Title:	Midcoast Maine Patient Safety and IT Integration
Principal Investigator:	Maureen Buckley, PhD, RN – Vice President of Patient Care

Team Members:
Northeast Health and Partner Organizations

Donna Deblois, MS, RN – Executive Director, Kno-Wal-Lin Homecare and Hospice
Dana Goldsmith, MD – Vice President of Medical Affairs
Don Gross – Director, Knox Center for Long-term Care
Paul Klainer, MD – NEH Board of Directors
Joel Lafleur, MD – General Surgery, Medical Staff President
Bob McKeown – Executive Director, Quarry Hill Retirement Community
Dennis Puls – Chief Information Officer
Chris Shrum, MPA – Director, Government Funding
Bill Zuber – Director, Performance Improvement

Consulting Team

Jeff Brown, MS – Davis Group (Human Factors and Safety Science)
Duane Cromwell, PhD – Davis Group (Culture and Organization Change)
Paul Davis, RPh – Davis Group (Medication Administration, Planning and Organization Change)
Jeff Dunn, MD – VHA Consulting (Quality and Patient Safety)
Richard Howe, PhD – Howe Consulting (HIT)

Organization:	Northeast Health
Project Dates:	09/30/2004-09/29/2005
Federal Project Officer	Dr. David Stevens
Agency Support	$200,000 – Agency for Healthcare Research and Quality
Grant Number:	#1 P20 HS015170-01

Structured Abstract

Purpose: Northeast Health defined three key objectives of AHRQ's Transforming Healthcare Quality through Information Technology planning grant (THQIT):

- Assess and plan for the full integration of information across the entire Northeast Health system;
- Study organizational change within a rural healthcare system and develop an effective intervention strategy that takes into account organization culture and organizational structure;
- Introduce a more effective, consortium-wide planning process.

Scope: Northeast Health implemented a Meditech HIT system and experienced both technical and cultural challenges. Taking a sociotechnical systems approach to the project, NEH, which includes its five primary partner organizations and more than 20 physician offices, engaged VHA Consulting, Howe Consulting, and the Davis Group to assist in assessing quality, patient safety, culture, and technology.

Method: The study included three assessments—quality/patient safety; organizational culture; and technology—and was a mixed-method design that included quantitative analysis of patient/procedure outcomes, qualitative interviewing, and observation. Because of previous sociotechnical challenges to HIT implementation, mock scenarios were piloted during the implementation of a new Meditech HIT module.

Results: The study concluded that

- NEH had established a strong HIT infrastructure to build upon;
- By fully adopting the Meditech HIT system, NEH would realize significant improvements in the majority of the quality standards assessed and accomplish clinical integration;
- To be successful, the implementation needed to consider the sociotechnical system, shift the organization culture, and be mindful of human factors.

Key Words: Meditech, sociotechnical, culture, rural, technology

Purpose

The Transforming Healthcare Quality through Information Technology planning grant assisted Northeast Health (NEH) and its partners in planning activities that would lead to successful implementation of health information technology (HIT). The successful implementation would promote and improve patient safety and the quality of healthcare. NEH' s efforts were in line with AHRQ's objective to support community-wide planning processes across multiple healthcare organizations, enabling them to develop HIT infrastructure that provides for effective exchange of health information within the community.

The following outlines the purpose of the NEH THQIT planning grant:

- The integration of information across the entire Northeast Health system is central to the THQIT planning grant. Investigators plan to build an information technology infrastructure that is coordinated throughout the region, relying on a uniform electronic medical record; the development of a continuity of care system model; and better collection, analysis, and dissemination throughout the consortium of patient data to improve clinical decision making. The integration of information would improve medication management, the patient discharge process, and the case management system, which includes patient referral and community outreach.

- Northeast Health would study organizational change within a rural healthcare system and develop an effective intervention strategy that takes into account organization culture and organizational structure. Various organizational development and adult learning theories would be assessed against the current makeup of those people involved in the implementation and operation of the new technology to determine the most effective training and support system for a rural health system.

- The THQIT planning process would help introduce a more effective, consortium-wide planning process that considers capital, clinical, and administrative needs. A prioritization process would be established that weighs the need, the impact on the system, the cost of implementation, and the long-term operating costs. This new paradigm would result in increased economies of scale, a more effective development process, and overall savings to the system.

