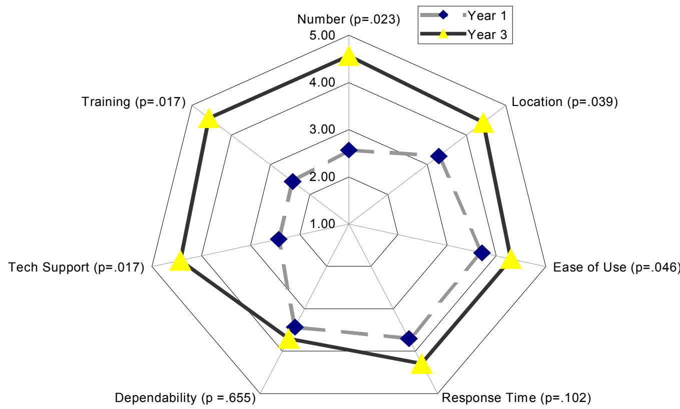


Figure 36: Clinician Satisfaction with Computer Resources (matched-pairs)

Clinicians in our project use a CPR for reviewing patient data, entering orders, writing prescriptions, and documenting patient encounters. They believe that using a CPR has improved their ability to manage patient records, make informed decisions that improve patient outcomes, and practice more cost-effectively. Decision support functionality in a CPR provides the capability to positively influence clinicians' ordering behavior in keeping with their own consensus-driven intents. Providing feedback to clinicians on their individual behavior using analysis of aggregate data provides an important tool for continuous quality improvement. We have demonstrated to our organizations that a CPR system is an essential tool for patient care and a strategic asset for the organizations. We are currently planning the deployment of the system as an enterprise CPR because we believe a CPR is a fundamental infrastructure for health care delivery.

Experience at the Associates in Internal Medicine

We concentrated on the NMFF General Internal Medicine practice in the evaluation section of this report. The other site using a CPR was the Associates in Internal Medicine. However, they have only been using the CPR for approximately six months and only three of the six physicians in the practice are part of the intervention group. Consequently, it is too early to report on quantitative impacts. Below, we summarize some of the early experience with this site.

State of Automation and Workstation Deployment

The AIM offices had limited computer resources prior to the start of the NetReach project. They had dedicated computers for their Medical Manager practice management system, and there were several standalone MacIntosh computers used by individual physicians to keep records on patients. Physicians used laptop computers and modems to connect to the hospital's PRIMES system to retrieve hospital results. A dedicated printer received laboratory results from a private firm. We deployed a total of fifteen workstations in the office for use by physicians, nurses, medical assistants, and the office manager. Three exam rooms were equipped with PCs. All the PCs were connected to a local area network installed by the site. In early 1998, we installed a workstation at a satellite office in a suburb 30 miles north of the hospital.

Two of the physicians in the intervention group were already enthusiastic Macintosh computer users. These physicians had already developed their own mini-record using ClarisWorks. After the conversion to IBM-compatible PCs, they transferred their data into an Excel spreadsheet. This new method provided comparable functionality. It was not until later when they recognized the additional advantages of using a full-functionality CPR that they were interested in becoming a pilot group for the CPR.

Need for Test Results and Integrated Data

Before the NetReach project, access to NMH's PRIMES lab reporting system was achieved via an unreliable modem connection to the physicians' personal Macintosh laptops. The other physicians had to call the hospital lab for their inpatient lab results. Most of their outpatient laboratory requests are sent to a private laboratory, whose results are returned to a dedicated printer. EKGs, treadmill tests and flexible sigmoidoscopies are performed on-site.

Following implementation of the CPR, physicians began to enter results for EKGs, treadmill tests, and flexible sigmoidoscopy procedures into the CPR directly as a permanent record. Instead of the modem connection to PRIMES, the intervention group accessed the hospital results through the CPR, and the control group accessed PRIMES through their network connection.

Need for Communication

Prior to the NetReach project, nurses and clerks communicated with their physicians via notes taped to the recipient's door, or placed on chairs or desks. After we deployed the networked computers, the physicians and their staff communicated primarily via e-mail for both clinical and administrative matters.

