



## **Nicholas E. Davies Award of Excellence**

# Transforming Healthcare with a Patient-Centric Electronic Health Record System

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# Introduction

Evanston Northwestern Healthcare (ENH) is the first integrated healthcare system to put a totally electronic medical record system into an acute care setting with three hospitals as well as 68 office locations. The significance of this state-of-the-art system — now in use by 100 percent of all physicians, nurses and other medical professionals at ENH — is that all patient-related documentation and orders are now paperless throughout the organization. All practitioners work from a single, integrated source of clinical information that is secure, current, legible, organized and instantly accessible in all ENH locations.

The foundation for the electronic health record (EHR) was laid by the technology vendor, Epic Systems. Upon this framework, ENH and Epic built a system that incorporated the knowledge and skills of ENH clinicians. Numerous changes were required to create an entirely paperless environment. New products that were being developed for the Emergency Department and Pharmacy needed to be incorporated into the final system.

The collaboration between ENH and Epic made this more than a technology project. We required a dynamic system that had the flexibility and capability to help caregivers practice better medicine. The end result is a revolution in medical care, and Evanston Northwestern Healthcare is proud to play a leadership role in this revolution.



A nurse in Evanston Hospital's Infant Special Care Unit can update a chart without leaving her little patient's side.



Evanston Hospital 420 beds



Glenbrook Hospital 136 beds



Highland Park Hospital 240 beds



68 Medical Group locations

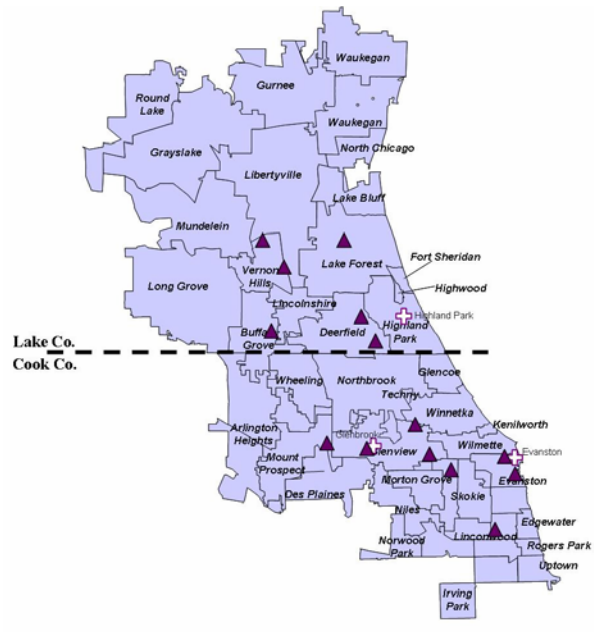
# Management

## 1. EHR System Planning

ENH laid the foundation for the success of its electronic health record (EHR) by making it part of the organization’s overall strategic objectives and by making it the number one goal for the corporation for three years.

### Overview of the Organization and Its Strategic Objectives

Evanston Northwestern Healthcare owns and operates three hospitals with nearly 800 beds — Evanston Hospital, Glenbrook Hospital and Highland Park Hospital. ENH also employs some 500 physicians in a faculty group practice (284 of whom are community-based) and has a professional staff of more than 1600 physicians who admit patients to the three hospitals. ENH is a teaching institution, affiliated with Northwestern University’s Feinberg School of Medicine. For nine of the past 10 years the hospitals of Evanston Northwestern Healthcare have been named among the nation’s 100 Top Hospitals and 15 Top Teaching Hospitals by Solucient, a leading provider of strategic healthcare information.



<u>Facility</u>	<u>EHR Usage</u>
<b>✚ Hospitals</b>	
1,600 physicians	100%
1,300 nurses	100%
All other caregivers and support staff	100%
<b>▲ ENH Medical Group Locations</b>	
284 community-based physicians	100%
All support staff	100%

A primary focus of ENH is to continuously improve the health of the community it serves and to use resources cost-effectively. As part of its 1996-2001 strategic plan, ENH set as its primary strategic objective to be the best integrated healthcare delivery system in its region — in simpler terms, the best place to receive care. Any patient using the organization’s services should be able to move from the physician’s office, to a hospital service, to an ambulatory service and receive the same high quality of care at every facility because physicians would have access to complete, accurate and up-to-date patient information. Certainly information technology would play a critical role in achieving integration.

ENH’s willingness to adopt and embrace information technology began more than two decades ago. Initially, clinical information systems focused on laboratory, unit clerk ordering and billing. The information systems (IS) team also developed a set of order screens that allowed physicians to enter medications. This offered the advantages of drug-to-drug interaction alerts at the time of ordering, order legibility and order speed to the pharmacy and to the patient. The screens fed directly into the pharmacy system. Although not required, many physicians at Glenbrook and at Evanston did use the system.

However, because the system required the physicians to go to the paper chart to place all non-medication orders, the system lost support over time. After a year of use, ENH dropped the physician order entry part of the pharmacy system.

Undeterred and taking lessons learned from the project, the IS group and the organization's Medical Informatics Committee began to work with the organization's existing software vendors toward an integrated computer system in 1996. (The Medical Informatics Committee is a free-standing committee of physicians and clinicians, led by Arnold Wagner, Jr, MD, that meets monthly to provide advice to the IS group on a wide range of technology issues.) By 2000, this included electronic nursing notes, patient vitals, a consolidated results repository and an electronic patient chart after discharge, as well as a complete picture archiving and communications (PACS) system and a teleradiology system. This was still a long way from a true electronic health record.

### ***EHR Project Vision and Goals***

In 2001, ENH's chief executive officer, Mark Neaman, working with the Board, established as the organization's number one priority the implementation of a paperless, patient-centric electronic health record (EHR) with true computerized physician order entry (CPOE) that would cover the three hospitals and 68 office locations. This one project had the potential to impact all five of the organization's strategic objectives:

- Best possible care and clinical outcomes for patients
- Patient safety
- Patient satisfaction
- Retention of talented staff
- Sound financial performance

Hospital leadership reinforced the importance of this project through corporate publications and at corporate Board meetings, department head meetings, the CEO's twice-a-year State of the Union addresses, quarterly professional staff meetings, unit staff meetings, and new employee orientation.

The vision for the new paperless system included the requirement that every physician and every clinician would use the system. Only with adoption at 100 percent would the system project meet its goals:

- Improve **patient safety** by eliminating problems associated with illegible orders and medication errors
- Ensure that physicians, clinicians and administrators have **access** to the right patient data at the right time
- Ensure the **accuracy** of the information and coded data in the record
- Simplify **processes** and make them consistent across the organization

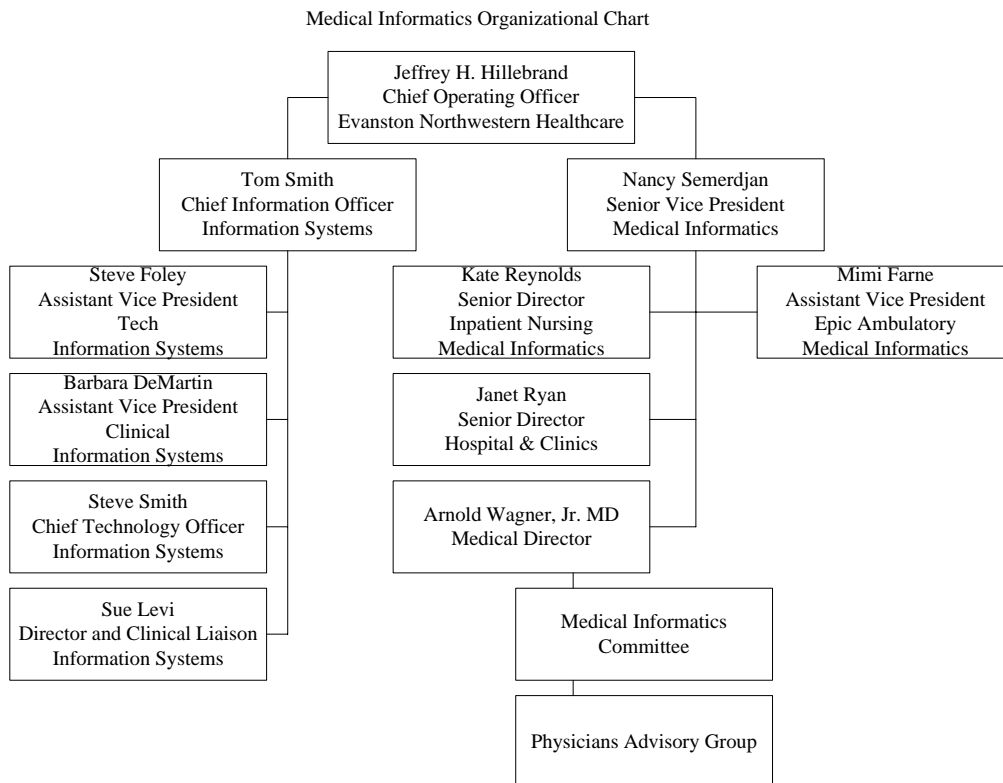
### ***EHR Project Leadership, Governance and User Involvement***

The project steering committee included ENH's top leadership: CEO, COO, CFO, CIO, Sr. Vice President of Medical Informatics, President of Hospitals and Clinics, President of the ENH Medical Group and the chairman of two key physician groups. The steering committee set the objectives for the project, monitored progress toward those objectives and resolved conflicts and shortages of resources. The COO, Jeffrey Hillebrand, chaired the steering committee's semi-monthly meetings, oversaw the development and implementation of the project, and held responsibility for the project outcomes.

ENH formed a Medical Informatics department, led by Senior Vice President of Medical Informatics, Nancy Semerdjian. This department would be dedicated to day-to-day management and accountability for the project. Her department led the project as a clinical project, rather than an IT project. They served as the link between the operations end-users and the IS department. To this day, Medical Informatics is

dedicated to supporting the new system, overseeing upgrades, leveraging new functionality, and working with operations to adjust and enhance workflow processes as needed.

The chairman of the two key physician groups, Dr. Arnold Wagner, a project champion from the beginning of the planning process, involved and represented the physicians in shaping the tool set within the EHR/CPOE system. The Physicians Advisory Group, dedicated to providing guidance on his new system, worked to identify and manage resistance to the project before it escalated. This group continues to meet weekly to address issues and recommend enhancements to the EHR. The second group, the Medical Informatics Committee, provides guidance to the IS department on all technology-related issues.



### ***Guiding the Investment and Justifying the Decision***

In March 2001, ENH made the decision to launch the project and began considering vendors to provide the technology for an EHR/CPOE system. This included the organization’s then major software vendor, McKesson, and two additional software vendors, Cerner and Epic.

At this point, the plan was to implement the new system in the three ENH hospitals. Physicians who had reviewed Epic software as part of a separate project to update office documentation, recommended that ENH expand the scope of the project beyond the hospital to include all ENH facilities. This would bring to life the CEO’s vision of a single integrated patient-centric EHR and eliminate all paper records throughout the organization. In May 2001, the decision was made to implement a system that covered hospitals and offices with a single patient-centric database.

The vendor review revealed that the vendors either did not have the level of integration that ENH envisioned or they had the potential but had not yet implemented a solution at any other healthcare organization. In June 2001, ENH selected Epic as the vendor that came closest to delivering on the ENH vision. Epic had the software needed to build the system, but ENH would be the first customer to implement a suite of Epic applications in a paperless environment across an integrated delivery system.

The following reasons also contributed to the decision to select Epic:

- Epic’s past success with physicians, in particular because the change would affect physicians the most
- Epic’s overall product quality, as evidenced by having been selected as the top vendor three years in a row by KLAS
- Confidence in the senior management of Epic
- Epic’s strength in physician-related processes and physician preference for Epic

The steering committee built the financial case for the decision based on projected savings in four areas:

- Billing — lower receivables and staffing efficiencies
- Diagnoses — greater coding accuracy
- Medication — fewer medication errors
- Scheduling — centralized scheduling

Capital and operational dollars from fiscal year 2001 through 2004 were \$35 million and returns are projected to be \$60 million over five years. In July 2001, the ENH Board of Directors accepted the proposal from senior management and approved a \$25 million capital spend for the hardware, software and other resources needed to complete the project. For the 2003-2004 operational budget, they approved additional IS positions to continue the install and to support the system in the future, as well as funding for ongoing software and hardware maintenance costs.

In August 2001, ENH contracted with Epic to deliver software to support seven operational areas:

- Registration — *Prelude*
- Scheduling — *Cadence*
- Physician billing — *Resolute*
- Inpatient and outpatient clinical documentation and orders — *EpicCare Inpatient*
- Ambulatory (offsite) clinical documentation and orders — *EpicCare Ambulatory*
- Pharmacy — *EpicRx*
- Emergency Department — *EpicCare ED*

Several Epic applications had been implemented at other healthcare organizations, which helped to mitigate the technology risks of implementation at ENH somewhat. However, ENH would be the first organization to implement EpicCare for a true paperless EHR system with total CPOE; the first to implement EpicRx and EpicCare ED, which were not yet built at the time; and the first to fully integrate all applications into a seamless system.

Concern for the risks involved in the project, and strategies to mitigate those risks, were part of every meeting from the start of the project. The steering committee addressed global risks as part of the ROI analysis. The IS group identified and managed the technology risks inherent in the project. However, this project was a clinical and operational project, not an IS project. Team leaders from each of the seven operational areas met as often as two or three times a week with their own staff to shape the system. These planning meetings uncovered multiple issues. When necessary, team leaders escalated the issues to the steering committee for resolution. Team leaders also met with each other as often as two or three times a week to ensure the interoperability between departments.

The degree of physician acceptance also put ENH at risk. The hospitals have many physicians who admit almost exclusively to an ENH hospital, but nearly a third of the physicians are “splitters,” admitting patients to other hospitals that compete with ENH. ENH viewed the defection of this group as the most significant risk of the project. With an onerous system, the hospitals could lose these important admitters and suffer a major revenue loss. Yet ENH remained firmly committed to making the system mandatory among all physicians, and chose to deeply involve physicians in the design of the system and over-deliver on training.

## 2. Implementation

ENH believed that rapid implementation created the greatest potential to reduce the number of patient care errors and improve the quality of care. As such, the organization chose a no-pilot, all-at-once approach to provide an integrated system as quickly as possible. Leadership believed that results within a hospital would not be realized until the implementation and integration from patient admission through discharge was completed within that hospital. The goal was to get to one set of data as quickly as possible and to reduce the risks inherent with dual systems.

At the start of the project, ENH made an important logistical decision for the inpatient roll-out. The clinical applications — emergency department, clinical documentation, CPOE, and pharmacy — would all go live on the same day for a given hospital. In the ambulatory roll-out, the physician offices would go live with scheduling, billing, ordering, clinical documentation and CPOE on the day of go-live.

However, as described in detail later in this document, ENH revised that strategy and implemented the system in two major phases for hospitals: 1) documentation and then 2) order entry. For the physician offices, 1) administrative functions and then 2) clinical. The hospital selected for the first implementation was Glenbrook Hospital because it was the smallest and most flexible in terms of culture.

### **Implementation Planning and Governance**

Planning for the implementation ran on two parallel tracks. The first track was the hardware and technical track, which focused on selecting hardware for mobile devices in the clinical areas, identifying network and wireless changes, and setting up the central computer room or command centers. More detail on this is provided in the Technology section.

The second track focused on redesigning workflows and then building and installing the software to support these new workflows. Early on, the steering committee knew that to succeed, most if not all workflow processes would need to be examined and redesigned. Existing processes were too inconsistent and convoluted to have an electronic system dropped on top of them. Hillebrand and Semerdjian assigned a team leader to each of the seven different operational areas involved, as well as a team led by IS and a training team led by Jane Dowd, the Chief Learning Officer. In selecting team leaders, Hillebrand and Semerdjian selected individuals who had clinical experience, who had process redesign and performance improvement experience, and who had the trust of the operations staff. This team would be responsible for the detailed planning and preparation for the implementation.

### **Implementation Preparation**

To *implement* a consistent set of processes for managing clinical information, ENH first had to *develop* a consistent set of processes. The steering committee and team leaders knew that while quality of care was excellent, variability in the delivery of that care varied greatly from facility to facility, floor to floor, shift to shift, and clinician to clinician.

Throughout the implementation process, ENH worked with the vendor, Epic Systems, to enhance the applications to meet ENH’s needs. Through this collaboration, Epic Systems interpreted the knowledge and skills of ENH clinicians to build a system with the flexibility to function for the variety of processes within an acute care setting. Epic recognized these changes as needed for a system that would function in an acute care setting, and built them into its applications. ENH kicked off the project in September 2001.

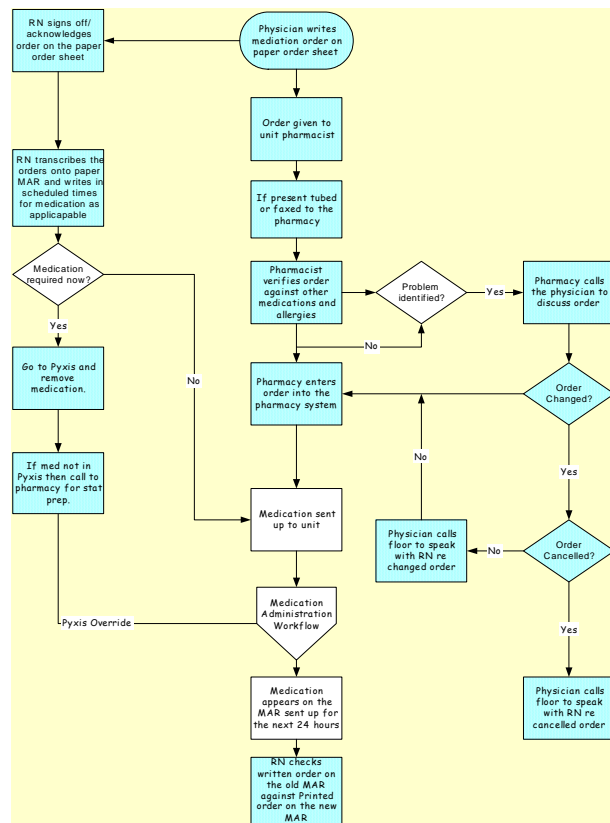
To prepare for what was to be the most challenging part of the entire project, team leaders, and key physician leaders participated in a training class on the capabilities of the new software. With this understanding, team leaders began to redesign workflows throughout the three hospitals. For three months, they led more than 150 end-users through a complete analysis of the patients and information

flow throughout their areas and the organization. This analysis touched every workflow, and revealed redundancies, workarounds, and hand-offs that significantly slowed the flow of patients and information and created numerable opportunities for error. With this insight into current processes, the team leaders then worked intensively with end-users to redesign the flow of information and create integrated workflows. The result was 500 integrated high level workflows that provide for consistency in managing clinical information across the organization. (See Appendix A) These 500 eventually developed into 2,000 detailed workflows.