Scope

With a 95-member medical staff, 25 specialties, and more than 1,200 professional and support staff, Northeast Health is the community-based, rural health network serving midcoast Maine. The consortium includes an acute care hospital, two long-term care facilities, a home health and hospice organization, and a range of independent to assisted living facilities. Northeast Health has an annual operating budget of nearly $100 million and treated approximately 35,000 patients last year.

In 2001, Northeast Health implemented the Meditech HIT system, bringing online a number of clinical modules, specifically patient care management, patient registration, pharmacy, and lab. Extensive training was provided to physicians, nurses, and clinical support staff. Within the initial 18 months of going live with the Meditech medical information system, Northeast Health providers submitted 75 percent of their orders using CPOE. However, physicians, nurses, and other clinical staff constantly complained about the cumbersome nature of the system. It got to a point when the Special Care Unity (intensive care) refused to use the Meditech system, which began a cultural revolt within PBMC. It was decided, by hospital administration, to back away from Meditech's patient care management module and reassess the situation.

With an initial investment of over $4 million and using only an estimated 20 percent of Meditech's capacity, NEH was at a crossroads with Meditech and other HIT projects. It was clear that NEH needed to move forward with some form of integrated HIT system and that there was limited good will amongst physicians and staff to experience another troubled implementation. Fortunately, the organization received AHRQ funding through the THQIT planning grant program to assess its current state of HIT, evaluate past HIT implementations, and establish a plan to move toward a digital health community.

Taking a sociotechnical systems approach to the project, NEH recognized that, to be successful with operating HIT, attention must be paid not only to the technology but also to quality and patient safety; organization culture; and human factors. A project team was established, consisting of representatives from each partner organization within NEH as well as external consultants. The following outlines the partnership and key individuals involved:

- Penobscot Bay Medical Center – Maureen Buckley, PhD, RN, Dana Goldsmith, MD, Bill Zuber;
- Northeast Health – Dennis Puls, CIO, and Chris Shrum, MPA;
- Kno-Wal-Lin Homecare and Hospice – Donna Deblois, MS, RN;
- Quarry Hill Retirement Community – Bob McKeown;
- Knox Center for Long-term Care – Don Gross;
- Penobscot Bay Physicians and Associates – Paul Klainer, MD;
- Affiliated physician practices – Joel Lafleur, MD;
- VHA Consulting (quality and patient safety) – Jeff Dunn, MD;
- Howe Consulting (HIT) – Richard Howe, PhD; and
- The Davis Group (organization culture and human factors) – Jeff Brown, MS; Duane Cromwell, PhD; Paul Davis, RPh

Method

Northeast Health, in collaboration with Davis and Associates and VHA Consulting, designed the THQIT planning process as an action research method, which embraces three elements: research, action, and participation. Unless all three elements are present, the process does not function. As Greenwood and Levin state, "action research is a form

of research that generates knowledge claims for the express purpose of taking action to promote social change and social analysis" (Greenwood, p. 6). In the case of Northeast Health's THQIT planning grant, the social change objective was to enable the development of HIT infrastructure that improves patient safety through the effective exchange of health information across the continuum of care within the midcoast community.

Given the sociotechnical nature of the study, a mixed-method design was implemented. The study included three assessments–quality/patient safety; organizational culture; and technology–and included quantitative analysis of patient/procedure outcomes; qualitative interviewing; and observation. Because of the previous challenges to HIT implementation, mock scenarios were piloted during the implementation of a new Meditech HIT module.

Literature and Document Review

To gain a full perspective on Northeast Health, VHA Consulting and the Davis Group conducted a thorough literature and document review. The following is a list of documents included:

1. NEH Strategic Plan, written in 2002
2. Press Ganey Survey Results for 2002 and 2004
3. The Bard Report of Physician Engagement
4. Organizational Charts of All NEH entities
5. Major NEH Initiatives, written September 2004
6. Key Performance Indicator (KPI) Documents for all Executives
7. Results of the NEH Executive Staff Meeting on Patient Safety, conducted by Joanne Turnbull
8. The Joint Commission Survey Findings
9. Focus Groups Research Report for NEH, conducted by Digiton Corporation

Quantitative Analysis

Using data from Midas and Meditech, Northeast Health collected and analyzed the following data:

General Clinical Measures • Length of Stay (DRG) • Readmission Rate (DRG)	**Financial Measures** • FTE per Occupied Bed • Paid Hours per Adjusted Discharge ▪ Expense per Adjusted Discharge
Adverse Drug Events (ADE) • Unreconciled medications per 100 admissions • Percent of unreconciled medications	**Information Technology** • Utilization rates for particular HIT components, such as CPOE

Survey Research

Existing survey research was reviewed and incorporated into the methodology. Currently, Northeast Health utilizes two validated survey instruments, the Avitar Patient Satisfaction Survey administered quarterly and the Press Ganey Employee Survey administered every 2 years. Both instruments measure aspects of organizational culture, one focused on the patient's perspective and the other assessing organizational culture, change management, and satisfaction of employees. Northeast Health has collected four quarters of Avitar data, and the Press Ganey Employee Survey was administered in November 2002 and November 2004.