The CPR has further enhanced communication between the physician, assistant and patient. As the assistant takes patient telephone messages the information is entered as a Telephone Encounter in the CPR, and forwarded electronically to the physician. Any instructions and answers to the patient's call are added to the Telephone Encounter by the physician and returned to the medical assistant. The closed Telephone Encounter documents the flow of all information sent between the medical assistant and the physician. The physicians have stated their appreciation for having all telephone encounters documented in the CPR. One physician pointed out that, when he sees a series of many telephone encounters listed in the encounter review, this is a signal that the patient should schedule an appointment with the physician to work out the problem in greater depth.

The CPR physicians report that they also communicate with their patients via e-mail and the number is growing. Comments include:

> *I have three patients and two families who communicate with me exclusively by e-mail…I include my e-mail address in all my correspondence. I think that it will improve as people get more accustomed to it.*
>
> *I use e-mail with many of my patients. The only rule is that that they may not complain of acute problems. They have to call for those. It is a handy way to deal with their needs. I even congratulate via e-mail a patient on the anniversary of his successful surgery for cancer. It allows a personal touch that is often missed in our more intense physician lifestyles.*

Need for Productivity Tools

The ability to use productivity tools such as MS Office has greatly enhanced the workflow of the office manager and her assistant. MS Word templates reduce time spent writing routine reports and agendas; Excel is used for all banking records, financial statements, and employee records. MS Schedule+ holds employee work schedules as well as relevant office dates and functions. All of these functions were previously done on paper or using primitive software applications.

The physicians appreciate the ability to print a summary of a patient's current status from the CPR, including history and medications, which is used for physician referral or hospitalizations. Writing patient letters from within the CPR, from test results to return-to-work authorizations, is done quickly and efficiently with templates, which pulls in specific patient data.

> *I had two patients admitted yesterday and had to bring summaries of care. Using the master report, … I was able to add the last 3 office visits, plus all the other data from the master report. It was VERY useful in the hospital care and saved me a TON of time getting care underway.*

Need for Time Efficiencies

A drawback of the AIM facility is the long hallway with physician offices and exam rooms along each side. When the medical assistants brought charts and the paper messages to the physicians there was a great deal of walking back and forth to deliver this information. One assistant estimated that the amount of time spent just delivering telephone messages was at least ½ hour a day. Information is now delivered electronically through the CPR, and only emergency messages are walked to the physician's office. Although the medical records area is central along this hallway, the patient's chart may be in the lab or another office which would require another long walk for chart retrieval. The CPR has greatly improved this process, alleviating the need for having to track down the patients' chart.

Remote Access

The physicians are realizing the benefits of using a CPR as patients return for follow-up visits. Each physician in the intervention group has purchased and configured a PC at home for remote access to the CPR. They find this to be a major benefit when they get patient calls or are on-call. One physician does her charting in the evening or early in the morning at home while her young children are asleep. There is no longer a need for a physician to pack up all the patient charts that will be used the next day at the alternate suburban office.

Future Direction

Enthusiasm for the CPR is high with this group. AIM is planning a move in August 1998, which will more than double their present office space. The group plans to use a CPR in their new office. The office recently upgraded their billing and scheduling system to accommodate a linkage to the CPR.

Clinical Sites Without a Computer-based Patient Record

At the sites where we did not implement a CPR system, we tried to tailor our information technology support to their individual needs to the extent possible. We implemented networked PCs and provided functionality of Phase I and Phase II. In this subsection, we report on the needs and how they were addressed at the sites where we did not implement a CPR during this project.

Erie Family Health Center

State of Automation and Workstation Deployment

Before the NetReach project began at EFHC, the clinic had eight standalone PCs and no network. We deployed another five workstations and assisted them in installing a network. Two of the NetReach workstations were installed in the clinical areas, a third was located in the provider's office space. The remaining two were placed in the nursing and medical directors' offices.

Need for Patient Delivery Information

We previously described (in the Evaluation section) our intervention to alleviate the clinicians' need for information from the Prentice Women's hospital where EFHC patients are delivered.