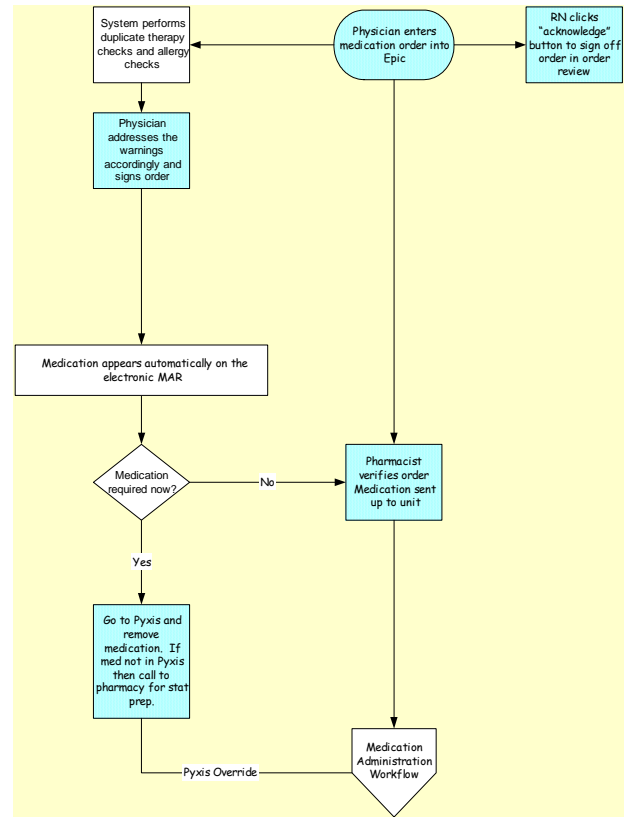
The high level workflows laid the foundation for the simultaneous development of:

- Deeper, more detailed department and unit workflows (see below)
- Policies and procedures to support the new workflows
- Training materials
- System planning and build
- Communications for change management

*Sample workflow process: medication administration*  
Before redesign



After redesign



As teams proceeded with the redesign of deeper workflows, they simultaneously gathered all paper documentation tools and order sets. Working with clinicians, the teams also analyzed and classified the data elements that were collected and reviewed. This enabled a complete redesign of the clinical information gathering by units. They then worked with IS to build the documentation in the Epic system so that users would enter data into the system only once. From there, it could be shared, retrieved and reused by any clinician in the care and outcomes management of the patient across the continuum of care. A sample of a flowsheet is shown below.

Sample flowsheet

Activities	Doc. Flowsheet										
Snapshot	Flowsheet: OB LD LABOR SINGLE ... Labor Singleton OB LD Admission Flowsht										
Patient Summary	Values taken by: REYNOLDS, KA ... Add Row Add Col Refresh Graph Legend Compact										
Chart Review		1830	1848	1910	1950	2020	2050	2120	2140	22	
Results Review	VITAL SIGNS	Temperature(F)	98.2		97.9						
Problem List		Temperature Site	ORAL		ORAL						
History		Heart Rate	78		76		88				
Notes		Respiratory Rate	18		18		22				
Demographics		BP	116/70		110/44		108/61				128/70
Medications		Cardiac Rhythm									
Allergies		Pulse Ox O2									
Order Entry		O2 Delivery Device									
Order Review		O2 Liter Flow									
Imms/Injections		O2 %									
MAR	Bedside Blood Glucose										
Intake/Output	DTRs										
Doc. Flowsheet	Clonus										
Initial Assessments	Hand Grasps										
Care Plan	Breath Sounds										
Patient Education	FETAL ASSESSMENT A	Mode	EXTERN..	EXTERN..	EXTERN..	EXTERN..	EXTERN..	EXTERN..	EXTERN..	EXTERN..	
D/C Instructions		FHR Baseline	130-140	130-140	130-140	125-130	125-135	130-140			
Standing Orders		LTV	AVERAG..	AVERAG..	AVERAG..	DECREA..	AVERAG..	AVERAG..			
ED Navigator		STV				ACCELE..	ACCELE..				
	UTERINE ACTIVITY	Pattern									
		Mode	EXTERN..	EXTERN..	EXTERN..	EXTERN..	EXTERN..	EXTERN..			
		Frequency	2.5-3	2.5-3	1.5-3.5	1.5-4.5	2-3.5	1.5-3.5			
		Duration	60-80	60-80	50-80	50-80	50-80	50-80			
	IV INFUSIONS	Quality									
		IUPC									
		Resting Tone									
		Pitocin mU/min		12	14mu						
	PAIN	MgSO4 gm/hr									
		Insulin u/hr									
		D10W cc/hr									
		Pain Relief Plan									
	PAIN	Relief									
		Pain Location				BACK/AB..	BACK/AB..				
		Pain Intensity	0		0		2	3			
		Tolerance	TOLERA..		TOLERA..		TOLERA..	TOLERA..			

Simultaneously, physicians began standardizing physician documentation and order sets. They built templates to enable electronic documentation by physicians and established standards for order entry build. An indication of the success of these templates is the fact that many physicians have discontinued the practice of dictating notes and results, and now enter them directly into the electronic health record. Similarly, the standard order sets developed for physicians practicing the same specialty provide a consistent quality of care. The physicians developed more than 1,000 order sets, which are widely used across the organization.

For the 68 office practice sites, the ambulatory team developed a basic set of workflows to serve as a model for all sites. The standardized workflows assured that each office performed critical workflows in the same efficient manner, while allowing for the unique set of physicians, specialties, personnel mix, and physical characteristics at each location and practice. Organization-wide registration conventions ensured that equivalent information was collected and entered into the system in the identical way from largest site to smallest outlying office. This helped to establish basic routines from co-pay collection and payment posting to scheduling patients or taking phone messages from patients. Skeleton processes were formulated to standardize clinical workflow while leaving ample room for individualized patient care.

**Implementation Process and Staffing**

The more technical components of the implementation process began in the fall of 2002, following completion of the initial workflow analyses. It required the conversion of the legacy patient demographics database from Medipac and the conversion of the clinical data repository (HNS). Cadence scheduling then replaced the organization’s legacy Patient Appointment Scheduling system used by the hospital’s outpatient diagnostic and treatment departments.

**HOSPITAL INPATIENT AND OUTPATIENT**

The schedule for the implementation was aggressive but attainable. The original plan for the hospitals was to go live with everything — ED, clinical documentation, CPOE and Pharmacy — on the same day. As

the first hospital go-live date approached, March 15, 2003, the ENH project team realized that the plan for the “big bang” implementation needed modification. The new pharmacy system was ready to be used in the Pharmacy Department but was not yet ready for physician ordering.

The team made a sound decision to use a modified two-phase approach: go live with documentation first and then order entry (CPOE). In the first phase physicians and nurses performed all clinical documentation in the EHR. Ordering remained the same: physician wrote orders on an order sheet and clerical staff entered the orders. Medication orders went to Pharmacy on paper and the pharmacists entered the orders into the EHR. This gave nursing use of the electronic medication administration record (MAR) at the first hospital go-live. Also, many of the hospital outpatient departments began entering their own orders in between the documentation go-live and the CPOE go-live. This helped familiarize the ancillary departments with their own department’s orders and helped identify any order transmittal issues prior to physician usage. The goal was to have physicians get comfortable with the system’s documentation, security procedures, navigation, results and clinical information retrieval, work the “issues” out of the ordering process, and stabilize all equipment and devices before the physicians began CPOE.

At order entry go-live in May, all physicians began entering orders. Medication orders they entered were then automatically routed to pharmacy for verification and dispensing only. Departmental orders either interfaced to or printed to an ancillary system. At this point all paper was removed from the inpatient environment and patient charts as they had once existed were gone.

For each hospital go-live, ENH created a command center with 20 to 30 workstations, a phone at every workstation, one to two laser printers, a scanner, a lab label printer, a copy machine, a fax machine and 20 to 25 walkie talkies. For two weeks from the start of each go-live phase in each hospital, the command center was staffed 24/7 to provide support to end-users and resolve any issues that surfaced.

In addition to the personnel based in the command center, support staff covered every clinical location in the hospital that was open for business. The support staffing levels were determined based upon volume and criticality. Support staff had varying degrees of knowledge and expertise, but all had more knowledge than the end-users during the go-live. They included Epic personnel, consultants, and IS personnel to resolve functionality issues and answer technical questions and trainers and unit-based superusers who had received special training.

## **AMBULATORY**

For each ambulatory offsite location, the implementation schedule included a staggered series of project plans that began four months before a site’s go live and allowed for three to five practices per month. In the first eight months, ENH rolled out all primary care sites, including Internal Medicine, Pediatrics, Obstetrics/Gynecology and Family Medicine. Implementation for the remaining 30 specialties began in the ninth month and continued at the same pace.

The preparation meetings included office management and clinical staff along with team members for registration, scheduling, billing and the clinical system. Information Systems staff managed security, hardware and connectivity strategy. The training team incorporated plans for training, competency testing, and allocating time to spend in the practice environment. As the go-live dates approached, appointment conversion from the older scheduling systems to the new one was completed. The team conducted dress rehearsals to test the planned workflows and hardware from patient check-in through typical office visit scenarios to patient check out.

Typically, the front desk operations went live at the first of the month to allow the staff time to adjust to the new routines. Two weeks later, the clinical staff began using the electronic medical record. The ratio of support staff to clinical users was one to three for a full month. Weekly sessions with the staff hashed through any workflow issues, allowed time for venting frustrations and new training topics as needed.

The rollout across the organization proceeded as follows:

Go-Live Dates	
First of 68 office locations	January 2003
First hospital go-live	March (EHR) and May (CPOE) 2003
Second hospital go-live	July and November 2003
Third hospital go-live	December 2003 and April 2004
Last of 68 office locations	October 2004

The first physician office went live with Cadence, Prelude, Resolute and EpicCare Ambulatory on January 2, 2003. From this point the ambulatory office roll-out and hospital roll-out were concurrent. For a more detailed view of the roll-out, see Appendix B.

The organization’s 68 group practice and medical service offices now have implemented the EHR.

**Transition to New Processes**

Because this was a clinician-owned system, designed and specified by end-users through the process redesign sessions, most were eager to transition to the new processes. The extensive and mandatory training prepared users for the change. Resources on hand at go-live and beyond — superusers, trainers, IS staff, supplemental IS staff consultants and Epic staff — also supported the transition.

The culture of the organization also helped to achieve buy-in and ownership. ENH has a very strong leadership that made it clear they were firm on this decision. The mindset among staff was to achieve the aggressive goals set by management for implementation and success. It was much easier to build enthusiasm for a project everyone was certain would come to pass than for a project that may or may not have moved forward.

For physicians, it helped that they had had previous experience with ENH’s successful transition to electronic X-rays and medical imaging (PACS). This established a foundation of trust in the leadership’s decision and approach to the EHR/CPOE system. It also gave them confidence that the EHR, once installed, would be reliable.

The system itself also aided the transition to the new work processes. Automation of manual processes happened seamlessly without the user needing to intervene. ENH and Epic Systems built Navigators to pull various tools together to support specific workflows. For example, the nursing documentation Navigators provide the electronic version of the old paper admission packet.

**Training, Education, and Support**

ENH made a massive investment in training — the largest to date for ENH and one of the largest in the country for healthcare. The role of the training team was not just to teach the functionality of the software, but also to introduce everyone to the new workflows and radically new ways of performing their jobs. Everyone who touched the health record across the entire organization would be formally trained and their competency verified, which exceeded Epic’s specified standards for system training. Only by demonstrating competency in a given area of the system would a user be granted access to that area of the system. This included physicians, who were required to complete 16 to 24 hours of training and pass the competency test. If they did not complete this requirement, they could not admit to or treat patients in ENH hospitals. The Professional Staff passed a rule to support this.

High level workflows served as the basis for designing the curriculum, initially developed by a group of director-level staff from operations. The curriculum was tested among users before being finalized. From the start of implementation through the end of fiscal 2004, the end result was:

- 9 general subjects, e.g., registration, billing, EHR
- 53 different courses
- 143,724 training hours
- 15,854 training encounters
- 9,554 people trained an average of 16 hours each

The training team that developed and delivered the learning completed a train-the-trainer course and achieved “proficiency” status on the software over an eight-week period. The training team included:

- Chief Learning Officer
- 9 principal trainers, pulled from operations at the director level and responsible for initial curriculum development
- 9 core full-time trainers from the ENH training department
- 40 supplemental trainers from operations
- 1 manager of training logistics
- 6 external consultants who served as trainers
- 400 superusers from all hospitals and medical groups to serve as local resources and training assistants
- 200+ training coordinators prepared to register staff and track competency assessment scores



Clinical chairmen were among the first to be trained so that these physician leaders could champion the system.

Formal classroom training was supplemented with a variety of additional training strategies:

- Superusers, who averaged 32 hours as classroom floaters, plus time as competency assessors back in the departments
- Review sessions
- Validation sessions
- Practice exercises
- On-site support
- Published Learning Resources
- Five different bi-monthly newsletters
- Physician CD-ROM for course review
- Four quick reference guides for go-live
- Online system announcements updated weekly for inpatient users

Training began in September 2002, five months before the first scheduled go live date. ENH trained 9,554 people on the new workflows and the system. To accommodate this volume, ENH converted an unused billing office with 17,000 square feet into a 13-room training center. Four additional training rooms were set up throughout the facilities.

To ensure that the quality of the training and content of the curriculum met the needs of the user, each user was required to complete an evaluation form at the end of the training session they attended. More than 95 percent of the attendees, including physicians, indicated that the training met or exceeded their expectations. Of course, the success of the implementation was the greater testament to the success of the training.

A much scaled-down operation remains in place today to teach new hires, students, and house staff to use the system and to prepare all users for software upgrades and enhancements. The training team is

currently embarking on its second wave of training to reinforce fundamentals and meet the needs of learners who are ready for advanced training.

The training team continues to produce monthly newsletters, each targeting a different audience. These newsletters communicate updates to the system, resolve problem areas or underused features of the system. The training team has also produced a CD ROM for course review, quick reference guides and online weekly updates for all end users. An e-learning project has allowed proctored training via the Internet beginning in June 2004. Superusers continue to provide support in their individual areas, and the training team in turn continues to support the superusers and end users.

ENH’s Chief Learning Officer has created an e-learning collaborative with HospitalU to share content and e-learning infrastructure with other healthcare systems.

### 3. Operations

#### ***Data Management and Security***

The initial development of the high level workflows provided the structure needed to plan the standards for the build of the electronic tools. The project steering committee had also laid out the “Rules of Engagement” to guide the teams toward success, which called for one-time data entry and reiterated the requirement for patient confidentiality:

<b>Rules of Engagement</b>
One-time, error-free, data entry; get it right the first time
Streamline workflows
Always maintain patient safety and confidentiality
Do not vary from the Epic standardized approach
Do what is best for the organization, not what is best for the individual or area
100% commitment from everyone to successful implementation
Maintain common look and feel
Share information across the enterprise
Provide users the appropriate tools, training and ongoing, to maintain maximum productivity, value, and satisfaction
Do not customize source code
Comply with all regulatory and legal requirements, including confidentiality

Custom lists and smart lists were developed to reduce documentation artistry and define standard descriptors for assessments and factual information. Documentation templates allowed the departments to define an acceptable level of note taking. Care plan templates were developed by critical pathway teams who reviewed evidence and standards of care for a particular condition or procedure, are now instantly available wherever that patient may be. Order sets built at the departmental level standardize practices among facilities. The CPOE functionality also serves as the tool that communicates tasks between discipline and departments. This functionality has brought a great deal of clarity to what needs to be done when and is bringing greater efficiency into the patient day. For example, departments can view tests scheduled by other departments and plan their tests to avoid conflicts.

The data capture tools were built for ENH so that the individual providing care enters data into the system once, at the point of care. That is a monumental step in ensuring the accuracy of the data captured within the system. To meet this end, standardized rows within the flowsheet, the primary data capture tool, enable the data to be entered through any type of template and be reviewed in the format appropriate to that user. Standardization of flowsheet rows also enables “smart links” to be built that pull data onto a note.

The system makes extensive use of patient summary reports for reviewing information, such as the Nursing Kardex Transfusion report and the Inpatient Facesheet (see next page).

