Grant Final Report

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Collaborative EHR Implementation to Bridge the Continuum of Care in Rural Iowa

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Abstract

Purpose: The primary objective of this grant was to evaluate the implementation of a comprehensive electronic health record (EHR) with computerized provider order entry (CPOE), active decision support tools, integrated Pharmacy Information System, clinical documentation, and bar code scanning enabled medication administration system in a network of small rural hospitals.

Scope: The project focused on seven critical access hospitals (CAH) in Mercy Health Network-North Iowa.

Methods: Qualitative and quantitative approaches were used to track the process and outcomes related to implementation. A well-formulated readiness process documented progress through project milestones. Annual surveys of employees assessed their perceptions of healthcare quality and care processes. Key informant interviews collected information on the implementation process and perceived outcomes. Quantitative data on outcomes related to implementation effectiveness and patient safety were monitored.

Results: The EHR system was successfully implemented. Surveys administered before and after activation to staff at all hospitals and interviews with key informants indicated that much of the success of implementing such a comprehensive, sophisticated clinical information system occurred because of the networking of the seven CAHs with the support of the rural referral hospital that owned or managed them (MMC-NI), which in turn was owned by Trinity Health. The readiness process developed by Trinity Health provided the structure and core to the project management approach used during the implementation at MMC-NI in 2005 and the subsequent implementation in 2008 at these seven CAHs. Yet this implementation experience at seven networked CAHs required further refinement to fit the unique requirements of these small rural hospitals. This project developed approaches to customizing the Trinity Health readiness process to fit their specific needs. Evaluation indicated that the extensive and well-orchestrated readiness process was a key factor in successful implementation. Review and restructuring of care processes and workflow occurred and was hardwired into the EHR system. Processes that were dictated by the systems being implemented included activation of specific vendor solutions, a two-stage implementation process with a staged phase in of read-only capability prior to full activation, extensive testing of cut-over, consistency of documentation forms, clinical decision support including evidence and alerts, role-based security access, management structure of readiness leader, orchestrated project management approach, use of super-users to support end users during initial weeks of activation, and extensive system activation assistance. A major process to align the pharmacy formularies was achieved by collaboration across the seven networked hospitals. Processes that varied somewhat across the seven hospitals included staffing during training, approaches for implementing 24/7 registration and pharmacist review of medication orders, and review of order sets. In summary, a successful implementation of a comprehensive clinical information system occurred at seven networked CAHs through a combination of on-site, networked, and system-wide support.

Key Words: health information technology (HIT), electronic health record (EHR), rural hospitals, critical access hospitals (CAH), patient safety

Final Report

Purpose

Seven critical access hospitals (CAH) in North Iowa, as part of the Mercy Health Network-North Iowa, in partnership with Mercy Medical Center-North Iowa (MMC-NI) and Trinity Health, combined clinical and technical expertise as well as financial resources to make it possible to successfully implement a highly sophisticated, comprehensive, integrated electronic health record (EHR) system with computerized provider order entry (CPOE), evidence-based care guidelines, decision-support tools, and an enterprise-wide master patient index that allow appropriate providers access to clinical information for care provided in any of the partners' facilities. Researchers from the University of Iowa and the University of Missouri provided evaluation for the AHRQ grant-supported project.

The short-term goals were to:

1) Provide all clinicians with rapid, round-the-clock access to accurate, complete, and current patient information;

2) Enable physicians and other clinicians to follow standard, evidence-based practices using uniform data standards at the point of care in all delivery sites;

3) Allow confidential and secure exchange of patient information across diverse health care setting;

4) Enhance clinicians' ability to communicate and coordinate patient management within each health care site, across Mercy Health Network-North Iowa facilities, and beyond;

5) Improve tracking and monitoring of clinical quality by pooling patient information across the network;

6) Provide administrative staff with standard, integrated, automated tools for patient registration, scheduling, billing, and claims that will improve organizational efficiency and financial performance as well as provide more timely care to patients;

7) Generate significant organizational learning about the effectiveness of this collaborative implementation process and integrated EHR system.

The long-term goals were to:

1) Increase rural patients' access to distant specialists and improve care provided across geographic separation;

2) Enhance medication safety through expanded pharmacist consultation;

3) Reduce health care costs through improved organizational efficiencies and reducing unnecessary treatments and medical errors;

4) Maximize use of expertise, resources, and learning within and across their organizations, MMC-NI, and contracted providers;

5) Enhance recruitment and retention of physicians and other health professionals;

6) Ensure the viability of their organizations through improving capacity to manage complex, high-risk patients and increasing patients' confidence in the care they provide.