Qualitative Methods

The quantitative data were combined with a host of qualitative methods that provided considerable context for the THQIT planning study. The qualitative data included structured interviews and observation.

Structured Interviews

Throughout the THQIT planning study, primary, secondary, and tertiary stakeholders were engaged in structured interviews. These interviews were designed to address various aspects of the research, including process, formative, and summative evaluations. Specific protocols were developed to gain insight into overall patient safety as well as factors related to HIT, quality, culture, and human factors. Interview data were analyzed and assessed for themes. Themes from the interview narratives were grounded in actual participant's comments. An estimated 70 interviews were conducted. Stakeholders interviewed included:

- Administrators and Executives of NEH
- NEH Board Members and Community Incorporators
- Nursing Supervisors
- Nurses
- Information Technology Personnel
- Physicians
- Quality Improvement Personnel
- Discharge Planners
- Executives and Staff of the Hospital,
- Kno-Wal-Lin Homecare and Hospice Administration and Staff
- Quarry Hill and Knox Center Administration and Staff

Observation

Observation was incorporated into the planning process to gain an understanding of face-to-face interaction, person-to-technology interaction, hand-offs between clinical areas, and transfers between settings. Five days of observation were incorporated into the

research design to help inform current utilization of HIT, define information needs, identify work-around habits, and comprehend communication patterns.

Simulation and Mock Scenario Testing

Simulation and the use of mock scenarios were designed as part of the research to test assumptions on organizational culture, education and training, and the implementation of HIT. Using the implementation of a new Meditech module for Penobscot Bay Medical Center's operating room, a series of simulated exercises and mock scenarios was designed and implemented over a 4-week period prior to the system "go-live." Six scenarios were designed to represent roughly 85 percent of the cases that are presented in the operating room. These scenarios involved cases that are planned surgeries, cases that present in the emergency department, day surgery cases that discharged following the surgery, and inpatient surgical cases.

The staff of day surgery, the operating room, the post-anesthesia care unit (PACU), and endoscopy participated in a month of training that included 3 full days of simulation and mock scenario testing, which were observed by the Davis Group. These exercises helped inform the design of future HIT implementation and improve the education and training process. Over time, the use of these scenarios is expected to help shift the culture.

Results

The results of the THQIT planning study are organized by healthcare information technology; patient safety, clinical outcomes and quality; organization culture; and scenario and mock simulation outcomes.

HIT Assessment

VHA Consulting, in collaboration with Richard Howe, a private consultant, conducted a thorough assessment of Northeast Health's HIT infrastructure, resource allocation, and utilization to complete a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis, which follows:

Table 1: Northeast Health HIT SWOT Analysis

IT Strengths	**IT Weaknesses**
• Integrated HIS (Meditech) to Build Upon • Basic Clinical Information is Currently Available • Core Clinical System is Integrated with Major Ancillary Departments • Physicians Have Local and Remote Access to Clinical Results • Bar-Coding is Used for Blood and Specimen Tracking	• No Point-of-Care Electronic Charting for Nursing • CPOE is Partially Implemented (25% of Physicians) • Automated Clinical Protocols Are Minimally Implemented • No Bar-Coded Electronic MAR • RIS/PACS System is Not Interfaced With Meditech EMR