Need for Referral Information

Another information need raised by the clinicians was a desire to track referrals made to NMH or Cook County. Many times the referral report doesn't make it to the chart, or the physician doesn't get one back at all. To track referrals better, the practice manager built an Excel spreadsheet. Every referral that is sent out is recorded in the spreadsheet by the referral coordinator. Each week, a summary is printed of patients with outstanding referral reports. This has helped the physicians follow-up on referrals.

Need for Access To Care

The EFHC staff noted that patients referred to an NMFF physician or to NMH under the Community Services Expansion Project (CSEP) were not always successful in getting care. CSEP covers physician fees and services for patients referred by EFHC providers to NMH or an NMFF physician. When a patient is referred, the provider fills out a multi-part form. One copy is given to the patient, who is to take it with them to their appointment. The second copy is sent to NMH Community Services and a third copy is filed in a binder at EFHC. This process was found to have a number of flaws. First, if the patient forgets to bring the form with them for the referral, they are often billed for the services directly. If the patient believes that they will be billed, they may leave before receiving care. If the patient receives a bill, they often ignore the bill because they were told the referral wouldn't cost them anything. Once the patient has ignored a bill long enough, it goes to a collection agency. Our investigation of the issue revealed that the major point of breakdown occurred because the billing and registration offices never received their copy of the CSEP form. As a solution to the above issues, the CSEP form was automated and sent to the appropriate parties by e-mail. A pilot was done in the fall of 1997 with OB patients and was very successful. Training is underway to include all referrals to NMH/NMFF. The receiving parties of the CSEP form would like to see other providers that refer to NMFF/NMH use the automated form by e-mail since it has made their job much more efficient.

Need for General Patient Information and Scheduling

The EFHC staff and clinicians use information from their in-house financial system (RAMS V) to check schedules, retrieve patient phone numbers, and to verify insurance coverage. Several of the workstations deployed at EFHC replaced RAMS V dumb terminals. After overcoming many technological challenges, we were able to provide access to the RAMS V system along with the standard NetReach applications on an integrated workstation.

Need for Communication

The use of e-mail has grown slowly at EFHC, but is now valued for the links it provides to off campus resources. Many of the EFHC Family physicians practice at NMH, Cook County Hospital, Children's Memorial Hospital and/or Illinois Masonic Hospital. E-mail provides an efficient way to communicate to other off-campus providers. Within EFHC, the departments (Pediatrics, Adult Medicine, Obstetrics, etc.) are using e-mail to keep communications open.

Need for Efficiency in Process and Cost

Efficiency in processes and cost have become very important since the clinic cut their staff by 32% due to recent changes in welfare policies. The registered nursing staff was reduced by 50%. The clinic staff has been challenged to look for ways to work smarter and reduce costs. Realizing they had the opportunity to incorporate the technology of the NetReach computers, they came up with several innovations. Following are a few examples.

- Recently, EFHC purchased patient education software to supplement their paper brochures. The printouts, which are available in Spanish, have been widely accepted by their patients. The nurses have found the software easy to use and geared toward their patient population.
- Tracking of abnormal pap smears, mammograms, and PPDs has been a problem due to the state of the medical records system at EFHC. The medical records are hardly ever complete due to the number of referrals done outside of the clinic. A report eventually gets sent to the primary provider, but it is often much later than is useful. To assist with tracking of abnormal results, a small Access database was made available to the clinic staff. It was originally requested by one internal medicine physician, but once others became aware, they asked to use it as well. The operations manager plans to expand its use to the other clinics within EFHC's system.
- The staff felt their system for tracking medications in a "free medication program" was lacking organization and followup. EFHC has a relationship with Cook County Hospital resulting in free medications for EFHC patients. The manual paper process involves filling out a multipart form. The pharmacist fills out the form from the physician written prescription pad sheets collected from the doctors. Daily, she sends the top two sheets of the multipart form to Cook County Hospital so that the drugs are ordered. When the drugs return, they are accompanied by one of the forms that was originally sent with the order. When the patient comes in to pick up their medications, they must place their signature next to the original entry for the medication. The biggest problems associated with this process are finding the sheet for the patient's signature and knowing who the provider is if there are problems/questions. The original form does not include the provider name. Many forms are shuffled through in an effort to find the appropriate line for the patient's signature. The operations manager requested ideas on how to automate this process to improve on the hunting that goes on when more information is needed or when the patient arrives to sign for their medications. An Excel spreadsheet was designed to meet the needs requested. It is currently being piloted, and the staff has been very positive about having it automated.