## Sample Kardex

Inpatient Home
**Thompson, Martha C.**
Workspaces

**Thompson, Martha C\*** Age 55YO MRN 008033292 Allergies **Penicillin** PCP (None) Attending Lerner, D Code Sts FULL ISO CONTAC LOS 178d MyChart No

ENH NURSING KARDEX

Report: ENH NURSING KARDEX ENH NURSING CAREPLAN HOV Snapshot

ENH Nursing Activiti Inpatient Face Sheet Charge Review

ENH LD NURSING KARDEX ENH Transfusion Report ENH ACKNOWLEDGE ORDERS

**Patient has an ADVANCE DIRECTIVE, refer to scanned document**

**High Fall Risk**

**Thompson, Martha C.** (Account#: <0080332924132>) (Encounter#: 19158) (SVO F) EV CCC-2308-01 (Adm: 5/11/04)

Att. Provider: (none) [Add/Edit comment]

Allergies: Penicillin Isolation: DROPLET Code Status: FULL HT: 5' 5" (1.651m) BSA: 1.75 m<sup>2</sup> Admission Cmt: CCU ADMIT  
WT: 67.132 kg (148 lbs)

**Best Practice Alerts**

Display Text	Additional Information	OrderSet
DVT Score is 5 or Higher	(Care Plan template: DVT CPO)	DVT PROPHYLAXIS ORDERS[727]
It has been more than 3 months since the last Hgb A1c, would you like to order another one?	(Base Name HGB A1C not found)	None

**Hospitalization Problems** [Add/Edit comment]

Problem	Noted	Priority	Class
ASTHMA NOS W/O STATUS ASTHMATICUS [493.90]	10/30/2004		
DIABETES UNCOMPL ADULT-TYPE II [250.00]	10/30/2004		
STREPTOCOCCUS UNSPEC PNEUMONIA [482.30]	10/30/2004		

**PATHWAYS** [Add/Edit comment]

ID	Start Date/Time	Description	Order Date/Time
32519138	10/30 0715	Initiate Asthma Critical Care Pathway-ONCE Comments: Initiate Asthma Critical Care Pathway (Care Plan template #12) Web links: Adult Asthma	10/30 0715

**Vitals (last 33 days)**

Date/Time	Temperature(F)	Temperature Site	Heart Rate	Respiratory Rate	BP	Pulse Ox O2	Pulse Ox Room Air	WT	Who
10/30/04 0700	102.2 F (38.9 °C)	ORAL	110	34	98/58 mmHg	94 %	--	67.132 kg (148 lbs)	KSR
10/30/04 0600	102.2 F (38.9 °C)	ORAL	112	32	100/55 mmHg	94 %	--	--	KSR
10/30/04 0500	101.5 F (38.6 °C)	ORAL	109	35	100/60 mmHg	95 %	--	--	KSR

**Blood Glucose (last 33 days)**

Date/Time	Bedside Blood Glucose Result	Who
10/30/04 0700	123	KSR

**Pended Orders All** [Add/Edit comment]

\*\* None \*\*

**Legend for order statuses on Kardex**

**Order Status Definition**

**Sent** The order has been sent from Epic.

**Scheduled** The order is scheduled to be sent from Epic.

**Completed** The order has been resulted or otherwise completed.

**Discontinued** This order has been discontinued.

**Legend for lab statuses on Kardex**

**Lab status Definition**

**In process** The order has been received by the lab and is being processed.

**Preliminary result** The lab has sent preliminary results for this order to Epic.

**Final result** The lab has sent final results for this order to Epic.

**Edited** The order's final result has been edited.

**Diet Orders ( Through Next 24 Hours)** [Add/Edit comment]

ID	Start Date/Time	Description	Order Date/Time
32519137	10/30 0715	Regular Diet- <b>HOW</b> [D,C] Comments: Regular Diet	10/30 0715
32519138	10/30 0715	Encourage Oral Liquids-- [D,C] Comments: Encourage PO fluids 1000ml/shift	10/30 0715

**Lab Orders (Last 12 Hours Through Next 12 Hours)** [Add/Edit comment]

ID	Start Date/Time	Description	Order Date/Time
32519143	10/30 0715	BMG - on admission-ONCE Start Time Order ID Status 10/30 0715 32519143 Sent	10/30 0715
32519144	10/30 0715	CBC w/o Diff - on admission-ONCE Start Time Order ID Status 10/30 0715 32519144 Sent	10/30 0715
P 32519127	Unscheduled	ABG on room air, if indicated - EVANSTON ONLY-MULTIPLE SPECIMENS	10/30 0715

**Radiology (Last 48 Hours Through Next 48 Hours)** [Add/Edit comment]

ID	Start Date/Time	Description	Order Date/Time
32519142	10/30 0715	Chest X-Ray-ONCE	10/30 0715

**IV Orders (Last 48 Hours Through Next 48 Hours)** [Add/Edit comment]

ID	Start Date/Time	Description	Order Date/Time
P 32519145	10/30 0730	ORDER IV THERAPY START IV - IP-ONCE [D,C]	10/30 0727

**Respiratory Therapy** [Add/Edit comment]

ID	Start Date/Time	Description	Order Date/Time
32519140	10/30 0715	Supplemental Oxygen (if hypoxic)-ONCE Comments: Supplemental Oxygen (if hypoxic). Via nasal cannula at 4l/min	10/30 0715
32519141	10/30 0715	Peak Flow-AS SCHEDULED Comments: a day and as needed	10/30 0715

**Admit/Disch/Transfer** [Add/Edit comment]

ID	Start Date/Time	Description	Order Date/Time
32519134	10/30 0715	Admission Order-ADT ORDERS Order Questions: Patient Status: INPATIENT AS INPATIENT Admitting Physician: LERNER, DAVID J Diagnosis: pneumonia	10/30 0715
32519139	10/30 0715	Anticipate Discharge Date-ADT ORDERS Comments: Expected LOS- 3 days	10/30 0715

**Appointments for Next 3 Days** [Add/Edit comment]

None.

**Treatment Team**

PROVIDER	ROLE	From	To
Lerner, David J	Admitting Provider		
Lerner, David J	Attending Provider	10/30/04 0000	N/A
Ray, Daniel William	Consulting Physician	10/30/04 0730	N/A

**Consults** [Add/Edit comment]

ID	Start Date/Time	Description	Order Date/Time
32519129	10/30 0711	Pulmonary Consult - Physician to notify Comments: +++ Requesting Physician, please phone or page the consulting Physician.+++ The consulting physician will NOT automatically be notified of the consult request as a result of this order. Provider: (Not yet assigned)	10/30 0715

The fact that ENH is a paperless organization allows all clinical and non-clinical information to reside in one data repository. This has cut down on the amount of time spent verbally communicating information and gathering the data together to review.

The system has unified the patient's health record. That is, it makes it very obvious to anyone looking at the record information what has and has not been entered.

To ensure the security of the data and control access, users must log on with a user-specific ID and password. Each user is assigned to a specific role and class of users, and this determines which areas of the EHR they have access to. Roles and classes are correlated to job function as well as to system competency. A user can only gain access to areas for which they have demonstrated competency through the training program.

### ***Impact on Operations***

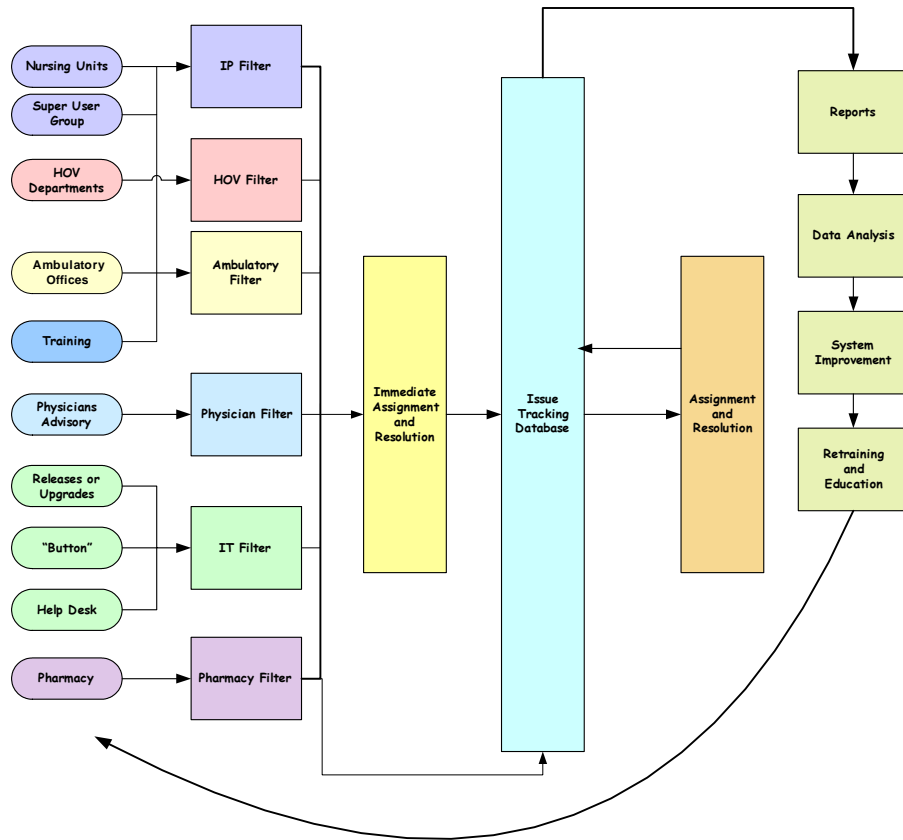
Every workflow and process has been affected by the new system. It has significantly reduced clerical work and time away from patients for many clinicians. While some physicians feel that using a computer is clerical but using pencil and paper is not, most see the advantages to be gained from an electronic patient record with computerized order entry: the chart is always available and legible, reporting is entered and available in real-time, remote review and collaboration is possible, data is consistently in the right place, and alerts provide notification of critical changes, to name just a few.

### ***Ongoing Planning, Support and Monitoring***

The Medical Informatics department is a permanent part of ENH and is dedicated to the ongoing development, maintenance and support for the system, including application updates and optimization as well as clinical process enhancements.

Users themselves are also a key means for monitoring how well the system is meeting their needs and what can be done so that it better meets their needs. The superusers group, the help desk, ongoing unit and department meetings, the Physician's Advisory Group, and quite simply any users who have something to say — good or bad, and feedback from outside organizations, such as those involved in patient transfers, all feed a database of issues. The system itself even includes "The Epic Button," which users can click on at any time or place within the system to submit an issue for follow-up. Issues are resolved immediately when possible and assigned for later resolution when not urgent.

Issues Workflow 05/01/04



#### 4. Evaluation of Management of the EHR Effort

Overall, the system is a tremendous success. It has been up and running at all three hospitals as of April 2004 and has changed patient care forever at ENH. ENH leadership believes that its approach to management — setting goals from the top and then giving flexibility in their planning to achieve those goals — creates the right environment for total involvement, creative problem solving and reliable results. Also critical was leadership’s *immediate* attention to any concerns, including resistance among physicians. Hospital leadership and the Physician Advisory Group always responded with the attitude that the project was going forward regardless, but that the system could be shaped and changed to meet their needs. For example, physicians pointed out that when they made rounds on their patients, they had to place new orders in one part of the system, go to another area to adjust existing orders, and document their rationale in a third place. Since backing down was not an option, the steering committee had but one choice: find a solution. The design team and Epic developed a navigating tool, called the Rounding Navigator that made the physician rounding process faster and easier.

The project had complete support from leadership: When people were needed for testing, their managers made them available for testing. When an emergency meeting was needed, people mobilized at once. Resources were made available for the extensive and compulsory training, and the floor and unit coverage needed during while staff was away at training.

The project was perhaps the most difficult that ENH and many of the people involved had ever undertaken, and it was not without its hitches. While altering the management effort would not have made the work any easier, a few changes would have made it smoother. For example, Epic Systems

recommended two people for implementation assigned to each of the seven application components of the system, but during the project ENH realized that that would not be enough.

At the peak of the project effort, thirty consultants were brought on board to work as temporary IS staff and to expand each team to seven or eight people. New positions were added to the IS department in the next budget cycle, and ENH was faced with new hires who did not have the benefit of the project history. It would have been far more efficient and effective to hire those people from the beginning so that they could have built their experience with the system. Also, making the last-minute decision to conduct the roll-out in two phases created extra work that could have been avoided had this decision been made at the beginning of the project.

ENH is now one of the few organizations in the nation using a completely electronic health record system that is built around the patient rather than the provider. The key feature of the system is its ability to function as a comprehensive, state-of-the-art suite of software products that work together in a *unified* fashion. This tightly integrated functionality distinguishes the system from many other electronic health record systems.

# Functionality

## 1. Targeted Processes

ENH is now one of the most “wired” healthcare organizations in the United States. With the Epic-based EHR/CPOE system, ENH has eliminated paper charts and multiple legacy systems, replacing them with a single, secure, electronic health record that is longitudinal, community-based and patient-focused—and updated in real time.

The record “follows” the patient—from the physician’s office to the emergency room or outpatient clinic and into operating room or to the bedside in the hospital—and assures that all caregivers have immediate access to complete and current information.

The Epic-based system integrates functions across the organization, including scheduling, registration, inpatient and ambulatory visits, physician orders, pharmacy orders and billing. The system requires physicians and other clinicians to place orders electronically at the point of care, incorporates the patient’s care plan into the record and alerts staff to potential medical issues. The system drastically reduces re-work and irregularities in everything from a telephone encounter in the office to inpatient medication ordering. The system eliminates the need for the paper-based patient chart, handwritten prescriptions, and much of the copying and rewriting of the same information that occurs with paper-based manual charting systems. Physicians, nurses and all caregivers document all the care they provide directly into the EHR using wireless mobile devices. This greatly reduces miscommunication, redundant tests, human error and handoffs between various members of the clinical team. It also ensures that clinicians make decisions with real-time point-of-care information.

The most unique and distinguishing feature of the EHR is the advanced way in which all of the modules (applications) function in a highly integrated manner. The flexible structure of the electronic health record allows ENH to easily record complex patient care scenarios and accommodates the variety of patient care models across all ENH units, departments and locations. This is accomplished because all of the modules share a common database. Each encounter (office visit, phone call, emergency department visit, outpatient visit and inpatient stay) is tied to an individual patient and data from any and all encounters is available to clinicians who are responsible for the patient’s care. Problem lists, allergies and medications are available at every encounter, giving clinicians the most current information. The EHR is available in the physician office, the exam rooms, at 6000 devices throughout the three hospitals, and at remote locations, such as from the physician’s home, through the Internet. Remote access is provided through SSL encryption and Secure ID passwords. Remote access is encrypted as it passes through the Internet for security.

Each of the following functions and the module that supports these functions is described below:

Function	Epic Module
Registration, ambulatory	Prelude
Scheduling	Cadence
Physician billing	Resolute
Inpatient clinical documentation and orders	EpicCare Inpatient
Ambulatory clinical documentation and orders	EpicCare Ambulatory
Pharmacy prescriptions and medication orders	EpicRx
Emergency department	EpicCare ED

## **Registration**

For inpatient and outpatient hospital ADT, registration and billing, ENH continues to use Medipac from McKesson. Registration for ambulatory care uses Prelude. There is a bidirectional interface between the Medipac and Prelude applications. The result is a single patient registration number for patients in all care settings and shared patient demographics and registration data. Specialized forms capture the insurance information needed for each payor's financial class.

## **Scheduling**

Scheduling using Cadence makes it easy to schedule an appointment or procedure from anywhere in the organization and provides context-specific instructions, benefit validation, extensive conflict checking, and solutions to complicated appointment searches. Comprehensive rules-based scheduling accommodates the needs of each clinician, room, and piece of equipment, maximizing the use of staff and capital resources throughout the organization.

## **Physician Billing**

Physician, anesthesia and dental billing with Resolute tracks revenue by entities, divisions, or a market while supporting multiple coverage classes and includes a highly configurable library of medical necessity checks and rules-driven charge/claims scrubbing routines. Components include:

- Point-of-service copay and prior balance collection
- Benefits
- Electronic claims management
- Electronic follow up and collections
- Web payment
- Financial reporting

## **CPOE**

Order entry varies by workflow. The physician order entry tools meet a variety of physician requirements yet help standardize processes. Features include:

- Configurable preference lists for common medications, procedures, and referrals assigned to multiple facility and security levels
- Infinite synonyms that allow for instant order lookup
- Order sets that allow multiple orders to be selected simultaneously
- Custom detail entry, making it easy to change default order settings on the fly
- Interactive order summaries that allow quick cancel, reorder, and review of existing orders
- Instant task management that automatically routes orders to worklists, adds flowsheet data points, and inserts patient education topics
- Automatic and on-demand drug interaction checking
- Duplicate order checking
- Last results displayed with new lab orders
- Ability to pull in relevant clinical documentation

Sample order set screens

Order Set (Contact Date: 05/11/2004) - Editing: Orders Close

[Clear All Orders](#) |  Verbal Orders | [Providers](#) | [Routing](#) | [Next](#)

[Pend Orders](#) | [Sign & Hold](#) | [Sign Orders](#)

**Asthma Adult CPG** Save Defaults | [Load Orig.](#) | [Delete](#)

**Asthma Orders**

**General Orders**

<input checked="" type="checkbox"/>	Admission Order		Details	
<input checked="" type="checkbox"/>	Initiate Asthma Critical Care Pathway		Initiate Asthma Critical Care Pathway (Care Plan template #12)	
<input type="checkbox"/>	Critical Care Consult		S:10/30/04(T)	
<input checked="" type="checkbox"/>	Document Condition		Is the patient stable? (64)	
<input checked="" type="checkbox"/>	Vital Signs		q4hrs overnight, then q shift	
<input checked="" type="checkbox"/>	Activity - Ad Lib		Ad Lib	
<input checked="" type="checkbox"/>	Regular Diet		Now First occurrence on 10/30/04 at 0706, Regular Diet	
<input checked="" type="checkbox"/>	Encourage Oral Liquids		Encourage PO fluids (FLUIDS, ENCOURAGE:12628)	
<input checked="" type="checkbox"/>	Anticipate Discharge Date		Expected LOS- 3 days	

**Supplemental Oxygen**

<input checked="" type="checkbox"/>	Supplemental Oxygen (if hypoxic)		Supplemental Oxygen (if hypoxic): Via *** at ***/min	
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**Consults**

<input type="checkbox"/>	Pulmonary Consult - Physician to notify		S:10/30/04(T)	
<input type="checkbox"/>	Consult to Allergist - Physician to notify		S:10/30/04(T)	
<input type="checkbox"/>	Social Work Consult		S:10/30/04(T)	
<input type="checkbox"/>	Consult COC (Discharge Planner)		S:10/30/04(T)	

**Respiratory Therapy Orders**

<input checked="" type="checkbox"/>	Peak Flow		q day and as needed	
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**Diagnostics**

**Imaging**

<input checked="" type="checkbox"/>	Chest X-Ray		ONCE First occurrence on 10/30/04 at 0706, Routine	
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**Labs**

<input checked="" type="checkbox"/>	BMG - on admission		Routine Lab, ONCE First occurrence on 10/30/04 at 0706	
<input checked="" type="checkbox"/>	BMG - Day 3		Routine Lab, ONCE First occurrence on 11/2/04 at 0706	
<input checked="" type="checkbox"/>	CBC w/o Diff - on admission		Routine Lab, ONCE First occurrence on 10/30/04 at 0706	