IT Strengths	IT Weaknesses
• State-of-the-Art Network Infrastructure • Most Physician Offices Have Ability to Purchase High-Speed Cable Access	• Clinical Users Need "New Involvement" in the IT Planning and Implementation Processes • IT Strategy and Relation to "Clinical Vision" is Not Well Articulated to Key Stakeholders • It is understaffed for implementation, customization and long-term support
IT Opportunities	**IT Threats**
• "Rejuvenate" and Re-implement Meditech HIS • Implement Clinical Data Repository • Fully Implement Bedside Clinical Charting • Implement Electronic MAR • Fully Implement Results Reporting for All Clinical Information • Implement Ability to Alert Physicians of Critical Results • Fully Implement Physician Notes and Charting • Fully Implement CPOE with Clinical Decision Support • Reduce LOS Through Full Use of Automated Tools and Processes	• Increase in Operating Costs with Maintenance of Duplicate Clinical Processes (Manual and Automated) • Decrease in Patient Safety Due to Duplicate Clinical Processes • Potential Increase in Medication Errors and/or LOS Due to Manual Paper Process for Pharmacy Orders • Inability to Access Patient Information Across Continuum of Care • Open Opportunity for Competitive Commercial Lab Vendors • Inability to Support Goals and Objectives of the THQIT Grant

Analysis of Initial Meditech Implementation Process

The THQIT planning grant allowed Northeast Health to study the initial Meditech implementation to gain an understanding of the pitfalls experienced in the process and learn how to better implement HIT. Through a series of one-to-one and group interviews with Information Technology staff, physicians, nurses, administrators, and other clinicians, Richard Howe made several key findings:

- Meditech's standard definitions for clinical databases, dictionaries, and data sets were not modified to reflect the work environment of Northeast Health.
- Executive leadership did not remain steadfast to the Meditech implementation process and overall vision.
- Meditech implementation was not clinically led.
- A clear clinical vision was not established early in the process.
- Superusers were not adequately trained and did not have representation from each department, each unit, or for all shifts.
- Bedside nurse charting was only partially implemented as a result of lack of training.
- Meditech implementation was under resourced and needed to engage more external support, either Meditech staff or outside consultants specializing in Meditech.

Patient Safety, Clinical Outcomes and Quality Assessment

Dr. Jeff Dunn from VHA Consulting worked with Northeast Health's Performance Improvement staff to conduct a comprehensive assessment of patient safety, clinical outcomes, and quality measures, incorporating both quantitative and qualitative analyses. Specific disease areas were studied.

A major indicator of quality is length of stay. For all major DRG classifications except orthopedics (joint and limb reattachment), Northeast Health far exceeds national standards as the table below indicates.

Penobscot Bay Medical Center Length of Stay Comparison

		Length of Stay				
DRG Name	Discharges	ALOS	Norm ALOS	Avg LOS Var	~75th %ile	~90th %ile
PSYCHOSES	538	8.1	6.9	1.2	6.21	5.52
NORMAL NEWBORN	238	2.1	2	0.1	1.8	1.6
VAGINAL DELIVERY W/O COMPLICATING DIAGNOSES	187	2.1	1.9	0.2	1.71	1.52
MAJOR JOINT & LIMB REATTACHMENT PROCEDURES OF LOWER EXTREMITY	154	3.9	4.4	-0.5	3.96	3.52
SIMPLE PNEUMONIA & PLEURISY AGE >17 W CC	148	6	4.9	1	4.41	3.92
ESOPHAGITIS, GASTROENT & MISC DIGEST DISORDERS AGE >17 W CC	105	6.5	3.2	3.3	2.88	2.56
ALC/DRUG ABUSE OR DEPEND W/O REHABILITATION THERAPY W/O CC	103	5.8	3.1	2.7	2.79	2.48
CIRCULATORY DISORDERS W AMI & MAJOR COMP, DISCHARGED ALIVE	102	5.1	3.9	1.2	3.51	3.12
HEART FAILURE & SHOCK	100	4.9	4.2	0.7	3.78	3.36
CHEST PAIN	97	1.9	1.6	0.3	1.44	1.28

Extended length of stay can often translate to an increase cost per case. The table below outlines Penobscot Bay Medical Center's cost per case for the major DRG classifications and compares that with national averages, the 75th percentile, and the 90th percentile.

Penobscot Bay Medical Center Cost per Case Comparison

DRG Name	Dschgs	Penobscot Bay Cost/case	Norm Cost /case	Top Qtr cost/case	Top 10% cost/case
MAJOR JOINT & LIMB REATTACHMENT PROCEDURES OF LOWER EXTREMITY	134	$9,391	$11,409	$10,268	$9,127
PSYCHOSES	134	$8,258	$5,199	$4,679	$4,159
SIMPLE PNEUMONIA & PLEURISY AGE >17 W CC	111	$6,426	$5,438	$4,894	$4,350
HEART FAILURE & SHOCK	108	$5,409	$5,050	$4,545	$4,040
CIRCULATORY DISORDERS W AMI & MAJOR COMP, DISCHARGED ALIVE	90	$8,218	$7,328	$6,595	$5,862
ESOPHAGITIS, GASTROENT & MISC DIGEST DISORDERS AGE >17 W CC	76	$5,219	$4,009	$3,608	$3,207
CHRONIC OBSTRUCTIVE PULMONARY DISEASE	71	$6,915	$5,101	$4,591	$4,081
SEPTICEMIA AGE >17	61	$8,358	$7,969	$7,172	$6,375
ATHEROSCLEROSIS W CC	55	$4,003	$3,400	$3,060	$2,720
CHEST PAIN	55	$3,536	$2,841	$2,557	$2,273