Need for Up-to-Date Clinical Information

The clinicians often need up-to-date clinical information along with the latest in clinical research studies to supplement their practice. They have found many sources on the Internet to meet this need. Users at all levels within the clinic have found useful information. The OB providers are on several professional list servers to keep current on nurse midwifery across the nation. They use a web site to help with translations – English to Spanish and vice-versa. As previously mentioned, about 85% of their patient population is

Latino. Other clinicians use the Internet to get the latest medical information on many diagnoses. Searches on Medline are commonly done. Other specialty web pages are accessed to assist with patient care, for example, the American Cancer Society and the Center for Disease Control (CDC) web pages.

Summary and Future Direction

Even though we weren't able to offer the CPR to EFHC, they have realized great value from using the NetReach workstations. They have been creative and open-minded with the technology and continue to come up with new ideas every day.

NMFF Cardiology

Initial State of Automation and Workstations Deployed

This outpatient area relied on one terminal for retrieval of test results via the hospital result reporting system. This terminal was in constant use, often with clinicians waiting in line to retrieve test results. One consult room contained a clinical workstation with a proprietary cardiac result reporting system (Marquette MUSE system). The medical receptionists used terminals to access the IDX scheduling system.

We deployed NetReach workstations in the three consultation rooms, at the two nursing stations and in the clinical practice manager's office. Since the medical receptionists access the hospital result reporting system regularly, we installed workstations in their six cubicles.

Need for Communication

The cardiologists have two to four clinic sessions a week and spend the remainder of their time at their administrative offices, which are located throughout the campus. Not everyone has e-mail access and for those who do, there is no e-mail standard. It was difficult to provide a consistent communication method that included all the physicians and staff. Although voicemail is available, it is used inconsistently. The clinicians maintained unofficial shadow charts for easier access to the cardiology notes, especially when handling phone messages. Without standard technology and processes, it was difficult to help the site overcome the communications challenges associated with the geographic distribution of the group.

Need for Patient Education Material

A nurse clinician at the site maintains cardiac-related patient education materials. She confirmed the need for customized patient education materials. We worked with them to evaluate patient education software, but the general material did not meet their specialty areas needs. The clinicians felt the information was too basic and geared more for the internal medicine patient.

Need for Access to Hospital Results

Initially this site had one terminal to access the hospital results reporting system. The medical receptionists give patients normal lab results over the phone. Prior to deployment of the integrated workstations, the medical receptionist would take a message noting the patient's lab-result request, walk over to the terminal to access the hospital's PRIMES system, pull up the test result and print it. If the result was normal, the receptionist would then call the patient back with the result (the physicians inform patients of abnormal lab results). With access to PRIMES from the workstation we installed in their cubicle, the medical receptionists were able to handle patient requests for results in one step with the patient on the phone.

While the NetReach PC provided integrated access to existing electronic interfaced patient information, we were unable to create interfaces for systems not currently interfaced with the hospital result reporting system. For example, the MUSE system is proprietary software that requires its own dedicated workstation, and does not support interfaces to other systems. Each cardiac diagnostic testing area has its own manual or electronic result reporting system that is not interfaced with the hospital results reporting system. Echocardiogram results are logged manually on index cards. If the index card gets lost there is no record of the echocardiogram.

Summary and Future Directions

Some of the physicians used the office productivity tools to develop patient tracking databases (e.g., adult congenital heart clinic, cardiac pregnancy clinic). Additionally, the clinicians frequently access the Internet for current cardiology information. At the conclusion of the project the physicians voiced their frustration with the lack of automation/integration of existing systems and the absence of a campus-wide e-mail standard. Unfortunately, the lack of integrated information, whose solution was beyond the scope and resources of this project, remains problematic.

Northwestern Internists, Ltd.