Scope

Enormous progress has been made in health information technology applications nationally. Today, hospital-based information systems include enterprise-wide clinical information sharing and point-of-care decision support in such applications as EHR and CPOE. However, rural hospitals are less likely to have these clinical information system capacities because of expense, limited in-house technical expertise, and the fact that many clinical information system applications are designed with larger hospitals in mind.

The implementation of a sophisticated clinical information system in seven CAHs occurred because they were affiliated with MMC-NI and Trinity Health.

Trinity Health, which was formed through the merger of two health systems, began with an inherited mix of hardware platforms, legacy systems, and vendors. Subsequently, Trinity Health adopted a system-wide strategy for information technology consisting of agreement on core vendors, centralization of software purchasing across the organization's information technology infrastructure, and standardization of applications and management. MMC-NI had previously implemented a clinical information system in July 2005 as part of Trinity Health's staged activation throughout its system. The implementation of this same clinical information system in MMC-NI's network of CAHs may be one of the first in the nation to activate such a sophisticated system using a collaborative approach across the seven networked CAHs simultaneously.

Methods

The methods for the project include the process of preparing for and implementing the comprehensive clinical information system plus the methods used to evaluate the process and outcomes of implementation. These are described below along with information about the organizations involved.

Organizations Involved in the Project

Trinity Health of Novi, Michigan owns or manages 45 hospitals, mostly in the Midwest. Trinity Health has as one of its strategic priorities the implementation of comprehensive clinical information systems throughout its hospitals and affiliated clinics. MMC-NI implemented the same clinical information system as other Trinity Health hospitals in July 2005. MMC-NI owns or manages nine CAHs in north Iowa, and partners with them as Mercy Health Network-North Iowa. The current grant tracked the implementation of nearly the same clinical information system in seven of these nine CAHs, in what is termed the EHR[10] project. Characteristics of the seven participating CAHs are described below.

Study Hospitals. Mercy Health Network-North Iowa serves a 14 county region in north central Iowa with a combined service area population in excess of 200,000. The majority of primary care physicians practicing in the seven CAHs are also affiliated with the primary care practice network managed by MMC-NI. While the dominant referral pattern is between primary care providers practicing in the network CAHs and medical and surgical specialists working out of MMC-NI, referrals are also made to other regional medical centers.

Table 1 provides a summary of the operating characteristics in the seven CAHs participating in the EHR[10] project. All CAHs had 25 or fewer acute care beds (one included a 10-bed psychiatric unit). Two had attached nursing homes. Inpatient admissions in the CAHs ranged from 350 to 1,795, and all but two offered obstetric services. Full-time equivalent staff ranged from 92 o 180. 2007 CAH total net revenues ranged between $11 and $21.6 million.

Organizations Involved in Evaluation. A subcontract to the Department of Health Management and Policy at the University of Iowa and a subsequent subcontract to the Center for Health Care Quality at the University of Missouri were used to provide outside evaluations throughout the project.

Table 1. Operating characteristics of the seven networked Critical Access Hospitals*

Operating Characteristic	Ellsworth	Franklin	Hancock	Kossuth	Mitchell	New Hampton	Palo Alto
Acute care beds	35**	25	25	22	25	18	25
Nursing unit beds	0	52	0	0	0	0	22
Total admissions	1,795	394	350	841	688	489	651
Births	105	0	0	103	34	29	109
Outpatient visits	56,344	16,073	16,565	26,625	60,622	19,272	22,069
Emergency department visits	6,583	2,253	2,410	2,982	2,824	2,447	3,739
Total surgical operations	982	576	454	1,279	722	622	1,165
Full time personnel	180	92	75	140	107	81	131
Total revenue (in millions)	$18.4	$13.0	$11.2	$21.6	$16.3	$11.3	$18.6

Source – IHA 2007 Hospital and Health System Characteristics

* Critical Access Hospitals: Ellsworth Municipal Hospital; Franklin General Hospital; Hancock County Memorial Hospital; Kossuth Regional Medical Center; Mitchell County Regional Health Center; Mercy Medical Center- New Hampton; Palo Alto County Health System.