Despite the extended length of stay and the increased cost per case, Penobscot Bay Medical Center's mortality rate meets and exceeds national standards in the majority of disease classifications.

To provide context to the clinical data outlined above, Dr. Dunn conducted a series of one-on-one, structured interviews with physicians, nurse leaders, and frontline nurse caregivers, pharmacists, administrators, and other clinical specialists. The following highlights his findings:

Patient Safety

Since the release of the Institute of Medicine's (IOM's) report, To Err is Human: Building a Safer Health System, in 2000, the term 'patient safety' has become a rallying cry for those who would reform medical management and/or hospital administrative practice in the United States (Corrigon, Kohn, & Donaldson, 2000). The patient safety movement is multifaceted and complex, embracing a range of perspectives on the etiology of patient injuries and deaths, which should be deemed preventable, and what should be done to limit their occurrence.

- Error reporting program is in place and is nonpunitive. However, there is no formal written definition of medical error, and the culture does not embrace program

monitoring. Therefore, though there is willingness to report errors, there is no great motivation to do so.
- The effectiveness of patient safety programs is not audited or measured.
- Leadership in patient safety is ineffective. Executive leadership is not highly visible, there is no proactive Performance Improvement program (the organization culture does not encourage frontline staff to be active in performance improvement), and there is no board-level safety committee. There are no champions of performance improvement.
- Safety rounds are conducted in a limited way, primarily for the physical plant, and could utilize more core measures to assess patient safety.

Medication Administration

- All IV medications are prepared in the Pharmacy. Medications are stored in patients' rooms, and floor stock is minimal.
- Critical drug monitoring programs are in place. Discharge medication programs are in place: ~a key transition. The Pharmacy monitors critical patient information.
- CPOE is used minimally. Medication administration software is not used. Standardized critical order sets are minimal.
- There is no anticoagulation delivery team in place.

Patient Care

- Care Paths are rarely used.
- Protocols not used in 100 percent of cases. When protocols are used, they not audited for resource utilization. Safety protocols not monitored.
- Although national safety guidelines are implemented, they are not tracked or audited. Guidelines for falls, medication errors and adverse drug reactions are in place, and double signatures are beginning to be used. However, accountability and follow-up are poor.

Recognizing that HIT also impacts financial data, the following was completed during the initial assessment comparing technically advanced hospitals with other hospitals and Penobscot Bay Medical Center. These data will provide the basis for an evaluation of cost effectiveness of HIT.

Attribute	**Technically Advanced Hospitals**	**Other Hospitals**	**PBMC**
All Payers: Average Length of Stay	3.24 days	3.73 days	4.45 days
Highest AA Credit Rating	35%	15%	NA
FTE's per Occupied Bed	3.3	3.8	4.95
Paid Hrs per Adjusted Discharge	90.3	113.9	140
Expenses per Adjusted Facility Discharge	$3,995	$4,511	$6,268

Annual Increase in Expenses	0.6%	2.8%	6.2%

Culture

Davis and Associates conducted a cultural assessment of Northeast Health from mid-December 2004 to end of January 2005. The assessment draws upon the work of Ronald Westrum, who has developed a cultural typology that is based on how different organizational cultures handle safety information (Westrum, 1992; Reason, 1997). Culture can constitute a significant barrier to effective communication, stifling the ability of personnel to explicitly address safety issues, allowing risk to go unaddressed.

Westrum Framework

Ronald Westrum, at Eastern Michigan University, has developed a cultural assessment framework that has quickly gained acceptance in patient safety applications. According to Westrum, "The most critical issue for organizational safety is the flow of information." Poor communication is the number one identified reason for compromises of patient safety both in adverse events and sentinel events. Westrum goes on to say, "Failures in information flow figure prominently in many major accidents, but information flow is also a type marker for organizational culture."