Initial State of Automation and Workstations Deployed

Before the NetReach project, the people at this site accessed their scheduling system using terminals in common areas and their offices. We initially deployed seven NetReach workstations locating two PCs in the common areas and the remaining five PCs went in physicians' offices. Two physicians occupy an office and the computers are shared by using a Lazy Susan between their desks. The response to the NetReach computers was extremely positive to the point that they chose to add, at their own expense, additional PCs. Though the PCs were a scaled down version of our integrated workstation, they would increase accessibility to the applications for all health care team members.

Need for Access to Patient Information

This site used voicemail extensively. Patients, staff and vendors leave messages directly into a physician's voicemail. The physician is responsible for returning the call or forwarding the message to a nurse for follow-up. While retrieving voicemails, the physicians rely on the computers to obtain patient data (e.g. demographics, appointments, and lab results) or enter data (e.g. referrals). The availability and location of the computers for phone communications is often critical.

Need for Timely Information Distribution

Using the NetReach workstations, the physician liaison developed an Intranet site for their office. He felt an Intranet would provide easy access to items routinely published, e.g., on-call schedules, cost schedules, office policies and procedures. The Intranet would also provide easy pointers to frequently accessed sites, such as knowledge-based resources and patient education materials. Throughout the office, the Intranet quickly became a very useful tool for all physicians and use of it has been integrated into their daily routine.

Summary and Future Directions

During the course of the project, the site went through a number of dramatic changes, including a major office renovation project, replacement of their office management system with Medical Manager, addition of four more physicians and a practice growth of over 40%. Adapting to the use of a CPR was simply not a priority for them. Today they rely heavily on use of computers and have completed deployment of PCs throughout the entire office.

680 Lake Shore Drive

Initial State of Automation and Workstations Deployed

This primary care private practice started out with the least amount of automation in comparison with the other project sites. Two of the five physicians had personal computers that were connected to the university network, while the office manager and billing clerks access the billing system via terminals. The office was not networked nor connected to the hospital computer network. A terminal in a common area provided access to PRIMES via a direct line. The receptionists used a manual appointment system and accessed the billing system for patient demographic data as needed. Limited by space considerations, we deployed only two NetReach workstations at this office.

Need for Access to Hospital Results

The physicians regularly access PRIMES for hospital laboratory-test and radiology results.

Need for Communication

The physicians received MSMail accounts as part of the integrated workstations. Two of the physicians already had Eudora accounts through the university so they had to deal with two mail systems. One of the physicians is on the Hospital Board and relies on MSMail for all administrative communication.

Need for Patient Education Materials

The physicians identified the need for customizable patient education materials. This site participated in the patient education software pilot. While some of the physicians liked the software content, document retrieval (having to leave the exam room, pull up the material and wait to print it out) did not fit in well with their exam flow.

Need for On-line References

The physicians took advantage of Internet access and set up clinically related bookmarks for quick reference (e.g., Physician's Desk Reference, American Diabetic Association). The CDC Travel Immunization website provided immunization requirements quickly and eliminated the many phone calls previously used to obtain current information.

Summary and Future Direction

During the course of the project the office staff began using MS Office productivity tools. The physicians and staff credit the NetReach project as being a catalyst for adopting information tools in their practice. At the conclusion of the project the clinic was moving ahead to network the office, upgrade the billing system and implement a Windows-based scheduling system. They believe the introduction of the NetReach workstations reduced receptionists' computer fears and will make the upcoming application training easier.

Neurology

Initial State of Automation and Workstation Deployment

Before deployment of the NetReach workstations at Neurology, the clinic used terminals to access their IDX scheduling system and PRIMES. There were a few standalone PCs available.

We deployed 11 networked PCs in areas close to the exam rooms. Because of the size of the rooms, we could not put them in the exam rooms.

Need for Communication

One of the biggest issues at neurology was communication because most of the clinicians spent only part time in the clinic and all but two have their administrative offices located elsewhere on campus. Consequently, one of our biggest contributions to this site was to implement e-mail for all the staff. The clinic has found e-mail to be a valuable tool. The triage nurses use it to communicate with the physicians on non-urgent patient care issues. Some physicians and clinicians also communicate with their patients via e-mail. This has become very efficient for some patient communications where the patient is part of a research study and requires fairly frequent support and information.