**Blood Gas**

<input type="checkbox"/>	ABG on room air, if indicated - EVANSTON ONLY		MULTIPLE SPECIMENS, S:10/30/04(T)	
<input type="checkbox"/>	ABG on room air, if indicated - GLENBROOK ONLY		MULTIPLE SPECIMENS, S:10/30/04(T)	
<input type="checkbox"/>	ABG on room air, if indicated - HIGHLAND PARK ONLY		MULTIPLE SPECIMENS	

**Medication**

**IV Fluids**

<input checked="" type="checkbox"/>	0.9% NaCl 1000mL		at 25 mL/hr, Intravenous, INFUSION starting 10/30/04 at 0706	
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**Medications**

<input checked="" type="checkbox"/>	Methylprednisolone (Solu-Medrol) IVP		Intravenous, Q6HR starting 10/30/04 at 0900	
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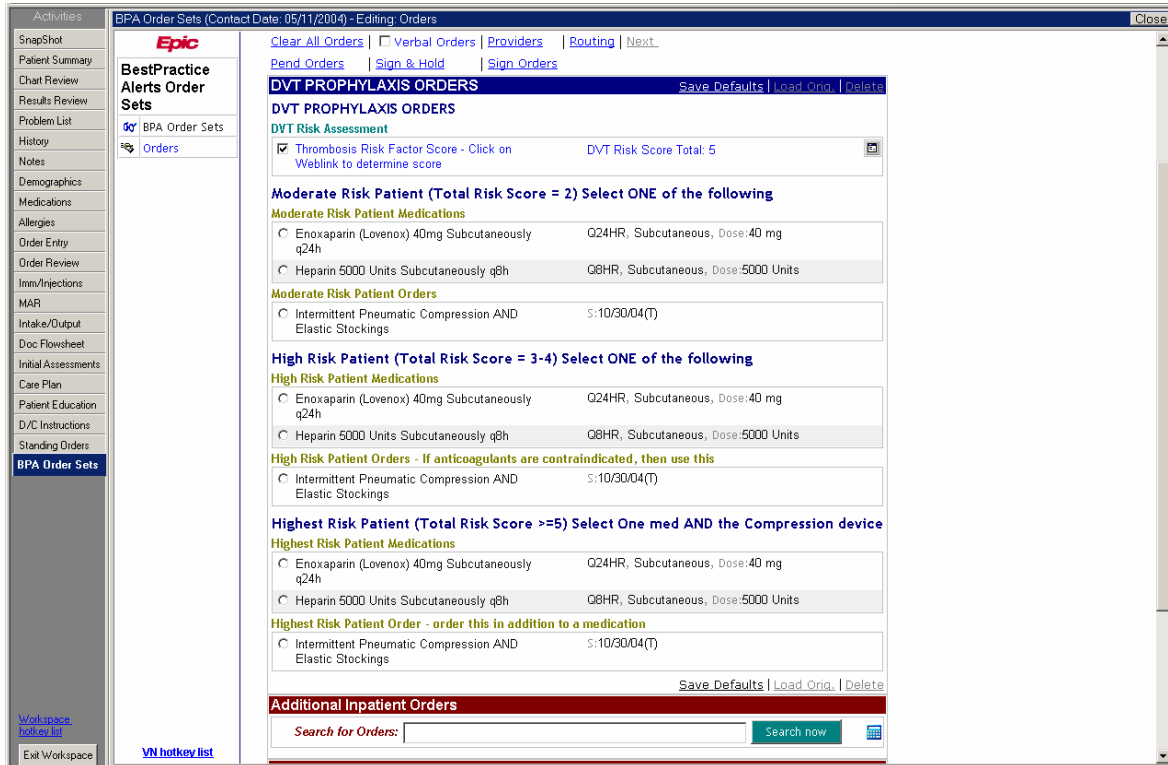
**Respiratory Therapy Meds**

<input type="checkbox"/>	Albuterol 2.5mg Inhalation Solution Q4H via Nebulizer		Q4HR, Inhalation, S:10/30/04(T), Dose:2.5 mg, Duration:15 Minutes	
<input type="checkbox"/>	Ipratropium (Atrovent) 0.5mg Inhalation Solution Q4H via Nebulizer		Q4HR, Inhalation, S:10/30/04(T), Dose:0.5 mg, Duration:15 Minutes	

**Additional Inpatient Orders** Save Defaults | [Load Orig.](#) | [Delete](#)

**Search for Orders:**

<input checked="" type="checkbox"/>	CODE STATUS	Details	
<input checked="" type="checkbox"/>	ISOLATION	Details	



## Nursing Flowsheet Documentation

Efficient, structured flowsheets make it easier to document care completely and comply with regulatory demands. Common tasks such as charting vitals, intake/output, and daily assessment are streamlined. The use of documentation Navigators ensures that all the relevant data is captured in sync with the new workflows.

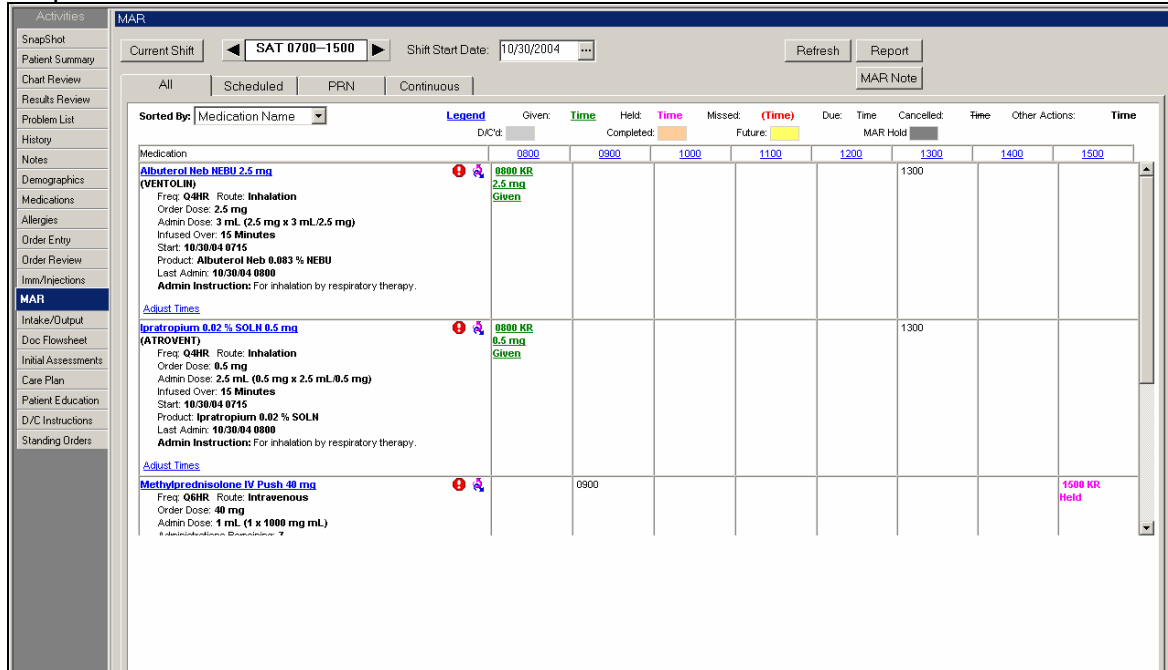
## MAR

The electronic Medication Administration Record works in concert with the EpicCare EHR, CPOE, and the EpicRx Pharmacy System to produce a dynamic and complete picture of a patient's medication status. The instant an order is placed or discontinued the information is reflected on the MAR.

Features of the MAR include:

- The MAR Report, which tracks all medications received in a simple and concise way
- The ability to document comments against a dose to alert a user of a task associated with that dose — for example, “Trough blood level due”
- Information on any drug interactions for each medication individually
- Dual sign off for those medications considered by JCAHO to be high risk
- Administration instructions and physician comments included with the medication order — for example, “hold if MAP less than 60mmHg; give with food”
- Ability to enter discrete variances to explain why a medication was not given
- Alerts to nurses when a medication is overdue
- Nursing observation captured directly within the MAR, such as pain acuity

### Sample MAR screen shot



Medication	D/C'd	Given	Time	Held	Time	Missed	Time	Due	Time	Cancelled	Time	Other Actions	Time
<b>Albuterol Neb NEBU 2.5 mg</b> (VENTOLIN) Freq: Q4HR Route: Inhalation Order Dose: 2.5 mg Admin Dose: 3 mL (2.5 mg x 3 mL/2.5 mg) Infused Over: 15 Minutes Start: 10/30/04 0715 Product: Albuterol Neb 0.083 % NEBU Last Admin: 10/30/04 0800 Admin Instruction: For inhalation by respiratory therapy.			0800		0800		1000		1100		1200		1300
<b>Ipratropium 0.02 % SOLN 0.5 mg</b> (ATROVENT) Freq: Q4HR Route: Inhalation Order Dose: 0.5 mg Admin Dose: 2.5 mL (0.5 mg x 2.5 mL/0.5 mg) Infused Over: 15 Minutes Start: 10/30/04 0715 Product: Ipratropium 0.02 % SOLN Last Admin: 10/30/04 0800 Admin Instruction: For inhalation by respiratory therapy.			0800		0800		1000		1100		1200		1300
<b>Methylprednisolone IV Push 40 mg</b> Freq: Q6HR Route: Intravenous Order Dose: 40 mg Admin Dose: 1 mL (1 x 1000 mg mL)			0900										1500 KR Hold

The electronic MAR provides active decision support at the point of care, increasing patient safety and reducing the likelihood of adverse drug events. Dose, route, site, and comments can be easily documented at administration.

### Interdisciplinary Notes

EpicCare’s interdisciplinary clinical notes foster open and complete communication among caregivers by maintaining patient documentation history in a single location. EpicCare’s integrated structure offers complete and up-to-date narrative and interdisciplinary notes for each admission, keeping clinicians aware of each other’s actions. Specialized documentation templates for any discipline and intelligent documentation tools facilitate rich text formatting and rapid data entry. Extensive sorting, filtering, and searching options help prioritize notes.

### Care Plans & Critical Pathways

Care plan templates provide a framework for multidisciplinary care. Together with order sets they provide support tools for ENH’s Critical Pathway Guidelines. Clinical Pathways provide a roadmap and a means for capturing best practices for predefined encounters. The pathway defines timing and sequencing of care and services, provides decision points in care, identifies expected outcomes, and allows variances from the plan of care to be captured.

### ICU/Acute Care Support

EpicCare’s ICU functionality extends the core clinical system to the ICU. The system provides fine-tuned, configurable workflows for treatment decisions and high-density information review.

## ***Inpatient EHR***

### **The EpicCare Inpatient application features the following:**

- Patient summary reports
- Flowsheets
- MAR
- Order sets
- Inbasket
- Initial assessment
- Programming points for automated consults and tasks
- Care plans
- Navigators
- Smart text
- Summary reports
- Education
- Allergies
- History
- Problem list
- Medications
- Results review

## ***Ambulatory EHR***

### **EpicCare Ambulatory features:**

- Episodes of care management
- Problem list management and support
- Encounter documentation
- Telephone support
- Structured clinical documentation and workflow support
- CPOE
- Results management and communication
- Medication management
- In-basket workflow manager
- Patient and affiliate correspondence
- Education
- Residency support
- E & M coding and support

## ***Emergency Department***

The EpicCare ED module was jointly developed by Epic and ENH and combines instant access to comprehensive patient information with efficient patient management tools. For example, a “mini” patient registration quickly captures essential demographic and medication information so patients can be triaged immediately. Real-time patient tracking allows clinicians to see the status of every patient in the ED at a glance. Flexible reporting functionality tracks patient wait times or total ED stay time in relation to acuity, diagnosis, provider, and other parameters.

## ***Pharmacy***

EpicRx was also jointly developed by Epic and ENH. It automates hospital pharmacy communication and workflow. It coordinates ordering, dispensing, administration (MAR), billing, and patient management activities. Integrated with the EHR and the embedded decision support engine, EpicRx delivers timely alerts, proactive guidance, and financial support suggestions throughout the treatment process. Physicians can order any medication—even complex IV and TPN mixtures—quickly from preference lists configured in the pharmacy. EpicRx presents the paperless medication orders to the pharmacist in a configurable workspace for quick review, editing, and approval. Because EpicRx is integrated with EpicCare, the pharmacist can access full clinical information from within the workflow. MAR integration ensures that nurses, physicians, and pharmacists all have access to the most current record of administrations, variances, and notes.

The table on the next page shows how functionality ENH and Epic designed into the pharmacy system has substantially enhanced patient care and safety.

Issue	Tactic
Reduce medication errors	CPOE has eliminated transcription-related errors, from order to pharmacy system and order to MAR, that were previously 42% of ENH reported medication errors, including actual events and near-misses.
Improved safety in medication administration	Delayed administration of patient medications has decreased 70 percent and omitted administration of medications has dropped 20 percent
Improve turn-around times	Time from order to administration of first dose antibiotics was reduced from 160 minutes to 80 minutes.
Avoid allergic reactions	Allergies and intolerances must be entered within the past year before medication orders can be placed for a patient. They are attached to the patient record and cross all encounters so that redundant entry is not necessary.
Capture immunization history	Immunization history is saved at the patient level and is accessible and updated in all arenas of care.
Ensure appropriate medication dosing	<ul style="list-style-type: none"> <li>• Specific dose options have been built into the system for all formulary medications, eliminating free-texting of dose.</li> <li>• Alerts for dose minimum and maximum for single dose, daily dose, and duration of therapy notify prescribers when outside of appropriate range.</li> <li>• Preference lists and order sets direct the physician to select the appropriate drug, minimizing the need for the physician to determine if for example, a piggyback or a syringe should be ordered. The system is structured so that individual physicians are only selecting from those medications that apply to their practice.</li> <li>• Relevant laboratory results are presented to physicians at order entry for specific medications.</li> </ul>
Provide medication-related alerts	Drug interactions, duplicate therapy, dose alerts, and allergy alerts are presented to the physician at the time of order entry.
Provide alternative recommendations	If physicians place an order for a non-formulary medication, they receive a list for recommended alternatives. They can select the recommendation or continue with the original non-formulary order. If they do continue with the non-formulary they must enter a reason.
Calculate weight-based dosing	For appropriate medications, the dose can be expressed as a weight-based dose. The weight that is used in the calculation of the dose is set up in the system to use actual weight or ideal weight as appropriate for the drug.
Reduce order clarifications	Required fields for specific medication orders ensure that all necessary information is included with the initial order, such as which eye the eye drops should be administered to.
Generate legible orders	Electronic order entry ensures complete legibility.
Ensure pharmacist review of orders for appropriateness	A pharmacist must review all medication orders before the nurse can administer the medication except in true emergency situations. Pharmacists are now able to review orders from many areas, such as PACU.
Provide access to drug references	Desktop access via the intranet is possible to Micromedex, OVID, ENH Formulary, ENH Drug Use Guidelines, ENH Policy & Procedures, IV Administration Guidelines, and several other secondary and tertiary medical references.
Link directly with automated dispensing cabinet	The Epic-based system and the Pyxis system are directly connected. If a medication is pulled on override or pulled from a Pyxis Medstation an electronic message populates the MAR for the nurse to chart against. Patient-specific medication orders are electronically transmitted to Pyxis so that the correct product is removed for administration to the patient.
Improved communications for missing doses	The system allows a nurse to electronically notify the technician in the central pharmacy when a replacement drug is needed, minimizing the need for pages, call backs and “on-hold” delays.

## 2. Information Access

All caregivers at ENH now have immediate access to current, complete, legible information about their patients, including hospital admissions, office visits, laboratory results and imaging studies. However, the system offers much more than a record-keeping function. Physicians use it to order tests, view and interpret results, communicate with other physicians, and conduct best-practice care planning. They are aided by appropriate decision support to improve the safety and quality of care of the patients.

More than 1,600 physicians and 1,300 nurses use the EHR for inpatient hospital care, and 284 physicians at the 68 ENH office locations also use it.

The system's high degree of integration provides a comprehensive view of a patient's information for authorized users to access and update throughout the entire ENH system. The EHR includes all eight of the core functions that the Institute of Medicine (IOM) has specified should be included in any EHR system: health information and data, result management, order management, decision support, electronic communication and connectivity, patient support, administrative processes, and reporting. As a result of the rapid staged roll out of these eight core capabilities, and only 18 months after its initial implementation, ENH is fully utilizing all of the core capabilities. Electronic communication, connectivity and patient support was fully extended to patients in July 2004. At that point the electronic health record at ENH operated with all eight of the IOM core functions. These functions are not limited to the inpatient domain, but are available to all patients in all ENH-owned office settings and now in affiliated physician offices.

From the beginning, ENH has recognized that the benefit derived from an EHR system is based on community participation in a shared patient-centered EHR system. The ENH model for an EHR system can be described as one in which the information surrounds the patient—clinicians and ancillary service providers contribute to the record, and derive information from it as needed. The guiding principle of ENH's deployment efforts has been to capture a piece of information once, capture it accurately, and share it as broadly as appropriate.

### ***Data Management***

The system uses a single data foundation for care and administrative departments across the healthcare organization, regardless of location. It captures all the clinical, financial, and operational data relating to a patient and organizes it into a consistent whole. The result is an always-current lifetime record of comprehensive, relevant information.

The Master Person Index keeps the database clean by finding duplicate records and by actively preventing users from creating them. Uniting demographic, registration, and encounter data from all Epic and non-Epic systems, it compares a broad sample of identifying information to evaluate patient records. The Chronicles Extended Relational Database Management System is the high-performance data engine at the heart of every Epic application. Chronicles extends strictly relational data tables with multi-valued attributes and a time dimension, optimizing them for individual record searches and record updates. In layman's terms, it's designed to be fast.

Legacy clinical systems that support and surround the EHR are described below:

- McKesson's Medipac for inpatient and outpatient hospital ADT, registration and billing.
- SeeBeyond E-Gate, which is being used as an interface engine for the integration of various ancillary systems, such as SoftLab, Radnet, Tamtron, Apollo, and Pyxis with Medipac and Epic via real-time HL7 interfaces. Currently 46 open connections exchange patient management and clinical transactions.