Westrum identified three typical patterns. The first is a preoccupation with personal power, needs, and glory. The second is a preoccupation with rules, positions, and departmental turf. The third is a concentration on the mission itself, as opposed to a concentration on persons or positions. Westrum called these, respectively, pathological, bureaucratic, and generative patterns, outlined below.

Pathological Culture	Bureaucratic Culture	Generative Culture
Don't want to know	May not be informed	Actively seek problems
Messengers are executed	Messengers are listened to if they make it through channels	Everyone a messenger: messaging rewarded and reinforced
Responsibility is avoided	Responsibility is siloed	Responsibility is shared
Failure is punished or concealed	Failure leads to local fixes	Failures lead to systemic reforms
New ideas are actively discouraged	Action on new ideas is dampened by political or hierarchical constraints	New ideas are actively sought and explored

In looking at culture, the Davis Group recognizes Edgar Schein's notion that three distinct cultures exist within any given organization: "operators" or line managers and workers who deliver care; "engineers" or physicians; and "executives" or hospital administration. This segmentation is a particularly important concept, given the inter-relationships and interdependence in healthcare. *"In effect, all of the research*

findings about the importance of teamwork, collaboration, commitment, and involvement fall on deaf executive ears ... What this line of thinking leads to is the possibility that the organization as a unit may not ever be able to be a reliable learning system unless it reconciles the built-in conflict between these three cultures." ("Culture: The Missing Concept in Organizational Studies," Edgar Schein, **Administrative Science Quarterly**, 41, 1996, pp. 236-38)

In applying the Westrum framework, the Davis Group assessed the environment in which the system operates, Northeast Health as a system, and Schein's three distinct cultures. This approach provides a comprehensive look at all aspects of culture as it relates to patient safety.

Assessment	Pathologic	Bureaucratic	Generative
Cultural Milieu	**X**		
Northeast Health		**X**	
NEH Executive Team		**X**	
NEH Management Team		**X**	
Physicians		**X**	
Nursing		**X**	

Key findings from the Cultural Assessment

- The culture of the local area seems to have the ability to remember stories for a long time, particularly of negative incidents, and to amplify the stories over time in an unforgiving manner. There is a definite vein of pessimism and a tendency to be skeptical and harsh in its criticisms of local institutions.
- The addition of new team members responsible for both physician and nursing care has given the team a new opportunity to come together and decide what is strategically important and to be a strong guiding coalition for change.
- The Executive Team is strongly aligned around the need to move toward being a generative-functioning team, capable of driving the whole healthcare system to a higher level of patient care quality and safety, with attention to the needs and well-being of the care team, coupled with responsible financial stewardship.
- The members of the management team at the next level of the organization that we interviewed or observed at work are universally dedicated to providing quality and safe patient care and fully embrace the mission of the organization. With some exceptions, they are functioning with a bureaucratic mindset that has decision making often optimized for that entity or function but suboptimized for the overall generation of solutions that work for the entire organization.
- NEH follows a " professional bureaucratic" formula in its relationship with the physicians in the community, and it should not be as surprise to find they act in primarily bureaucratic ways. As one physician stated in an interview, "Sometimes our interests coincide with those of NEH regarding our patients' care, and sometimes

they compete. We can always be trusted to look out for the best interests of our patients, but we can't and don't totally ignore what's in our own interest, as well."

- Any improvement of the physician culture, and movement toward being a generative organization overall, would need to rely on extensive physician involvement---in ways and modalities that work easily into their practices---in problem solving and decision making.
- Nurses are part of the same "professional bureaucratic" organization as physicians and are subject to the same "litany of challenges." Such pressures may be the stimulus for beneficial innovation, as necessity spawns invention, and traditional ways of working are re-engineered for quality and efficiency, or they may simply create ad hoc workarounds with risky side effects, interpersonal conflicts, and plummeting morale.

Simulation-based assessment of information display, training, and implementation

The fields of Human Computer Interaction and Human Factors have developed methods and tools to enhance the usability of complex technological systems, including information technologies. In essence, the term 'usability' describes the ability of operators to access and exercise the intended functionality of a tool or technology. Though any information technology bound for healthcare settings should have extensive usability assessment before being released, this is rarely the case. Indeed, information systems that are not well matched to the real-world cognitive and perceptual needs of users are both problematic and common in healthcare. Compounding design usability issues, poor preparation and assessment of HIT implementation can lead to limited acceptance or rejection among staff---a lesson learned by NEH in its first Meditech implementation effort. Recognizing that NEH staff widely perceive Meditech Information Technology to be awkward and difficult to use, we believed it necessary to pilot an approach to:

1. examine the usability of the information display "build,"
2. train in the use of Meditech, and
3. train in the implementation process.