Need for Patient Education

The clinicians expressed an interest in having patient education materials on-line. At that time, they were using many patient education pamphlets and videos, but wanted to evaluate on-line products. The products were included in a trial of patient education software. However, the clinicians found that the software wasn't specific enough for their use. Further, it required too many steps to be able to print out the material needed.

Need for Neurological Testing Center Results

One of the biggest needs that the clinicians identified was on-line access to results from the NTC, where most of their diagnostic tests were read. We explored the possibility of accessing the results from the NetReach integrated workstations, but found it was not possible due to infrastructure incompatibilities.

Need for Access to Current Research

The clinicians had a need for up-to-date research information, such as what research studies were in progress, what were the inclusion criteria, and how could they get their patients registered for certain studies. The Internet was able to provide them with most of the information needed to enroll their patients in appropriate research. Along the same lines, using the Internet gave the clinicians access to research studies and contacts to peers in the field of neurological research.

Need for Educational and Diagnostic Resources

Once we gave the neurology clinicians the tool to create their own resources, they moved forward in an impressive manner. Below is a letter from the Chairman of the Neurology Department about how he used the NetReach workstation placed in the Neurology department of the hospital.

I have been pleased with the responsiveness of the NetReach Project to our Neurology practice needs. I have been active in developing computer processes both within the Department, as well as for our major national society, the [American Academy of Neurology](). We started by developing the Stroke Toolbox. You'll find this at http://www.aan.com/stroketools/home.html and it was developed using NetReach Project resources. It's designed to give Neurologists practical items in their clinical venues. Take, for instance the rt-PA protocol (link to http://www.aan.com/stroketools/tpa.html) You'll see that this has an initial assessment tool, the patient education materials (some yet to be developed), then lab profiles needed, and -- for qualified patients --a calculator for the drug dose and (soon) standard orders. Everything in one package! This, by the way, is accessible in our ER and on the Neurology ward (4 Passavant)… Personally, I believe that such one-stop web sites will be standard fare in the near future. We're managing the only one available for stroke & have opportunities to expand this into other areas.

I've also set up some clinical calculators for pharmacokinetics, etc. and a site to quickly locate genetic tests. This is at http://www.flash.net/~dstumpf/clinical/home.html I'm using a non-Northwestern site for this because it runs cgi- and perl-scripts requiring cgi-bin file access which we do not have readily available. But I use these in clinical settings using NetReach computer systems.

We are now developing a Resident tracking package. This is password protected & not completely "done" yet. The use of databases on-line represents an important new direction to the web. We should try to develop cgi/perl script capabilities in house so that we can use such systems for resident tracking, patient sign-out rounds, etc.

The neurology department chairman uses a multitude of medical websites as well as the tools he created. He finished his note by saying, " I enjoy the systems we have established & they clearly have changed the way I do business."

Summary and Future Directions

Overall, the environment of this site provided some challenges in trying to address needs. While we were not able to bring them their diagnostic results on-line, we were able to provide them with tools to improve their work flows and to impact patient care. In the future, additional efforts should be made to complete the process of bringing Neurological Testing Center results to the clinic where patient care is delivered.

DAVIES AWARD

We were named a 1998 recipient of the Nicholas E. Davies Award for Excellence in Computer-based Patient Record Implementation by the Computer-based Patient Record Institute. CPRI established the Nicholas E. Davies Recognition Program in 1994 to promote the dissemination of best practices in CPR implementation with an emphasis on evaluation of CPR systems. The award program, modeled after the Baldrige Award Program for Quality, evaluates the entire CPR project from strategy and management through implementation and demonstrated impact. The application was composed of responses in four categories: management, functionality, technology, and impact. The review process included a site visit to speak with organizational executives, project management, and end users. Out of 12 national applicants, four were selected for a site visit, and two organizations were subsequently awarded the Davies Award. We presented our project at the Davies Symposium held on July 9-10, 1998 in Washington, D.C.[27]