- Cerner Radnet Radiology Information System, which provides quick turnaround on diagnostic studies with a direct interface to the EHR. ENH has recently implemented Radiology Desktop and the radiologists have begun using voice recognition and digital dictation.
- GE PACS Centricity PACS (Picture Archiving Communications System) for computer-based imaging, database, storage, and networking technologies instead of film. ENH has installed PACS workstations in certain key areas for immediate viewing by physicians to provide urgent solutions to critical care of patients. The PACS application has also been rolled out to all referring physicians who choose to use it. Through an API interface PACS will be available via a direct link to the EHR.
- SSC SoftLab Laboratory Information System, which provides clinical laboratory, microbiology, and blood bank functionality to the lab department. All results from SoftLab are interfaced to the Epic clinical repository.
- Cardinal Health Pyxis, for medication management process, which is used in all clinical areas. A two-way interface allows the MAR to be populated with medications to chart administration.
- IMPAC Medical Systems Tamtron Anatomic Pathology System, which integrates anatomic pathology laboratories into Epic. A new Web application allows access to reports by outside referring physicians.
- LUMEDX Apollo Cardiology Data Repository and Reporting System, which helps physicians organize their data through special forms in the software that capture data specific to various procedures. Many reports that are stored in the Apollo repository are now interfaced to Epic. ENH uses several modules that allow for immediate report generation post catheterization and other procedures. Reports are sent directly to the EHR via an HL7 interface. Some reports have not been interfaced due to complex formatting, graphs, and special tables. These are scanned into the EHR.
- Dictaphone Dictation and Spheris Total E-Med Transcription services from a Web-enabled platform and secure national data centers. Dictation and transcription is still available for physicians even though the use of Epic charting tools (templates, smart text) has greatly decreased its use. All dictated reports are interfaced into Epic and can be associated with an encounter or visit, or to a specific order.
- GE MUSE 12-Lead EKG for Web-based EKG wave form storage and image (PDF) retrieval. ENH went live with the integration of MUSE and Epic in January 2004. It allows for clicking on an icon in Epic and through an API seamlessly entering MUSE to be able to view the EKG wave form image (PDF) associated with the EKG order and report.
- ESKER FaxGate manages faxing by automatically sending and receiving documents from any application. ENH auto-faxes prescriptions from ambulatory offices.
- McKesson Horizon Patient Folder (HPF) Image Management System, for electronic paperless chart. This electronically captures, indexes, completes, and stores our legal electronic health records. HPF manages the recording, tracking, and completion of deficiencies as well as the release of information process, and routes work to appropriate users through adaptive workflow.

### **Data Capture and User Access to Information**

Data is captured by the Epic-based system in three ways:

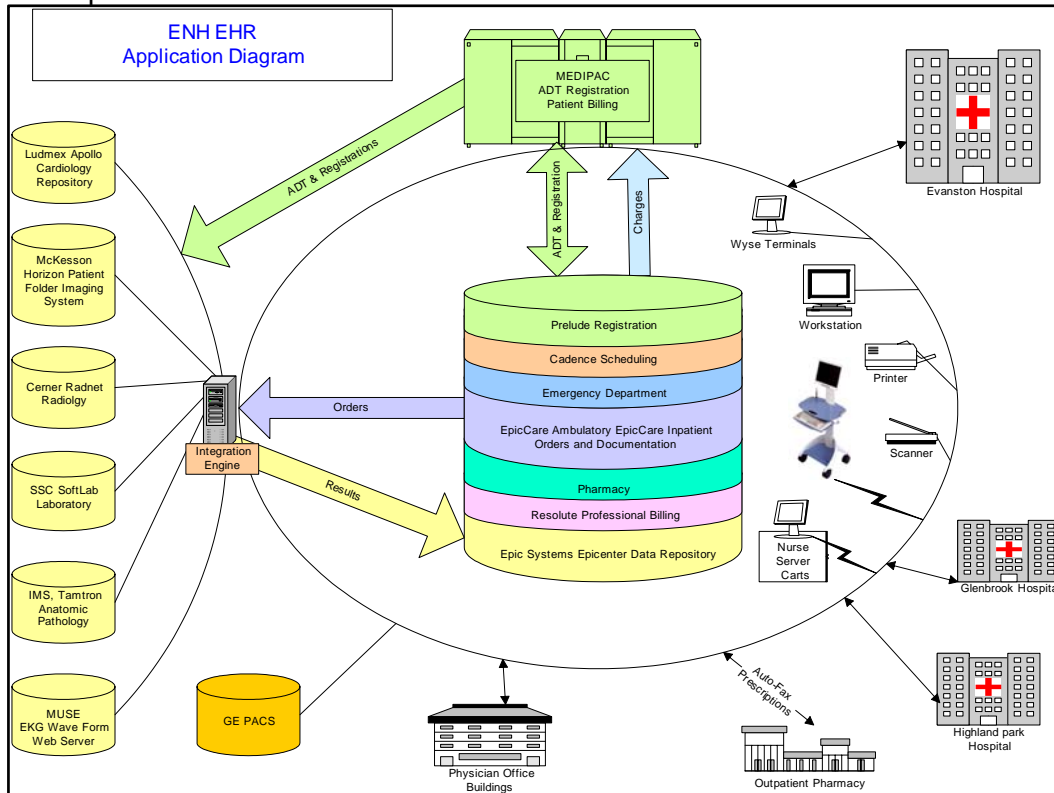
- Data is entered by clinicians at the point of care from 6,686 configured workstations, including PCs, fixed Wyse devices, wireless carts dubbed *Jetsons*, and wireless Lyonsville Medcarts
- Data is interfaced from other supporting computer systems
- Images are scanned into the system when paper records are presented from other institutions or when patient signatures are required.

All clinicians, including physicians, use the system to document care, record observations, place orders and review results. It is the single source of clinical information. Paper patient charts are no longer used. This helps to eliminate delays in documentation in the longitudinal EHR. For example, with point of care

documentation vital signs go in right away. Any changes in patient status are served up online and the nurse doesn't have to read through a paper chart searching for information.

All data is stored in a single database using the CACHE system provided by to Epic by Intersystems of Cambridge, Mass.

### Data Capture



The system is very directive, giving users alerts, choices and prompts as they enter data to ensure its accuracy and completeness.

All clinicians have access to data at and beyond the point of care as appropriate to their responsibilities. For example, many physicians access the system outside of the hospital or office, reviewing charts from home or other remote locations. Remote access is possible from anywhere in the world.

### 3. Decision Support

The new system provides physicians and other care givers with online decision support, and ENH continues to build on these capabilities. Examples include:

- The system will not allow a user to place a medication order if the patient's allergies have not been verified within the past year.
- A high fall-risk alert automatically appears in the Kardex when appropriate.
- All female patients under a certain age must be asked if they are pregnant before an X-ray can be taken.

More alerts and tools to support physicians will be added over time. ENH chose not to delay the implementation of the EHR to build in the full set at the start, but has recently added alerts such as a scoring methodology for all patients at risk for deep vein thrombosis. Physicians are then led to specific recommended order sets based on the risk score.

## Tailored Information Integration

### PATIENT SUMMARY REPORTS

The patient summary reports weave disparate pieces of data together into a “picture” of the patient that is easily recognizable and relevant at that point of care. Examples of these reports include:

- TPN report
- ICU results
- Kardexes for general and specialty areas
- Transfusion report
- ED summary report
- ICU accordion report

The ICU accordion report is an impressive decision support report, as it is dynamic and allows the user to drill down in time intervals.

### Sample ICU accordion report

The screenshot displays an ICU accordion report for a patient from 04/19/04 to 04/21/05. The report is organized into several sections: Vitals, Drips, IABP, Intake, Output, Net, Vent, and ABC's. Each section contains a table of data points over time, with columns representing 2-hour intervals. The Vitals section includes Temp, Pulse, Resp Rate, Pulse Ox, and Blood Pressure. The Drips section includes IABP. The Intake section includes P.O., I.V., Blood, and Other. The Output section includes Urine, Emesis, Drains, and Other. The Net section shows the difference between intake and output. The Vent section includes Mode, Rate, Tidal Vol, FIO2, PEEP, Peak Air Pres, Plateau, Compliance, Resp RR, Resp VT, Resp RSI, Resp MV, and Resp VC. The ABC's section includes PH, ABO, PCO2, PO2 Resp, Bicarbonate, and CBC W/O DHT.

	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-22	22-00	00-02	02-04	04-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-22	
<b>Vitals</b>	4/19/04																				
Temp	100.6				99.1				97.9					97.6				96.8			99.1
Pulse	3	78	66	88	64	63	68	60	57	60	57	69	85	82	103	97	94	99	90	102	
Resp Rate	0	8	8	10	7	6	8	9	7	6	5	7	12	18	12	30	26	26	25	24	
Pulse Ox	0	100	100	100	100	100	99	99	99	99	100	100	100	100	98	98	95	97	99	98	
Blood Pressure	6	112/55	103/57	123/66	109/56	128/65	134/70	168/78	150/74	89/47	92/50	132/62	150/74	132/78	147/77	151/70	151/72	156/69	133/74	148/68	155/60
<b>Drips</b>	4/20/04																				
<b>IABP</b>																					
<b>Intake</b>																					
P.O.																					300
I.V.	1058		500		1007	500	500		1778					910					891		
Blood																					
Other																					
<b>Intake Total</b>	<b>1058</b>	<b>500</b>	<b>1007</b>	<b>500</b>	<b>500</b>	<b>1778</b>	<b>910</b>	<b>891</b>	<b>300</b>												
<b>Output</b>																					
Urine	5	76	0	55	10	45	150	120	400	145	30	60	440	280	490	780	900	700	420	295	205
Emesis																					
Drains																					
Other																					
<b>Output Total</b>	<b>5</b>	<b>76</b>	<b>0</b>	<b>55</b>	<b>10</b>	<b>45</b>	<b>150</b>	<b>120</b>	<b>400</b>	<b>145</b>	<b>30</b>	<b>60</b>	<b>440</b>	<b>280</b>	<b>490</b>	<b>780</b>	<b>900</b>	<b>700</b>	<b>420</b>	<b>295</b>	<b>205</b>
<b>Net</b>	<b>5</b>	<b>982</b>	<b>0</b>	<b>445</b>	<b>-10</b>	<b>962</b>	<b>350</b>	<b>380</b>	<b>-400</b>	<b>1633</b>	<b>-30</b>	<b>-60</b>	<b>-440</b>	<b>630</b>	<b>-490</b>	<b>-780</b>	<b>-900</b>	<b>191</b>	<b>-420</b>	<b>5</b>	<b>-205</b>
<b>Vent</b>																					
Mode	V	SIMV		A/C	A/C		A/C	A/C		A/C		A/C		CPAP							
Rate	8	8		4	4		4	4		4		4		4							
Tidal Vol	0	800		700	0.7		0.7	700		700		0.7		0.7							
FIO2	0	.30		.30	.30		.30	.30		.30		.30		.30		.30	4 L		2 L	2 L	
PEEP	5	5		5	5		5	5		5		5		5							
Peak Air Pres		23		24	24		24	23		20		20		21							
Plateau		19		18	17		17	17		17		18		16							
Compliance		57		54	57		57	57		57		54		63							
Resp RR														20							
Resp VT														28.57							
Resp RSI																					
Resp MV																					
Resp VC														1							
NI														-36							
<b>ABC's</b>																					
PH, ABO							7.37														
PCO2							39														
PO2 Resp							108														
Bicarbonate							23.0														
<b>CBC W/O DHT</b>																					

## FLWSHEETS

ENH uses flowsheets to capture, display and summarize patient data in the EHR. Rows of data can be arranged into different views, and each department has its own flowsheet that is organized by and supports that department’s unique workflows.

The data that a clinician in a given department enters into that department’s flowsheet appears on all flowsheets. There is no duplication of data and the data flows seamlessly from one flowsheet to the next. For example, a medication administered in the emergency department would be visible to the physician visiting the patient in the ICU later that day. The result is standardized information that can be located easily on the record.

Examples of flowsheet templates include:

- IV therapy line maintenance
- Blood administration
- Pre and post procedure for multiple departments
- Admission assessments
- Nursing assessment
- High Fall Risk, with programming point to trigger alert on Kardex
- DVT risk assessment
- Intake and Output
- Wound and skin care
- OR Preop checklist with site side verification
- Hemodialysis

Information is also automatically calculated. For example, in the past when a physician suspected a patient was under or over fluid requirements, nurses had to calculate “net” fluids over a four day period, a lengthy process involving calculator or pencil and paper. Now the record automatically calculates the figure.

## **NAVIGATOR**

Through the workflow analysis effort, ENH and Epic developed the concept of “navigators” to help users move around the system. Navigators guide the physician and clinician through a workflow and providing the data the workflow groups determined was needed for decision making at that point in time.

Navigators streamline processes that are more complex and make the movement through the EHR more intuitive and faster for physicians and others facilitating patient care. This has helped tremendously to speed the learning process, the transition to the new system, and input time.

### **The following navigators are currently in place to support workflows:**

- |                                   |                              |
|-----------------------------------|------------------------------|
| • Visit Navigator                 | • Antepartum Navigator       |
| • Admission Navigator             | • Postpartum Navigator       |
| • Discharge Navigator             | • ISCU Navigator             |
| • Transfer Navigator              | • RN Assessment Navigator    |
| • ED Navigator                    | • RN Surgical Navigator      |
| • Rounding Navigator              | • Echo Navigator             |
| • RN Assessment                   | • GI Lab Physician Navigator |
| • Pre-admission Testing Navigator | • GI Lab RN Navigator        |

These screenshots have been pulled from training materials. The text around the screenshot helped users to understand the intent of the Navigators and how to use them.

**Try the Discharge Navigator**  
(found in the Action menu on the top toolbar)

Very Efficient ordering for any patient being discharged.

1. Check to reorder inpatient medication to continue after discharge
2. D/c suspended home medications
3. Order additional outpatient procedures and medications
4. Prints prescriptions for any new/modified medication order.

**Current Inpatient Medications - Check to Reorder**  
These are current medications for the patient. They will be discontinued after patient is discharged. You may want to reorder them if you want the patient to continue taking them after discharge.

<input type="checkbox"/>	Warfarin TABS 7.5 mg	2-3X/DAY, Dose: 7.5mg, (11/06/2003-)
<input type="checkbox"/>	Uracyn 3 G	Q6HR, Dose: 3G, (11/06/2003-)
<input type="checkbox"/>	Aspirin SUPP 600 mg	DAILY, Dose: 600mg, (11/06/2003-)
<input type="checkbox"/>	Vicodin TABS 1 Tab	Q4-6HPRN, Dose: 1Tab, (11/06/2003-)

**Currently Suspended Outpatient Medications - Check to Resume**  
These are suspended medications for the patient before the admission. They will be resumed after patient is discharged. You may wish to discontinue them if you don't wish the patient to resume using them after discharge.

<input checked="" type="checkbox"/>	METOPROLOL 25 MG TAB	daily, . . . 0, (09/08/2003-)
<input checked="" type="checkbox"/>	ASPIRIN 81 MG PO CHEW	daily, . . . 0, (09/16/2003-)

**Additional Inpatient (before discharge) Orders**  
Search for Orders:  **Only for inpatient orders!**

**Additional Outpatient (after discharge) Orders**  
Search for Orders:

[Clear All Orders](#) |  Verbal Orders | [Providers](#) | [Routing](#) |

**Rounding Navigator: The Most Current Information on Your Patient**

The new navigator, found in the Action drop down menu on your top toolbar, is a current status report on your patient including all of the most recent progress notes. Orders can be modified and discontinued from this navigator.

Rounding (Correct Date: 03/01/2003) - Viewing

<input checked="" type="radio"/> Rounding Report	Medical Problems	[Add/Edit/Cl...]								
<input checked="" type="radio"/> Orders	<b>Hospitalization Problem List</b>									
<input checked="" type="radio"/> Order Sets	Excham	Noted Priority Class								
<input checked="" type="radio"/> Progress Notes	ACUTE STRESS REACT NOS [364.9]	10/27/2003								
	<b>Chronic Problem List</b>									
	Excham	Noted Priority Class								
	PLEURISY W/O EFFUS OR TB [911.0]	10/27/2003								
	CHOLELITHIASIS NOS [574.2]	10/27/2003								
	<b>Vitals (last 1 days)</b>									
	Date/Time	Temp	Pulse	Resp	Sat/O2	SpO2	Wt	Hgt		
	11/05/03 0900	--	--	--	--	--	178 lbs (80.740 kg)	PK		
	<b>Intake/Output Detail Report (Last 4 Shifts) at 11/05/03/06</b>									
	IN/OUT	P.O.	I.V.	Blood	Total	OUT/OUT	Urine	Emesis	Total	Net
	Mon 11/04	--	--	--	--	Mon 11/04	--	--	--	0
	Tue 11/04	--	--	--	--	Tue 11/04	--	--	--	0
	Wed 11/04	--	--	--	--	Wed 11/04	--	--	--	0
	Thu 11/05	418	350	450	1218	Thu 11/05	560	50	610	608

**CARE PLANS AND CRITICAL PATHWAYS**

Over the last decade ENH developed numerous Critical Pathway Guidelines. As ENH prepared to implement the EHR, multidisciplinary teams used those guidelines to determine what should be done, where, when and by whom. Today, more than 50 Critical Pathway guidelines are built into the HER—and not into three-ring binders. The screen shot on the next page shows the care plan that supports clinical pathways. The instruction below the screen shot was provided as part of user training communications and explains the advantages of the care plan and how to use it.

### Our New Care Plan Activity Features



After selecting the appropriate template the user will now be able to view not only the problems, but goals and interventions. (Continue to **Select All** if it is a CPG Care Plan and then review and delete/resolve.)

- The discipline assigned to your security sign-on, such a social worker or nurse, default in separately when adding problems/goals and problem interventions.
- Interventions can be added directly to problems as well as to goals with EDIT function.
- Highlight your problem and select Document.
- Also new: **Goals and Intervention details** can easily be deleted or added to when using the [\[Edit Intervention\]](#) hyperlink.

### Decision Support and Practice Standardization Applied during CPOE

The system has a robust set of decision tools and more are constantly being added.