We chose the Penobscot Bay Medical Center Operating Room Meditech Build Team as the group to pilot a simulation-based assessment of the user interface, training effectiveness, and the implementation process. The goal of this assessment was to do our best to limit any glitches with the technology when working with real patients. A series of simulated exercises was designed and implemented with perioperative stakeholders over a 4-week period prior to the system “go-live.” Six scenarios were designed to represent roughly 85 percent of the most common cases that are presented in the operating room. These scenarios involved cases that are planned surgeries, cases that present in the emergency department, day surgery cases that discharged following the surgery, and inpatient surgical cases.

The staff of day surgery, the operating room, the post-anesthesia care unit (PACU), and endoscopy participated in a month of training that included 3 full days of simulation and scenario testing, which were observed by the Davis Group. As a result of these exercises:

- previously unidentified quirks of Meditech operation were identified, and strategies for contending with these were developed and trained;
- problems with the wireless network were identified and addressed prior to "go live";
- issues of acceptance related to physician and nurse resistance were respectfully dealt with through education, consistent communication in response to concerns, and highly visible leadership commitment to the technology;
- problematic features and behaviors of Meditech that can not be altered by users were reported the Meditech company;
- a model for the Meditech implementation process has been developed that can be applied through NEH.

Recommendations

The recent JAMA article *Role of Computerized Physician Order Entry Systems in Facilitating Medication Errors* conveys the importance of effectively implementing and maintaining CPOE systems that take into account organizational culture and work patterns. Koppel et al illustrated the need to customize HIT upon implementation: "For example, if usual dosages are 20 or 30 mg, the pharmacy might stock only 10-mg doses, so 10-mg doses are displayed on CPOE screens." This suggests the need for better integration across functions, in this case pharmacy and physician, and the need to redefine clinical databases.

The article makes the following five recommendations that serve as the basis for the recommendations:

1. Focus on the organization of work, not on technology;
2. Aggressively examine the technology in use; be cognizant of workarounds, medical problem solving ethos, and low staff status;
3. Aggressively fix technology when it is counterproductive;
4. Pursue errors' "second stories" and multiple causations to overcome barriers enhanced by incomplete error reporting; and
5. Plan for continuous revisions and quality improvement, recognizing that change generates new risk.

The goal of Northeast Health's THQIT initiative was to advance patient safety in a rural, integrated health system through the use of HIT. As Richard Howe shared with the Northeast Health team, "Information technology is not a business goal. That is like saying the telephone on your desk is a business goal. IT is a tool that allows you to accomplish your goal." The recommendations outlined below embrace both Koppel's recommendations and Howe's insights and follow the framework that healthcare is a sociotechnical system that involves HIT, quality, culture, and human factors.

Meditech Rejuvenation and Expansion of HIT

The cornerstone of Northeast Health's THQIT recommendations is the rejuvenation of the current Meditech clinical information system and expansion of other health information technology (HIT). Since Northeast Health backed away from the initial Meditech implementation, there has been some debate within the organization as to the future of an integrated medical information system throughout the continuum of care. The work Richard Howe completed through the THQIT planning grant outlined a successful rejuvenation process that other community hospitals in the country had followed to address similar issues experienced with the Meditech system. The following are Dr. Howe's recommendations:

- Implementation of all Meditech modules and completion of the rejuvenation process of existing modules;
- Redefine the clinical database for order entry; revise treatment protocols to reflect evidence-based medicine; and implement a number of key modules, such as the Clinical Data Repository, Patient Accounting and Medical Records, nurse charting, bedside e-MAR, and all general financial applications;
- Establish an interdisciplinary team, including physicians, nurses, pharmacy, lab, frontline clinical staff, administration, financial personnel, materials services, and human resource representatives, to work closely with outside experts who have extensive knowledge in Meditech and clinical processes; and
- Establish treatment protocols that mirror Northeast Health's culture, environment, workflow, and patterns of communication.

This process would address both technical functions and human interaction with HIT to ensure that the rejuvenated Meditech system would best reflect Northeast Health's work. There would be a need to modify work habits to effectively utilize the Meditech system, but, with a custom clinical database design and treatment protocols that meet the intuitive ways of delivering patient care within this particular system, it is anticipated that many of the barriers experienced in the initial implementation would be greatly reduce or eliminated.