** Includes 10 inpatient psychiatric beds.

Implementation Process

Implementation was staged in two phases. Phase I consisted of transitioning to a read-only mode of the clinical data repository of patient demographic information, laboratory results, and transcribed physician notes. All sites were live on Phase I by mid to late summer of 2007. Phase II implementation consisted of transitioning to an interactive EHR, complete with CPOE, active decision support tools, integrated Pharmacy Information System, clinical documentation, and bar code scanning enabled medication administration system. Activation of Phase II was accomplished in two cohorts, the first cohort consisted of three network hospitals which activated on July 25, 2008, and the second cohort consisted of four network hospitals that activated on September 5, 2008.

After all sites had met Phase I prerequisites, (i.e. updating to the same code on their patient management systems and installing the same lab systems), sites were ready to begin Phase I preparations. To accomplish data integration, teams consisting of subject matter experts from each site, along with a data integration project lead, technical staff from legacy system vendors, and a Project Coordinator, met on a regular basis to define data elements to be mapped from their Patient Management and Laboratory Information Systems to the clinical data repository. Processes were developed and trained for communicating changes, auditing, and cleaning up the database on an ongoing basis. Phase I training was provided to clinicians, and once it was determined that data was flowing appropriately to the clinical data repository, sites transitioned from auto printing of lab results and transcribed reports for inpatients to electronic retrieval.

Preparations for Phase II began during the first project year while sites were involved in securing funding and board commitment and a statement of work was being developed. Defining the structure for communication and decision-making that would enable effective change management across seven disparate organizations was essential to the success of this project. An assumption of the project budget was that MMC-NI would "lead" the network sites in their change management efforts, requiring a resource commitment. Therefore, considerable time was spent during the first project year to align dedicated resources and obtain organizational commitment, not only from the CAHs, but also from MMC-NI. Clinical information analysts, as well as individuals from clinical, ancillary, and patient management and accounting departments in MMC-NI were secured as resources to lead affinity teams with their network peers in preparing for conversion to an EHR. Each network hospital identified subject matter experts from those same departments who understood workflow processes, practice and quality standards, and in the case where information systems already existed, in-depth knowledge of that system. There were 13 affinity teams for this project, supported by 16 MMC-NI leaders/staff experts. Due to the collaborative nature of Mercy Health Network-North Iowa, many of these teams existed prior to the EHR[10] project. Focus of pre-existing teams changed to addressing project tasks and milestones.

At the local level, the team member had the responsibility to communicate to a larger interdisciplinary team, lead by the site's Director of Nursing/Chief Nursing Officer (DON/CNO). The DON/CNO was chosen to lead this team as they usually are accountable for operations in CAHs. The role of the larger interdisciplinary team was to ensure that all departments integrated the changes, monitored the project plan for task completion, and minimized barriers to task completion and process change.

Sites used a readiness process designed by Trinity Health to facilitate change management. The readiness plan consisted of 14 milestones, where each milestone was achieved by the

completion of multiple tasks. Milestones related to aligning resources, redesigning workflow that incorporated the use of technology to support real-time documentation and communication/transmission of data, testing, training, implementation, and transitioning to support. Both cohorts completed the majority of readiness steps together, which began roughly 13 months prior to the first cohort activation, with early readiness activities occurring simultaneously with the final stages of integration and testing of Phase I elements.

Activating in cohorts was designed to allow sites to support one another through the initial weeks of using the new EHR. Sites had identified trainers and Super Users, staff who had earlier and more hours of training and practice using the new technologies and who traveled to another network hospital during the first two weeks of a site's activation to lend support and assistance to end users. Even though Super Users from Cohort 2 did not have actual experience in use of the system, the experience from MMC-NI was that early use in vitro boosted confidence of Super Users to further enhance their own activation experience. Conversely, Super Users from Cohort 1 had actual real life experience to share with the second cohort by the time of the second activation experience.

Bar code medication administration was implemented in two cohorts, approximately 5 months after EHR implementation.

Evaluation Methods

Qualitative and quantitative approaches were used to track the process and outcomes related to implementation. A well-formulated readiness process documented progress through project milestones. Annual surveys of employees assessed their perceptions of healthcare quality and care processes. Key informant interviews collected information on the implementation process and perceived benefits. Outcomes related to implementation effectiveness and patient safety were monitored. The methods for each approach are described.