Universal tools available at all inpatient, outpatient, and ambulatory settings

- More than 1,000 physician order sets that help physicians place orders efficiently and follow best practices
- All medication and allergy alerts for all medication orders
- Allergy verification alert prohibiting order entry if allergy not documented within the past year
- Recommended doses for weight-based medications and age-related alerts
- Hyperlinks to best practice information
- Most recent related lab results pulled in when ordering anticoagulants
- Duplicate order warnings for existing diet orders in system
- Links to laboratory results when ordering certain medications
- Icons to alert user to new orders, new results, new notes when opening patient lists
- Use of Navigators to bring forward all current orders for review

Tools available at ambulatory settings

- Detailed patient information available off-hours and weekends for covering physicians
- Prompts for health maintenance measures to promote wellness
- Custom designed flowsheets by specialty to collate pertinent data for monitoring trends over time, such as anticoagulation and diabetic parameters
- Facilitation of communication between PCPs and specialists
- Initial efforts to integrate critical pathway collaboration across the organization in the areas of breast cancer and diabetes

### Knowledge Access

The system also provides users with links to internal and external knowledge, including but not limited to Micromedex, OVID, ENH Formulary, ENH Drug Use Guidelines, ENH Policy & Procedures, IV Administration Guidelines, and several other secondary and tertiary medical references

### ***Patient Education and Support for Care Decisions***

Having a single, integrated electronic health record that all caregivers have simultaneous access to creates an unparalleled opportunity for collaborative decision making across the continuum of care. For example, the system allows ENH to create critical pathways that allow caregivers to assess the effects of a patient's course of care throughout the course of care, not after the course of care as with paper-based systems. With the Epic-based system, all responses to care are available to everyone involved now and in the future. The physician and nurse can review all care steps as they occur and adjust the plan of care to keep the patient on track for best practice outcomes.

The system makes it possible to track education throughout the patient stay using templates specific to a problem, diagnosis, or procedure. This also provides the clinicians with an understanding of a patient's knowledge and skill level. The system also houses more than 2000 sets of discharge instructions, and nurses can pull into this relevant discharge medication information for the patient to take home. Because the EHR integrates with ENH Medical Group practices, the patient's primary care physician can instantly see the information the patient received at discharge.

To bring the patient into the equation, ENH has purchased Epic's MyChart module, which ENH successfully piloted in the summer of 2004. This creates a shared health record that gives patients secure, controlled access to portions of the same electronic chart that providers use. Patients will be able to review lab results, medication lists, and other personal medical information online. They will also be able to pay bills, communicate with their physicians, and schedule their own appointments online.

Unlike other systems where patients electronically request appointments and must wait for a response, ENHfirst's users can directly schedule and cancel appointments with physicians. In fact, it works much like an airline web site, allowing the patient to view actual availability and book the time.

All medical information, including messaging with a physician, resides on a secure server. The system sends an email alert to the patient's designated email address when new information is available. Patients must return to the secure and private messaging section at ENHfirst and log in to see the content of the reply. All answers to questions automatically become part of the patient's electronic medical record.

### ***Aggregated Data Analysis and Reporting***

ENH can track individual and aggregate patient outcomes and report both internally and externally as specified by the Joint Commission, NRMI, and CMS.

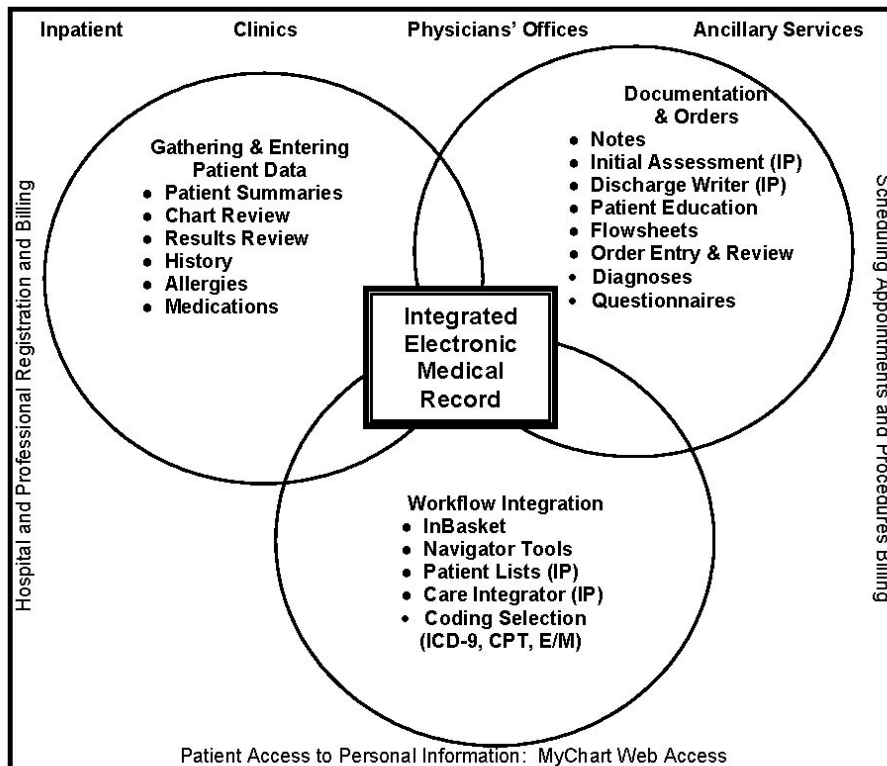
The EHR system includes Epic's Clarity Reporting System, which can be employed as a data warehouse, pulling together information from disparate systems into a single reporting database. It is housed on a separate online analytical processing server.

ENH also uses IBM's On-Demand Report Distribution, a web-based report collection, security, display and print system. Hundreds of ENH managers and clinicians who previously relied on boxes of delivered green-bar reports every month now have immediate access to the same data via the closest web browser and their personal ENH intranet login. OnDemand provides a secure, consistent and searchable interface for reports originating on ENH's major enterprise financial and clinical systems. In addition to saving the organization the cost of buying, storing, printing, sorting, delivering and disposing of hundreds of reams of paper every month, report access is now quicker and more efficient for all. The result is that printing of production reports is now the exception at ENH instead of the rule.

## 4. Workflow and Communication

The new EHR system at Evanston Northwestern Healthcare supports fully redesigned workflow processes (see Management Section 2. Implementation.) ENH redesigned all clinical and many administrative processes and then designed and built the new system to support these workflows.

The system has been specifically designed to reduce hand-offs among entities, care teams and care professionals. Instead, it provides for continuous access to patient information across all personnel participating in the care delivery process.



## 5. Data Sharing with Other Organizations

Few if any organizations have the capability to transfer medical records electronically as something more than a .PDF file. Continuity of care forms and transfer documents are printed from the floor. The Horizon Patient Folder stores an online print image of the patient record. Release of medical records occurs on paper printed from the imaging system when documentation is transmitted to outside organizations.

ENH has begun to extend the system out to the community. We have added an affiliate office with five physicians and two office locations to the EHR system. Work is underway to deploy the EHR in two additional independent physician practices in the winter of 2005. The affiliate office shares all demographic and clinical data and their financial data is "siloeed." Except for the financial data and billing, the affiliate offices will operate the same as the employed Medical Group offices.

## 6. Other Operational and Strategic Activities

ENH designed the new system with improved patient safety as the primary goal. Everything about the system supports this: record accuracy, record completeness, record timeliness, simultaneous access, remote access, and decision support.

The system also interfaces with all administrative and financial functions, creating a seamless flow of patient information throughout the organization.

ENH is now planning to deploy its Epic-based system to independent medical practices of physicians who hold ENH professional staff privileges but who are not employed by ENH. These community-based group practices will be able to use the EHR system to manage all business and clinical care functions of the medical practice, and the system will also electronically link the practice to ENH inpatient facilities. ENH has created an experienced implementation team and has structured a program with economic incentives that make it enticing for these independent practices—who would otherwise find it difficult to acquire such a system—to implement the EHR system. Medical practices that are early adopters of the Epic-based system will receive additional assistance and the benefit of the implementation experience and training from ENH.

## 7. User Satisfaction, Productivity and Effectiveness

### *User Acceptance and Satisfaction*

Evanston Northwestern Healthcare recently achieved the “Highest Value Rating” from KLAS CPOE Digest. KLAS creates and maintains a database of performance information on healthcare information technology software vendors. KLAS interviewed every hospital in the U.S. that were reported by vendors to have physicians and nurses actively using commercially available software to order and chart under an organized program sponsored by the hospital. ENH is unique in achieving the overall highest rating across all KLAS performance criteria.



100% of ENH physicians enter orders through the EMR.

KLAS Performance Criteria	ENH Performance
Reasonable mix of non-employed physicians	500 employed physicians, 1100 non-employed physicians
All active physicians have passwords	Yes
Percent of physicians actively doing CPOE >95%	100%
Medication orders NOT re-entered by pharmacist	Yes
Percent of all possible orders entered by physicians >95%	100%
Percent of physicians using electronic signature >90%	100%
Percent of physicians documenting/charting electronically >90%	100%
Percent of nurses documenting/charting electronically >90%	100%
Ambulatory clinics/physician offices order/chart electronically	Yes
Overall physician satisfaction with the software system >7	8 (of a possible 9)

ENH is conducting an in-depth, four-year survey to gauge user satisfaction and guide ongoing system optimization. The organization conducted the first survey before the system implementation to establish a baseline for performance. The survey will be conducted every year through 2007. Results will be used to monitor the system and adjust it as needed.

On a less formal basis, ENH assesses user satisfaction on a daily basis through regular meetings, the help desk, and the issues tracking database described earlier.

# Technology

## 1. Scope and Design of the EHR System

### *System Description, Architecture, and Data Model*

Evanston Northwestern Healthcare's goal in architecting the EHR system was to create a resilient environment using the latest high availability technology. The system would be used 24 x 7 x 365 and unplanned downtime would have to be held to an absolute minimum. Using a system failover model, ENH incorporated redundant servers, storage area network equipment and high availability software. The goal is that this system can take a hit to a critical component and recover in an acceptable period of time for that component. For example, a server failure can be solved by failing over to a backup within 15 minutes.

The backend application and database system components include two IBM P690 frames with 24 CPU capabilities. Multiple fiber channel adapters access the storage area network on an IBM ESS 800 frame. Connections to the Gigabit Ethernet network are through multiple copper gigabit adapters. The high availability solution couples the two servers using IBM's HACMP software.

The P690s can be set up as partitioned servers, with multiple servers setup to run on the same frame for the multiple components that make up the Epic system. The current production system requires 15 CPUs to accommodate the main production system, which uses 1600 Caché database licenses. Each 24 CPU frame has the capability to run 24 distinct environments if needed. The need for development, testing, shadow, training, and practice environments allowed us to maximize the partitioning capabilities of the P690 and to minimize floor space in the data center.

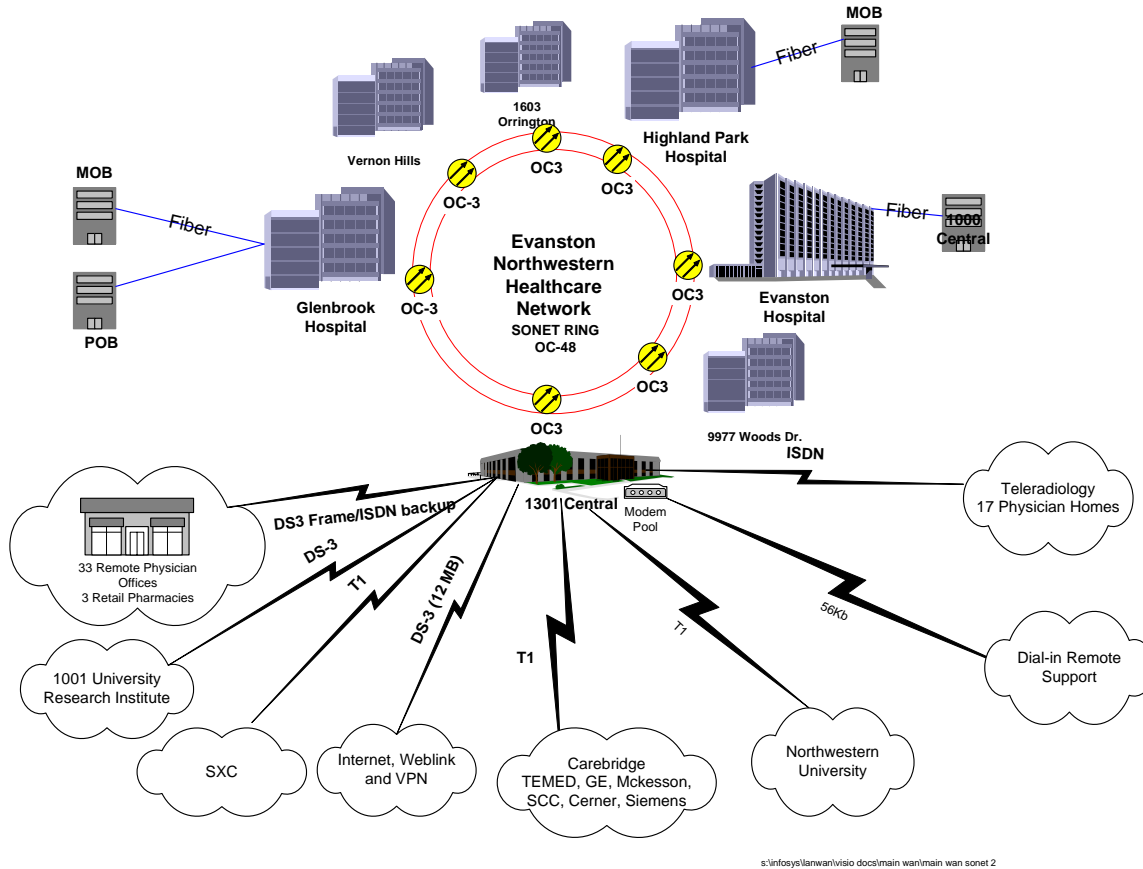
The applications and database are integrated and run on the same backend server. The client code is installed on a Citrix farm of 100 servers using Hewlett Packard blade technology. Users connect to the applications on 2000 thin clients via a webpage called E-LINK, the gateway to the client software.

Only a Citrix ICA web browser client is needed on the client end devices. In this way, ENH can leverage thin client technology at a lower total cost of ownership than with standard PCs. ENH's technology group updates applications on the Citrix servers instead of pushing them to the PCs. A scripting process makes it possible to complete updates in a matter of minutes.

Disks and the data stored on them are the most critical components of this system. The storage area network (SAN) uses fiber fabric infrastructure. The SAN infrastructure design eliminates many single points of failure. RAID levels for the data are hardware RAID 5. There are multiple connections to and from the SAN switch.

In 2001 ENH replaced its ATM network backbone with a gigabit network infrastructure to support applications with high bandwidth demands, such as CPOE, document imaging, and radiographic imaging. The Gigabit Ethernet network uses Layer 3 based LANs connected together over a WAN via a SONET (synchronous optical network) ring fiber-optic transmission system for high-speed digital traffic connecting ENH's seven major buildings. The SONET ring has had 100 percent uptime in more than six years in service. The standard building design is a pair of Nortel Network Passport 8600 layer 3 switches in each core or master switch. The core of the network supports Voice-over-IP and data switching and management of the overall network systems and applications. The standard design for each network closet is a cascade stack of business policy switches (BPS) with dual 100 Fx downlinks to the core. The standard design for areas that needed faster connections for imaging systems is Passport 8600 Layer 3 switches with dual gigabit downlinks to the core.

### ENH Physical Data Network



The ENH data center has dual electrical circuits, two uninterruptible power supplies (UPS) that can each handle 100 percent of the room requirements, and a diesel generator in the event of a prolonged electrical blackout.

The wireless network provides point of care capability to physicians and nurses using the Epic-based system. The wireless network has more than 400 access points and is installed at all three hospitals. Coverage is at 100 percent in all of these clinical settings, which also accommodates the Voice-over-IP phones that the nurses use.

Mobile carts, called “Jetsons” by nurses (after the 1960s cartoon), bring the chart to the bedside at point of care. The carts contain a terminal device connected wirelessly to the LAN.



One of 600 wireless “Jetson” carts used to access the EHR.

The Epic environment is complex, with many other environments needed to support day-to-day tasks and to provide reporting, testing, development and disaster recovery. By maintaining separate environments, ENH is able to enforce change control and to insure availability.

Remote access from outside of the organization is available through the Internet. A Citrix Secure Gateway and a two-factor authentication system establish a secure SSL 128 bit encryption connection. This two-factor system enhances the already strong authentication security. Each remote user uses a SecurID “key fob,” which generates new pass codes with every user login. Only the server knows which pass code will allow the user to gain access. This eliminates threats from outsiders stealing, copying, or reusing passwords.

The physicians can perform the same functions remotely that they can perform on a nursing floor. More than 1000 physicians have applied for and received remote access. Many physicians use it as many as 60 times per month—often checking from their office during the day and then again at night from home.

***Integration***

The Epic system interfaces with a number of clinical and ADT (admissions, discharge, transfer) systems. A view of this is provided in the diagram below. Epic is integrated with other current systems within and outside of the ENH network using Interface Manager. The ADT data as well as clinical and billing information is shared between Epic, Medipac (ADT and billing), Softlab/Tamtron (LIS), Radnet (RIS), cardiac graphics systems, Transcription system, PACS/EPF (imaging systems), medication dispensing system, and many others via real-time HL7 message exchange method and batch file transfers. Currently there are over 40 real-time interfaces in the ENH production environment.

***Scalability***

ENH selected the hardware components to allow growth into the future and designed the infrastructure to scale in a linear fashion. The infrastructure can grow with the addition of servers, memory, storage, and networking bandwidth.

**2. Security and Data Integrity**

***Security/Confidentiality and HIPAA Compliance***

Epic’s applications are all HIPAA compliant. ENH has set up the security for the new system on a “role” basis. Before go live, the steering committee reviewed each role within the organization and assigned functions to each role. Each person receives security clearance appropriate to the role they fit into. If necessary, security levels can be adjusted on an individual basis with management approval.

***Data and System Quality, Integrity, Protection and Storage***

The high availability requirements for any clinical hospital system demand a “hot” backup solution. Epic is not brought down to perform database backups. Rather, the application remains available to all users during the backup process. The Caché database used does not provide the capability for hot backups of the database like other major database platforms. It does, however, “freeze” the database into a consistent state that allows back ups. Users cannot perform any updates and the application is essentially unavailable while the database is frozen. The database must remain frozen throughout the backup.