SUMMARY

Motivated by a commitment to create a clinical information infrastructure for a new facility integrating ambulatory care and acute care, Northwestern Memorial Hospital undertook a research project to understand clinicians' information needs, define and implement a clinical system to address those needs, and evaluate the clinical and operational impact of the system in the practice environment. We began our project with a vision to provide clinicians with integrated access to patient information anywhere and anytime they need it in support of patient care, management, and research. After a comprehensive assessment of users' information needs in situ across seven diverse ambulatory-care sites, we found five common high-level needs: 1) need for integrated access to patient information, 2) need for ready access to summary information (e.g., problem list, medications, demographics), 3) need for timely and efficient communication among health-care team members, 4) need for effective means of providing patient instructions and education, and 5) need for convenient access to computer workstations with good training and support.

We concluded that a computer-based patient record system was the underlying technology required to address the needs of the practices studied. With the resources available, we chose to establish a networked information environment for all the project sites and to implement a complete computer-based patient record in two sites. We developed an implementation process to address the cultural and organizational changes needed to implement information technology in the practice sites. Our implementation team consisted of a clinical consultant team, which formed the front-line liaison with the clinician users, and a technical team, which installed and deployed the technology. With an emerging technology such as CPR, continual development and training are necessary to maximize the value of the investment in data. Robust network infrastructure, strong security mechanisms, high-level customer support, and remote-access capabilities are essential technical requirements for routine use of CPRs.

The ultimate measure of a CPR is its return on information. Whether in support of individual patient care or population health improvement, a CPR system provides an accessible repository of clinical data and management information tools. We studied (and continue to study) the impact of using a CPR in a controlled environment with approximately half of the clinicians using a CPR and the remainder using traditional paper records. We found that clinicians using a CPR provide better documentation of their patient encounters, have quicker access to relevant patient information, adhere better to clinical guidelines, and make more appropriate clinical decisions than the control group in our study. Communication among the members of the health care team is improved and communication with patients electronically has also taken place. Patients can benefit directly from a CPR that automatically prints a summary of the encounter with relevant patient instructions and educational material. We were also able to analyze populations of patients and their treatment regimens to identify patients for enrollment in disease management programs.

In summary, providers using a CPR felt they were able to manage patient records better, improve patients' clinical outcomes, and practice more cost-effectively. A computer-based patient record is essential to providing continuously improving quality health care to the population we serve. Above all, it satisfies the mission of our health system: to be an academic medical center where the patient comes first.

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Attachment A

Time Allocation Observation Study: Methodology and Rules of the Road

Methodology

- Enter date and time of observation, in addition to the observers name and the subject code for the observee, at the top of the form
- Using a timepiece that shows changes in seconds, record the activity that is occurring at HH:MM:00 seconds on the minute. For example, at 1:00:00, check off the activity that is taking place at that instant. At 1:01:00, check off the activity-taking place at that instant, etc. This is known as simple random sampling: sampling every n^{th} timeframe. In our case, that timeframe is every minute. Since time is a continuous variable, we need to be as precise as possible about sampling every n^{th} timeframe to ensure a random sampling.

Rules of the Road

Patient Encounter - Using the blank boxes on the *Patient Encounter* line, indicate the start and stop time of each patient visit. Denote each separate patient by a different letter of the alphabet (i.e., "A----------AB----BA--A C---C"). This notation will discern those activities that occur during the patient encounter versus those that occur during downtime or in between appointments. If the physician leaves the room, denote an x for outside the exam room vs the letter with the patient.

The following events occur within the context of a patient encounter –office visit, telephone, letter, or other means.

Reading Patient Chart – Can occur during or between patient encounters, therefore, it is important that observer indicates the start and stop times of the patient visit.

Reading Electronic Patient Chart - Can occur during or between patient encounters, therefore, it is important that observer indicates the start and stop times of the patient visit.

Talking (Patient/Clinician exchange) - Related to clinician obtaining data/information from the patient and/or significant other, as well as general banter between the clinician and the patient. (Does not include patient education - it has its own category below)

Writing in Patient Chart - Any documentation in the patient's *paper* chart including problem lists, medication lists, progress notes, etc. (does not include prescriptions or referral notes—Document these as "Healthcare Team Communication")

Typing in Electronic Pt Chart (problems, progress notes) - Any documentation in the patient chart including problem lists, medication lists, progress notes, etc. (does not include prescriptions or referral notes—Document these as "Healthcare Team Communication").