Training is a major aspect of the Meditech rejuvenation process, which Northeast Health failed to fully appreciate in the initial implementation. Training would be both academic and experiential training, utilizing classroom and clinical settings. Northeast Health would engage expert trainers from Meditech to work closely with clinical staff identified as superusers to design a comprehensive training program. Outside experts would deliver much of the classroom training, while Meditech clinical superusers would assist users in the unit and provide support over an extended period to ensure retention. On the advice of Richard Howe, Northeast Health plans to double Meditech's recommended resource allocation for training. In previous rejuvenation processes, Mr. Howe found this

level of training support necessary to effectively implement the system and sustain organizational change.

Meditech Module Implementation

Critical to the success of the Meditech rejuvenation is the sequence of implementation of particular Meditech modules. For example, materials services and certain financial modules need to be implemented prior to specific clinical modules, such as the Operating Room. Over the 3-year THQIT implementation process, Northeast Health would implement the following Meditech modules that represent the remaining modules to reach the full complement within the Meditech HIT.

Year 1	Year 2	Year 3
• Data Repository – Implement and report design • E-MAR at PBMC (medication order entry only) • Financial – General Ledger • Implement Operating Room • Implement Materials Services • Implement System Upgrade Other HIT • Implement Lab connectivity to remote sites • Enhance RIS/PACS web connectivity • Implement Well@Home monitor pilot	• Bedside Charting • Bar Coded e-MAR/Patient ID • Full Results in EMR • Implement Medical Records • Implement Patient Accounts • Long-term Care Module • Streamline Meditech user interface Other HIT • Well@Home full implementation	• Implement Physician notes and charting • Implement CPOE and Clinical Decision Support 100% • Utilize wireless technology for standard forms/protocols • Implement E-MAR across the entire NEH system • Implement Community-wide Scheduling • Implement Behavioral Health • Emergency Department Management • Human Resource and Payroll • Medical Practice Management Other HIT • Upgrade to PtCT Maestro at KWL

Quality, Culture and Human Factors

After acknowledging that a major HIT intervention works in concert with quality, culture, and human factors to create a sociotechnical system, it was recommended that Northeast Health plan incorporate a series of complementary practices, processes, and interventions to help ensure greater results of the THQIT implementation phase. These supporting actions would be incorporated into the overall Meditech rejuvenation and expansion.

Quality – Northeast Health adheres to limited best practices and evidence-based medicine. As part of the THQIT process, Northeast Health should develop standard order sets to accomplish best practices and implement those best practices across the continuum of care. Standardized best practices should be identified for the four key DRG codes

(AMI, CHF, CAP, and SIP) as well as for the 100K Lives program and CMS core measures. Structurally, Northeast Health implemented a best practice committee with representation across the system that oversees a quality reporting process and increases accountability to adhere to evidence-based medicine.

Culture – Creating a vision that fully embraces and clearly states the importance of patient safety and quality, coupled with building trust in the future vision for an integrated HIT, and particularly trust in the Meditech system, is essential in the rejuvenation process. Remediation with medical staff and nursing should be planned, as considerable skepticism and tension exist as a result of the initial implementation. As trust in the future vision is established and Meditech's true functionality is demonstrated by conducting site visits to highly integrated systems, a foundation could be set in which senior leadership can empower staff in the rejuvenation process. This empowerment could help foster the development of critical thinking skills and lead to improved communications across all roles and responsibilities at all levels of care within Northeast Health.

Human Factors – THQIT implementation includes additional assessment of human factors and related human factors interventions that involve HIT and have direct impact on patient safety. A gap analysis should be conducted to assess communication and transfer of safety critical information in both an IT setting as well as in human-to-human interaction. This analysis would allow Northeast Health to map information that is best transferred through IT or determine what is most effectively communicated human to human. Two interventions would be planned: the introduction of a protocol form (e.g., Daily Patient Goal Sheet) and interdisciplinary teaming or rounding. Both are designed to improve report, with more clinical information exchanged across the system.

Northeast Health would pilot interdisciplinary teaming by engaging the hospitalists in a limited number of beds in the med/surg unit. This teaming approach would involve the physician, attending nurse, clinical support, the patient, and their family. It would be modeled after a similar program implemented at Concord Hospital in New Hampshire.

List of Publications

1. Northeast Health THQIT Plan