ENH resolved this dilemma using a storage area network with special “flash copy” software that effectively copies a database of any size in just seconds. This technology enables ENH to freeze the database for a few seconds while backing up the database. The end-user sees only a very brief, almost imperceptible slowdown of performance that lasts only a few seconds at 2:00 am while ENH performs the three-step nightly backup: freeze, flash-copy, thaw. The backed-up data is then copied to tape through a tape area network.

The Caché database requires data integrity checks to ensure data is not corrupted. Daily data integrity checks on the files in the Caché database ensure data integrity. Ideally, the integrity checks would be run with no users on the system. In this way, the integrity check would report any corruption without failure. However, when the integrity checks run while users are on the system, occasionally an integrity check reports an integrity error on a database file where no such error exists. This is caused by a database update taking place at the same time and file location that the integrity check viewing. In these cases, the DBA reruns the integrity check for the file in question. In all cases, the second run has confirmed that there is no actual corruption.

A recent enhancement to this procedure automatically reruns, up to three times, the integrity check of any file that reports corruption. In this way, the integrity checking mechanism only reports corruption alarms to the DBA in the event of actual corruption as proven by repeated failure. Although occasionally false corruptions appear on the first pass through a file, the second pass is always confirmed, and does so automatically now, that there is no actual corruption. DBAs are no longer falsely alarmed.

The Caché database is marketed as a post-relational database. Unlike relational databases that require all data to be stored in two dimensional tables, Caché stores data in multidimensional arrays. This makes for much faster data access because it eliminates the need for “table hopping” and “joins” that are required in relational databases. Caché is optimized for web development, is compatible with new object oriented modeling, and also supports SQL based data access.

### 3. Standards

#### ***Common User Interface and Data Exchange Standards***

Epic is standardized across the enterprise. Access into the system and hardware configurations is largely the same across throughout the whole clinical and business environment.

Data Exchange Standards and ADT interfaces are all written in accordance with HL7 interface standards

#### ***Data Content and Vocabulary Standards***

The data dictionary in the Epic-based system acts as a user friendly, open-access data source that lists all the data fields currently active in the system as well as their data definitions. System users can find out for themselves if the data they are interested in is available for retrieval. This reduces the demand on centralized report writers, allowing them to respond to ad hoc and routine production report requests. The centralized report writers can write a report or retrieve raw data more quickly because the information they need is in the data dictionary. The completeness of this dictionary, which contains both generic data from Epic and information specific to ENH’s adaptation of the applications. Establishing the dictionary is very labor intensive on the front end, and to minimize the immediate labor needs ENH is establishing the dictionary gradually as requests for reports and data are filled.

ENH recently sent IS staff and physicians to SNOMED training and will adopt this as Epic makes it available in a future update.

#### ***Communication and Networking Standards***

ENH spent a great deal of time standardizing all networking and server equipment, limiting the number of vendors that the organization purchases from. Examples include Nortel for networking equipment, IBM for application and database servers, and HP for Citrix servers. By focusing on fewer vendors, ENH has reduced incompatibility issues, support costs, support issues, vendor liaison requirements, and testing of new technology. Purchases of equipment are centralized and coordinated through the IS and purchasing department.

## 4. Performance

### Availability

ENH has set a goal of 12 hours of *planned* downtime per year for the system. In the first 12 months, the system experienced 10 incidents of *unplanned* downtime. In the second 12 months we had eight unplanned downtime incidents. Only five of the 18 incidents were long enough to warrant printing the downtime reports described below. Any unplanned downtime is an issue, but the frequency and longevity of these outages have been improving. In no case did we have to activate our disaster recover site.

ENH has developed a unique paper solution to respond to unplanned downtime. In all three hospitals there are dedicated PCs that are on the LAN but directly connected to printers that are not on the LAN. These PCs receive a downloaded report that is refreshed every two hours for Med/Surg patient floors and every 30 minutes for ICU and ED. In the event of an unplanned downtime, nursing can print these summary reports of the patients' care. The reports include diagnosis, allergies, medications ordered and given, outstanding orders, recent lab tests and other results. ENH has also developed a similar report for the physician offices and is currently doing the same for outpatient departments.

### Response Time

Response is quite fast for commonly performed tasks:

- Opening an order set <1 second
- Opening medication orders <1 second
- Creating a letter template 2 seconds
- Opening a scanned document 1 to 2 seconds

Screens with more complicated information take a bit longer:

- Opening a chart 7 to 8 seconds
- Opening the order section 4 to 5 seconds
- Closing a chart and moving to the next 4 to 5 seconds

A known but infrequent problem exists for patients who have been in the hospital for more than 20 days and who have very complex charts. These charts have longer than average response times at opening. Epic has recently identified application issues that contribute to the problem. The release date for the fixes is yet to be determined.

### Continuity Planning

One of the organization's old data centers is now the disaster recovery site for the Epic-based system. This is located at Highland Park Hospital, approximately 20 miles away from the Evanston data center, the central hub where all of the production hardware is located. The disaster recovery site includes a server and SAN running the Epic-based system in a shadowing model that is updated from the production server in real-time, creating a redundant data repository in the event of a disaster. It also has five Citrix servers to facilitate up to 350 to 500 simultaneous connections. Highland Park Hospital is on the SONENT ring and network equipment is installed that will reroute connections automatically in the event of a disaster.

### Service Level Agreements

Around the clock technical and application support staff is available by pager for off hour support. The acknowledgement time is 15 minutes during normal business hours. All problems are reported to a centralized helpdesk that triages the call and attaches appropriate severity levels to the problem and assigns the ticket to a support person as deemed appropriate.

### ***Upgrades and Enhancements***

Epic currently issues three seasonal updates. The size of the update dictates the time for testing and training and potentially building for new files. ENH reviews update notices to gauge value and the work involved. After review, a timetable is established and a go-live date is published to the users. ENH continues to install every release as quickly as possible to enhance the system with the new features and functionality.

Downtime for an update varies by the extent of the update. The average planned downtime is three hours. ENH performs updates at midnight on a weekend, and additional personnel are present for support. Downtime summary reports are printed before the system is shut down and distributed to the floors and ancillary departments. The downtime report gives a summary of the patient “chart” and gives clinicians demographics, allergies, medications, and results for each patient.

# Value

For ENH, the primary purpose of implementing the Epic-based EHR/CPOE system was to move the organization along the path of becoming the best integrated healthcare delivery system serving Chicago’s suburban North Shore. The success of the project in achieving that objective derives from four key factors:

- *End-to-end process redesign before implementation*  
ENH viewed this project as a clinical project supported by IT tools. This project was a clinical project, and ENH launched the project with a full-scale analysis and redesign of all clinical processes.
- *Software functionality*  
ENH worked with a software vendor that was willing to modify and enhance the applications to meet ENH’s needs.
- *End-to-end system integration*  
ENH settled for nothing less than a fully integrated electronic health record.
- *One hundred percent adoption across the organization*  
More than 1,600 physicians and 1,300 nurses and other clinicians now use the EHR/CPOE system for inpatient and outpatient hospital care at all three ENH hospitals. More than 284 physicians use the ambulatory medical record system at 68 hospital-owned group practices and service offices.

The system allows ENH to provide quality care to patients individually and collectively in ways that would not have been possible without an electronic health record.

Epic-based System Characteristic	Quality Enhancement
Directive	The system allows ENH to build and easily update best practice order sets, pathways, guidelines and protocols specific to a patient’s diagnosis or procedure.
Concurrent	As clinicians document a patient’s response to care, it is available instantly to other clinicians to work with, shortening the treatment cycle.
Experiential database	Each patient’s longitudinal record is aggregated for analyzing trends in patient outcomes, providing the information needed for continuous improvement across the organization.
Interactive	In July 2004, ENH implemented Epic’s MyChart, which gives patients access to portions of their record and allows them to schedule appointments, pay bills, request prescription refills, view test results, and request medical advice from their physicians, — all online and in real-time.

Although the implementation is just wrapping up and it is too early to fully quantify results, the statistical and anecdotal data that is available demonstrate the effectiveness with which the new system is progressing toward the original project goals:

- Improve **patient safety** by eliminating problems associated with illegible orders and medication errors
- Ensure that physicians, clinicians and administrators have **access** to the right patient data at the right time
- Ensure the **accuracy** of the information and coded data in the record
- Simplify **processes** and make them consistent across the organization

The first three goals are addressed under item 1 below; the fourth is addressed under item 2.

## 1. Success in Meeting Project Goals

### *Patient Safety*

The new system has eliminated entire categories of errors and near-misses, including transcription errors, errors due to misunderstood abbreviations and mix-ups due to look-alike drug names.

- Errors and near-misses caused by transcription errors, which represented 42 percent of total errors before the system implementation, have been eliminated. All physicians directly enter their orders into the system and each medication order is passed directly, without re-entry, to the pharmacy and posted on the MAR.
- For look-alike drugs, ENH took advantage of the Medispan pharmacy database with their “tall man, small man” safeguards.
- The system does not allow physicians to abbreviate medication names.

The system has also reduced delays and omissions in administration of medications. With the system’s electronic medication administration record (MAR) and alerts to nurses, delayed administration of patient medications has decreased 70 percent and omission errors have been reduced by 22 percent.

These results are summarized in the table below.

Performance Indicator	Performance Change
Transcription errors	Reduced to zero
Delayed administration of medications	Decreased 70 percent: from 20 per month to 6 per month
Omitted administration of medications	Decreased 22 percent: from 18 per month to 14 per month

The Epic-based system also assures continuous compliance with applicable National Patient Safety Goals as defined by the National Institute of Medicine and required by the Joint Commission.

National Patient Safety Goal	System Functionality
Improve accuracy of patient identification	Verification screens assure the “time out” for right patient, right procedure and right site
Improve effectiveness of communications among caregivers	Prompts and requirements to document “read back” for verbal and telephone orders  Elimination of abbreviations
Improve the safety of using high-alert medications	Two care providers must independently verify and document the right drug, right dose, right person and the right programming of an infusion pump  New drugs can be added to the mandatory high-alert field within minutes by the pharmacist  Alerts built in for look alike and sound alike drugs, drug interactions and drug reactions
Eliminate wrong-site, wrong-patient, wrong-procedure surgery	Verification screens assure the “time out” for right patient, right procedure and right site
Improve the safety of using infusion pumps	Two care providers must independently verify and document the right drug, right dose, right person and the right programming of an infusion pump
Reduce the risk of nosocomial infections	Surgical pathways and order sets facilitate use of evidence-based prophylactic antibiotics in a timely, effective manner  ICU admission order set has VRE and MRSA screening orders defaulted in

**Patient Data Accessibility and Availability**

With the Epic-based system, point-of-care documentation is immediately integrated into the chart and available to all clinicians and members of the health care team. Physicians and other clinicians can access and update patient information wherever and whenever necessary. All health records are secure and password-protected, though instantly accessible to those who need to see them. For example, a physician in an office or at home can check on the latest progress of a patient in the hospital by accessing the electronic chart and reviewing the notes entered by an on-duty nurse. Physicians in the Emergency Department can immediately see a patient’s prescribed medications, saving precious time.

**INPATIENT AND OUTPATIENT VISITS**

The system has shortened inpatient diagnostic and treatment cycles as indicated by shortened length of stay for several diagnostic groupings common to acute care settings. ENH has realized nearly \$1 million dollars in direct cost savings related to shorter length of stay between October 2003 and March 2004.

**AMBULATORY**

The number of lost or mislaid patient charts, a chronic industry problem, is zero. At ENH Medical Group practices, the number of paper charts missing when pulling charts often ran as high as 10 percent. Reductions in the turnaround time for ambulatory test results are equally significant. The process redesigns supported by the system’s tools have produced dramatic results.

Test	Paper-based system (days)	Epic-based system(days)
General blood	1-2	same day
X-ray	1-5	1
CT	5+	2
MRI	5+	1
Cardiographics	5+	1
Mammogram	10+	1
Bone density	10+	3
Colonoscopy	5	0-1
Ultrasound	5+	1

### **Record Accuracy and Completeness in Hospitals and Medical Offices**

Billing denials and returned mail are both indicators of record accuracy and completeness. With the new system, the overall billing denial rate has dropped from 23 percent to 10 percent. The returned mail rate has dropped from five percent to zero percent.

## **2. Success in Achieving Simplified and Consistent Processes across the Continuum of Care**

Critical to the success of the project was the year that ENH spent analyzing and redesigning all processes related to patient care, patient throughput and information flow. End-users drove the effort to simplify systems and processes, make them more consistent, and ensure the compatibility between the processes and the functionality of the Epic software. This level of ownership and involvement helped ensure process and system adoption among clinicians. Without 100 percent user adoption of the improved system-supported processes, ENH would not have achieved its results in patient safety and information accessibility and accuracy. And now with the system in place, performance improvement is even easier.

### **Enhanced Clinical Outcomes**

ENH has a robust set of more than 50 clinical pathways that logically extend seamlessly across the organization. ENH is unique in its links that create a continuum of care that begins in the physician office, continues through hospital outpatient visits, the acute care stay and back to the physician office for follow up. *Clinicians can now view a patient’s progress and influence outcomes in real time.* Rather than making adjustments retrospectively for future patients, they can be made in presently for existing patients.

- The system allows ENH to embed best-practice pathways throughout the continuum of care and across all facilities. For breast cancer, for example, it integrates radiology, outpatient hospital visits, inpatient care, physical therapy, and medical office check-ups. In the paper world, support for best practices required the physician to remember to pull the correct pre-printed orders, and the nurse to remember to pull the correct paper pathway and place it in the chart. Each area of the organization had “pieces of the pathway” that they were accountable for, and information was difficult to share across levels of care. Caregivers could come together after the fact to analysis outcomes, but could not during the course of care to assess progress and make changes.

With the Epic-based system, the care interventions and physician orders from all areas are displayed in the record. All clinicians can review all care steps as they occur and adjust the plan of care for best practice outcomes. Because the single, integrated record is longitudinal and comprehensive, all responses to care are available to everyone involved.

- ENH’s acute coronary syndrome pathway is also embedded in the Epic-based system. This pathway outlines the best practice plan of care recommended by the College of American Cardiology. ENH

can track individual and aggregate patient outcomes and report both internally and externally (JCAHO, NRMI, CMS) and be certain that the patient is treated appropriately immediately in the Emergency Department, again if necessary in the cath lab, and through length of stay. The system also ensures that the patient has the right medications for discharge and the right follow-up in the community for cardiac rehab. Orders for community based rehab are built into the discharge product, which has improved patient participation in these recovery activities.

**Proactive Risk Management**

The system can easily be reconfigured for near-instant implementation of new safety procedures and performance improvements. As a result, ENH already has identified and obviated potential problems with patient treatment.

- Following the result of an unanticipated outcome among patients receiving the pain medication Dilaudid, ENH was able to respond immediately with a change in recommended dosages for patients. ENH changed all 32 order sets and 22 preference lists in just three hours. Through the system, ENH notified every clinician of the change. When a physician orders Dilaudid now, the system raises an alert to evaluate the patient for previous experience and select the dosing tree accordingly. Nursing documentation in the system ensures that nurses conduct the correct assessments at the correct time.

Before the new system was in place, making a change like this would have involved changing pre-printed orders, checking individual physician prescriptive habits on a patient-by-patient basis, with the pharmacist directly calling the physician for consultation and change, and providing nurses with multiple inservices. *The Epic-based system facilitated an almost immediate change in recommended dosages and clinician behavior.*

- A similar situation arose when ENH noted three cases of toxicity with Dilantin. Pharmacist review indicated that all three patients had a low serum albumin level, which potentiates the effect. ENH has now built into the system a mechanism that prompts the physician to check albumin level and allows the pharmacist to calculate adjusted dosages.
- Although ENH did not exceed upper limits for DVT complication (blood clots in the legs), the organization wanted to improve performance. A physician-led pathway team designed a DVT risk assessment tool to be completed by the physician upon patient admission. The risk score, if over a certain level, recommends heparin/lovenox prophylaxis. This was built into the system and implemented within a week.

**3. Success in Meeting Other Corporate Objectives**

This project impacted all five of ENH’s organizational objectives for performance improvement:

- Best possible care and clinical outcomes for patients
- Patient safety
- Patient satisfaction
- Retention of talented staff
- Sound financial performance

The first two were addressed above; the remaining three are addressed below.

**Patient Satisfaction**

The new system supports patients’ increasing involvement and concern about their care. As one nurse explained, “Patients nowadays are really into what medications they take. They want to know what it is, how many milligrams, who actually ordered it. I can double check on my computer, and it makes them feel more comfortable.”

ENH expects the MyChart function, which will be installed in July 2004, to generate the most significant changes in patient satisfaction. This will give patients online access to portions of their charts and give them real-time connectivity with ENH and their physicians.

**Retention and recruitment of talented staff**

The common belief is that more and more nurses prefer to work with the support of information technology, and for good reason. The new system has eliminated much of the work that nurses enjoy least and that take them away from their clinical duties: photocopying, faxing, rewriting documents, and other time-consuming tasks associated with manual processes. During a recent drive to recruit 100 nurses, ENH advertised and demonstrated the Epic-based system to potential hires. The drive successfully recruited 142 nurses in 100 days.

**Sound financial performance**

ENH has begun to see improvements in several financial metrics. For example, the copay collection rate has increased from 21 percent to 50 percent. Physician office practices have noted the system’s potential to enhance revenue through better charge capture and greater billing accuracy. To allow physicians and staff the opportunity to learn the system, most practices reduced appointments during roll-out. However, several noted that even with fewer patient visits, revenue remained stable.

ENH has tracked all cost reductions associated with the EHR. These are shown below.