Performing Patient Exam - The actual provision of patient care by a clinician to patient (includes washing hands, leaving the room to get a gown, etc.)

Giving Patient Education/Instructions - The actual sharing of information by a clinician with a patient and/or significant other for the purpose of educating and/or instructing (Searching for educational materials would be classified under "Administrative-Other"). This would include the review of information, such as the After Visit Summary.

Follow-Up With Patient - Phones calls or other communication with patients following their visit (test result notification, other follow-up)

Electronic follow-up with Patient - Includes other communication with patients following their visit (test result notification, other follow-up, emails, letters).

Clinical Procedure – Performs procedure (i.e., Pap smear; flex-sig., etc.) Observer may not be in the room at the time. But the primary focus for the period is the procedure.

Voice Mail – Listens to patient voicemail messages.

Collecting Other Information

Computer: Clinical - Related to the use of PRIMES and/or other computer terminals to obtain laboratory results.

Paper Reference Materials – Reading or obtaining information from PDR, journals, textbooks, etc. This includes searching for documents in their patient education drawer.

Electronic Reference Material – Use of electronic reference materials including the Internet, PDR, journals, textbooks, etc.

Clinical Communication-Clinical/Patient Care-Related

Talking - Talking with any member of the healthcare team staff (clinical or administrative in job title), but discussing clinical/patient care-related subjects. Includes talking on the phone.

Reading - Reading letters/memos that are clinical/patient care-related (test results/other information that comes back on paper). *Excludes* reading the chart, which should be categorized as "Reading chart".

Electronic Reading - Reading letters/memos that are clinical/patient care-related (test results/other information, Inbasket, etc). *Excludes* reading the chart, which should be categorized as "Reading Chart". Indicate where the electronic reading occurs - E, P, M, etc.

Writing - Writing to another member of the healthcare team (other physicians--referrals, or pharmacists--prescriptions) but related to patient care.

Typing Electronic – Using the computer to write to another member of the healthcare team (other physicians--referrals, or pharmacists--prescriptions) but related to patient care. Indicate means of communication - E, P, M, etc.

Other – Used to categorize transporting of data.

Data entry - Computer-based data entry.

Dictation – Telephone or hand-held dictation services.

Administrative Communication-Administrative-Related

Talking - Talking with any member of the healthcare team staff (clinical or administrative in job title), but discussing administrative-related subjects.

Reading - Reading the patient schedule (paper) or letters/memos that are administrative-related.

Electronic Reading - Reading the patient schedule or letters/memos that are administrative-related (i.e, IDX, or

Patient Demographics in EpicCare). Denote where the reading occurs – E, M, I, etc.

Writing - Writing to another member of the healthcare team but must be administrative-related. (i.e., Disability forms, Workers' Compensation forms, vouchers/orders, etc.).

Electronic Writing – Typing to another member of the healthcare team but is administrative-related. (i.e. Disability forms, Workers' Compensation forms, vouchers/orders, LOS, etc.).

Other - Miscellaneous administrative activities (i.e. transporting data).

Other Activities – If you really don't know the content

Reading Mail - To be used when type of mail cannot be discerned. (Reading clinical mail should be under "Healthcare Team Communication-Reading," and administrative mail should be under "Administrative-Reading".)

Reading Electronic Mail- To be used when type of mail cannot be discerned. (Reading clinical mail should be under "Healthcare Team Communication-Reading," and administrative mail should be under "Administrative-Reading".)

Personal - Making or taking personal phone calls (as can best be discerned), going to the restroom, food breaks or idle conversation

Idle - Doing nothing clinical or administrative in nature (standing around, walking back after depositing a patient at check-out, handling patient consent for this study, waiting for print-outs , etc.,)

Unable to Observe – Used to categorize time allocation minutes when the subject cannot be observed. For example, certain aspects of the physical examination or when the patient/subject request the observer leave the observation area.