<b>Staff-Related Reductions</b>	
Emergency Department Efficiencies: Reduction in dictation expense and consolidation of several FTEs	\$455,000
Psychiatry: Reduction in a clinical counselor, clinical educator and coordinator of utilization review	\$38,000
PMR: Reduction of .5 billing office FTE	\$15,000
Reduction of Medical Records FTEs: As a result of the EHR, medical records technicians no longer scan documents. Those positions were redeployed to other vacant positions within Medical Records.	\$494,000
Surgery: Reduction of a surgical data entry position	\$45,000
EPIC Work Model 2South rehab/others: FTE eliminations, overtime reductions and temp expense reductions	\$342,000
Medical Group Front Office Redesign: General reworking of the front office workflow (i.e., chart retrieval and filing) including position eliminations in primary care and specialty offices.	\$300,000
Making Epic Work Savings: ENH was able to do a greater volume of billable activities with the same labor. We attributed 50% of this improvement to Epic. This was equivalent to reducing 65 FTEs throughout the corporation.	\$4,000,000
Resolute Billing improvements: elimination of seven positions at the business office	\$480,000
EpicCare Inpatient and Ambulatory: improved front-end documentation	\$112,000
Physician Billing Office Savings: staff reductions and efficiencies	\$1,500,000
<b>Total</b>	<b>\$7,781,000</b>

<b>Revenue Related</b>	
Increased Hospital Charge Capture: as a result of charges being directly linked to orders	\$2,500,000
Improved Coding Edits: Better charge capture in the Emergency Department	\$134,000
Resolute Savings: more flexible editing of claims	\$48,000
<b>Total</b>	<b>\$2,682,000</b>

<b>Service Related</b>	
Overall Dictation Costs—Hospital	\$300,000
Medical Group Dictation	\$480,000
Computer System Eliminations: elimination of CCRV (order results viewer) and McKesson scheduling system as well as the maintenance contracts for these systems	\$554,000
Reduction in the use of paper	\$32,000
Forms savings	\$550,000
Reduction in lost patient items: reduction of lost personal items as a result of nursing staff using the template to list personal property upon admission	\$25,000
<b>Total</b>	<b>\$1,941,000</b>
<b>Grand Total</b>	<b>\$12,404,000</b>

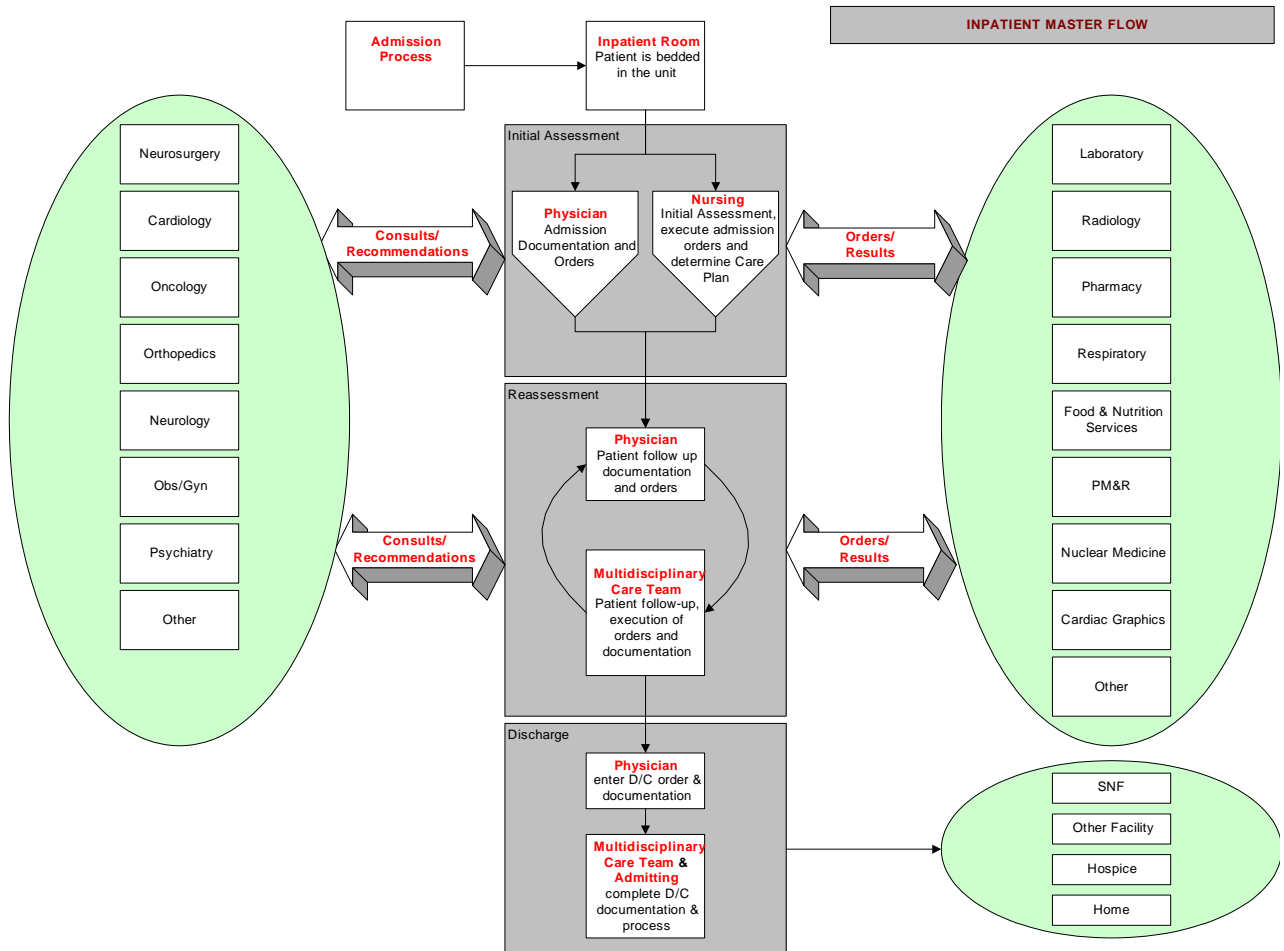
The annualized cost reductions show that even apart from the patient satisfaction and quality issues, there are good financial reasons to implement an EHR.

## Conclusion

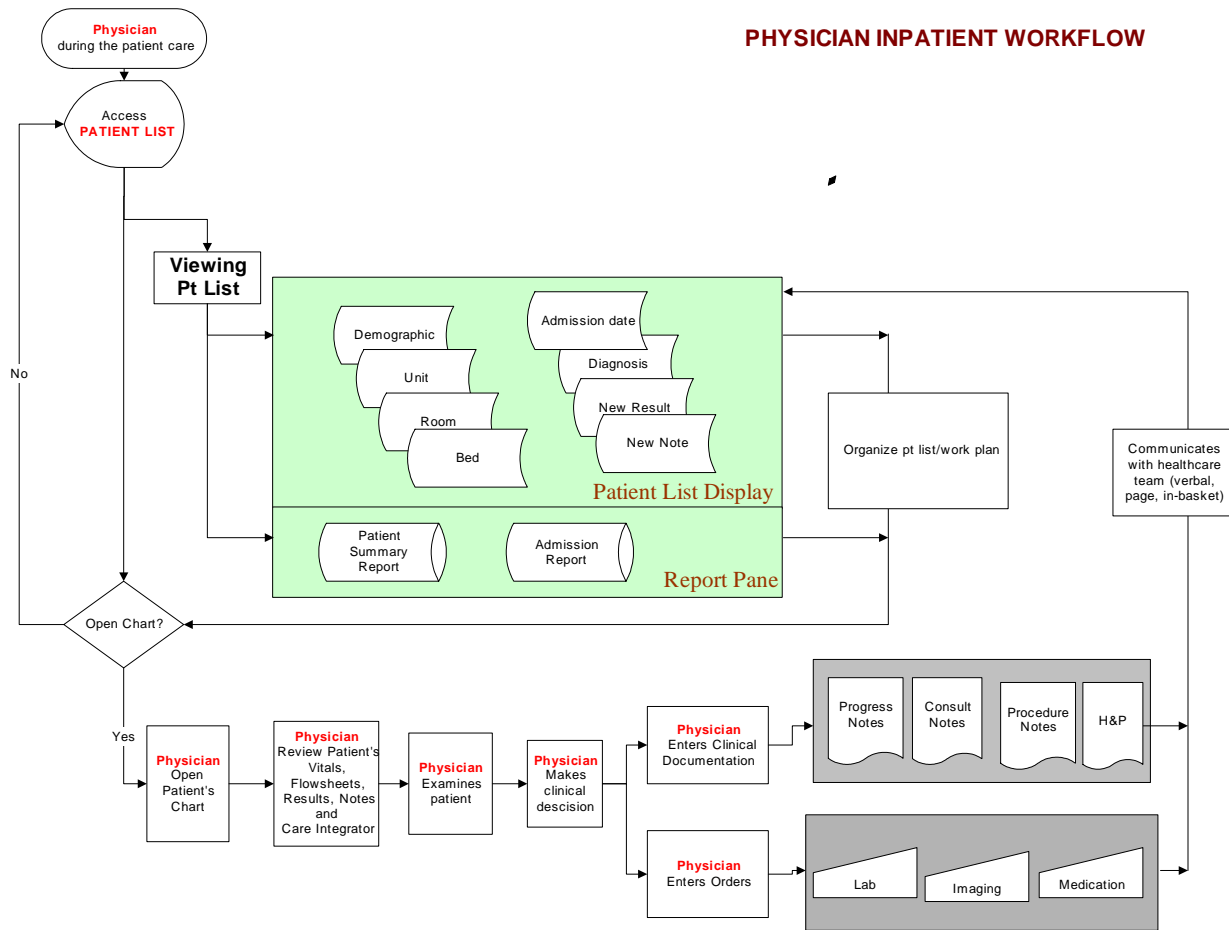
Evanston Northwestern Healthcare set out to launch an electronic health record at its hospitals and ended up with an integrated and paperless system that extends across the entire continuum of care — from inpatient visits to outpatient visits to the physician office. Patient information is available to every clinician throughout the organization in real-time. As Arnold Wagner, Jr, MD, head of the Physician Advisory Group for the system explains, “Evanston Northwestern Healthcare is showing how the innovative use of technology can deliver community-based medicine that leads to better patient outcomes. It puts the collective focus of our work right where it belongs — on the patient. And it makes Evanston Northwestern Healthcare a better place to practice medicine.”

**This new system is proven successful at delivering value to the organization, to its clinicians, and to its patients.**

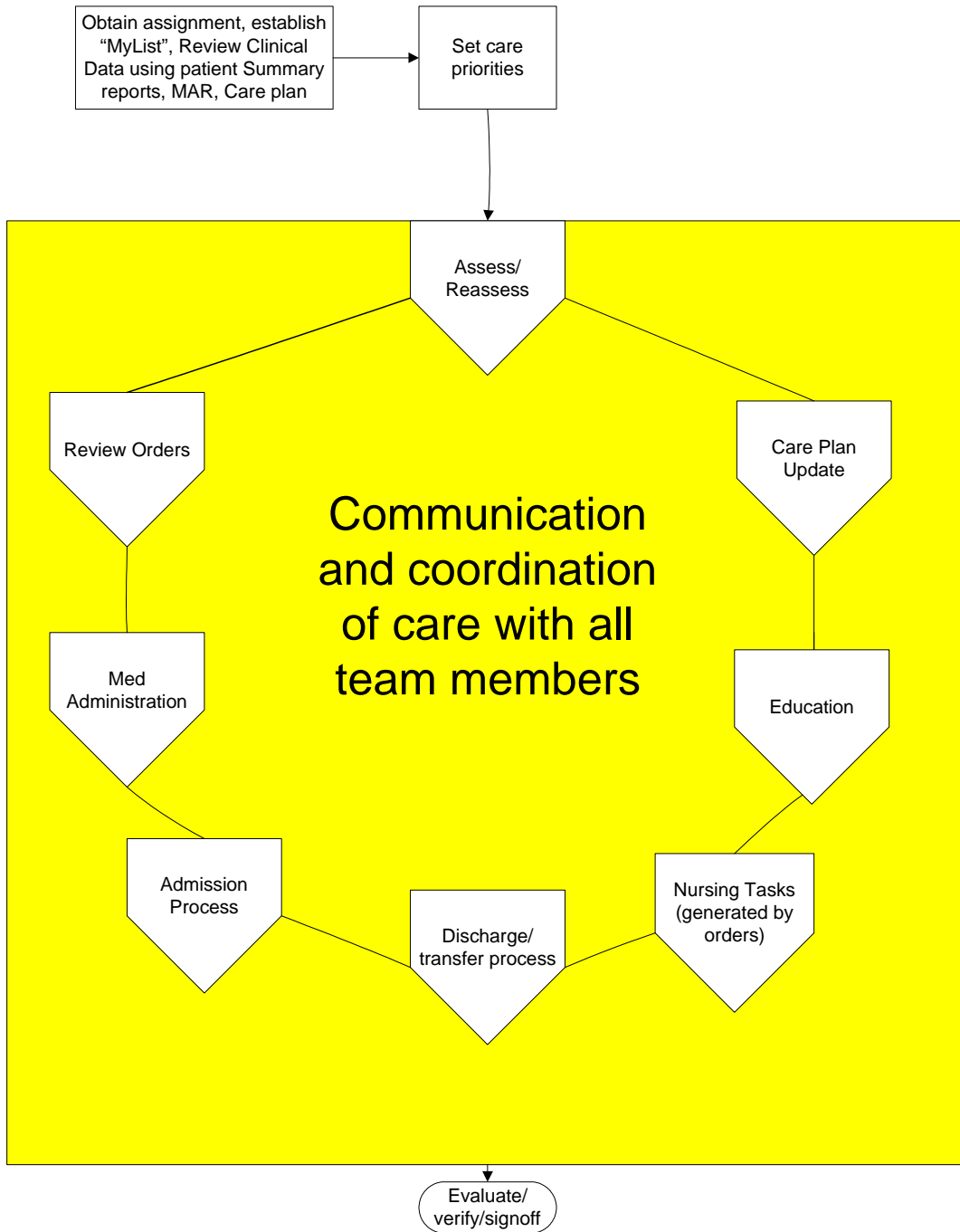
# Appendix A--Workflows



**PHYSICIAN INPATIENT WORKFLOW**



**Nursing Workflow**



# Appendix B—Epic Rollout Schedule

Epic Roll Out Schedule			
December 02	January 03	February 03	March 03
Rad US 12/02	GB Med West 1/02	GV Primary Care - GV 2/18	Glenbrook Hospital Documentation 3/15
Rad Angio 12/02	Nuclear Medicine 1/13	GV Primary Care-MP 2/25	GB Outpt Areas 3/15
Rad Mammo 12/09	Cardiac Graphics 1/13	Deerfield South 2/25	
Rad CT 12/09	Rad Therapy 1/13	Med Grp Ev - West 2/11	
Rad MRI 12/09	Vascular Lab 1/13	Call Center- All Order Entry Live 2/24	
Rad Diag 12/09	MG Pre-Reg Dept 1/02	Radiology -All Order Entry Live 2/24	
Call Center 12/09	Cardiac Graphics-All Order Entry Live 1/27		
Central Reg. 12/09			
PM & R Speech 12/09			
PM & R OO /Park Cntr 12/16			
PM & R /HPH Fitness 12/17			
PM & R 1000 Central 12/18			
PM & R Lymph 12/19			
April 03	May 03	June 03	July 03
Med Grp Ev East 4/8	Glenbrook Hospital Orders 5/17	Evanston Hospital Documentation 6/28	Maternal Fetal Medicine 7/15
Family Care Ctr 4/22	Ev Health Ctr 5/13	BG Health Ctr 6/10	EH-15 Hospital Departments Live on Order Entry 7/15
GBH-6 Hospital Departments Live on Order Entry 4/14	GB Med East 5/20	GV Health Ctr 6/10	EH-7 Hospital Departments Live on Order Entry 7/28
GBH-5 Hospital Departments Live on Order Entry 4/28	Ev Peds 5/20		
	Glencoe 5/27		
	Austin Internal Med 5/27		
August 03	September 03	October 03	November 03
OO Family Med 8/12	Dr. Breuer 9/16	Vernon Hills PC 10/21	Evanston Hospital Orders 11/1
OO Internal Med 8/12	Ev Spec Suites 9/16	Vernon Hills SC 10/14	EH OPD 11/11
OO Peds 8/19	GV Spec Suites 9/23	Deerfield North 10/14	EH Staff Ofc 11/18
OO OB/Gyn 8/26	Including Toxicology, Neuro, Peds Neuro, Rheum, PMR, Surgery, Neph, Pulm, Inf Disease, GI, Endo, Oncology, Cardiology, Gyn Onc	Family Care Ctr- HP 10/21	EH CAC 11/11
EH-10 Hospital Departments Live on Order Entry 8/11		EH Colposcopy 10/6	Kellogg Scheduling 11/1
EH-7 Hospital Departments Live on Order Entry 8/23			
December 03	January 04	February 04	March 04
Highland Park Hospital Documentation 12/6	OO Cardiology 1/20	Psych CORE 2/16	Lake Forest IM 3/17
OO Adol. Med 12/17	GB Cardiology 1/13	Psych HP 2/9	Ortho 3/16
OO Peds Endo 12/16	GB CHF Clinic 1/13	Psych Davis St. 2/23	
OO Vascular Surgery 12/11	VH Cardiology 1/20	Psych Ev 2/16	
OO Surgical Derm 12/10	Lincolnwood (WRP) 1/2	Psych GB Suite 2/9	
OO Endocrinology 12/17			
OO Med Dermatology 12/9			
OO Diabetic Ed 12/16			
April 04	May 04	June 04	July 04 thru Feb 05
Highland Park Hospital Orders 4/3	Berk 5/10	OGAE (Affiliate) 6/1	GB Amb Suite (8/04)
GV Park Ctr 4/20	Medical Genetics 5/12	TBD-Issues need to be overcome with specialty area	Urology-Blum/EH/GB (8-10/04)
HP Specialty Suites 4/13	ENT Ev 5/12	<ul style="list-style-type: none"> <li>▪ GB &amp; EH Plastic Surgery</li> <li>▪ UroGyne</li> <li>▪ GB Ophthalmology</li> <li>▪ GB LASIK Center</li> </ul>	OMEGA (9/04)
	Dept of Peds 5/19		TAU (Anticoag Clinic) (11/04)
			AGSW (Affil)(1/05)
			Orchard Medical(Affil)(2-3/05)
			Croghan (Affil)(3-4/05)
			HOV TBD: <ul style="list-style-type: none"> <li>▪ Research</li> <li>▪ Diabetic ED-Blum, EH, GH</li> </ul>
Green=Primary Care Office	Blue=Specialty Office	Red=Hospital Inpatient	Pink=Cadence, & Resolute