Readiness Process Milestone Evaluation

The EHR[10] implementation process involved several years of planning and execution. The process to prepare for implementation of the clinical information system is termed "Readiness" by Trinity Health. The readiness process for the EHR[10] project entailed 14 milestones, which were monitored and reported out by the use of a readiness dashboard and regularly scheduled system-wide readiness meetings. The dashboard demonstrated the degree of milestone achievement, both at individual hospital levels and at a project level, which gave one summative result for all project partners (e.g. the seven network hospitals, MMC-NI, and Trinity Health), using red, yellow, and green colored cells. In addition, issues identified as high risk were documented on the dashboard to communicate and monitor the effectiveness of the associated action plan.

Staff Perception Survey Methods. For an AHRQ-funded grant during 2003-2007 to evaluate the implementation process at MMC-NI, we developed and subsequently validated a survey instrument that measured staff perceptions of care processes. We used that survey, with slightly modified instructions, for the EHR[10] project. The survey items were measured on a six-point Likert scale (i.e., strongly disagree, moderately disagree, mildly disagree, mildly agree, moderately agree, strongly agree) with an option to indicate "don't know or not applicable". The

perception survey was sent to the seven hospitals participating in the EHR[10] project in March 2007, March 2008, and March 2009. The first survey administration (Wave 1) was timed to precede major changes related to the EHR implementation and thus captured a "steady state" baseline. The second survey (Wave 2) occurred a year later after Phase I of readiness had occurred. At this point, hospital personnel had become used to read-only electronic capacity, workflow processes had been redesigned, hardware had been acquired and tested, and Super-Users to support EHR and CPOE implementation were being trained. Thus the timing of the Wave 2 survey was at a time when the hospitals were within a few months before the activation of Phase II. At this point hospital personnel had not yet undergone training for full EHR/CPOE implementation. The third survey (Wave 3) occurred one year later, and following the activation for Phase II. For Phase II, the comprehensive clinical information system supporting clinical (ancillary and nursing) documentation, order entry, pharmacist medication order reviews (on-site and remote), electronic medication administration records, clinical decision support including references and alerts, on-unit automated medication dispensing cabinets, and bar code medication administration had been implemented in most hospitals. For implementation purposes the seven CAHs had divided into two cohorts with activation either in July or September 2008. Thus the Wave 3 surveys occurred 6 to 8 months after activation and just after automated medication dispensing cabinets and bar code medication administration were implemented.

Approximately 700 surveys were mailed each year. Survey packets, including the survey with attached cover letter and a stamped, addressed envelope were mailed to the human resources director at each hospital. For each wave, follow-up surveys were distributed increase response rates. The cover letter for the second mailing expressed thanks if the employee had already responded and reminded those who had not done so to please complete the survey and mail it back.

Surveys were entered by two individuals into a Microsoft Access template. Once the survey data were independently entered, both datasets were compared to disclose differences. All discrepancies were corrected, and a clean final data set was created. Out of the 1201 returned surveys, 1143 were usable for analyses. An overall response rate of at least 32% was estimated.

Pre Activation Interviews. Semi-structured interviews were conducted to collect information on the readiness process prior to implementation. Interview participants were the coordinators of all components of implementation at MMC-NI plus the Readiness Leader (the DON/CNO) and the Clinical Liaison at each CAH. These participants were chosen due to their high level of involvement in the process of implementation and their in-depth knowledge of the effects of EHR implementation on physicians and nursing staff. Interviews were conducted during June and September of 2008. Interview questions focused on what changes had taken place in hospital processes as a result of the readiness process, which changes were the largest, and how their hospital had implemented these changes. All information was recorded and field notes were taken by the interviewer.

Post Activation Interviews. Semi-structured interviews one year after activation were conducted at each of the seven CAHs with the Clinical Liaison and the DON/CNO. Interviews were conducted during June and July of 2009. Interview items were categorized into three main areas: changes *anticipated* by the hospital that would occur as a result of EHR implementation, changes *realized* as a result of EHR implementation, and which of these changes the

organization believed to have had the largest impact on the hospital and staff members. These three areas allowed for comparison between what each hospital believed the system would bring to their organization, and where the EHR system fell short or exceeded these expectations. All information was recorded through use of a digital voice recorder and field notes taken by interviewers.

Process and Outcomes Measurement. Process measures related to implementation success were collected. One of the primary process measures was the extent of use of the CPOE system. Orders entered by providers, orders triggered by protocol, orders entered by allied health providers, and orders entered by allied health providers that were cosigned by a physician were tracked monthly. Monthly saturation rates were calculated as the percentage of orders entered in the system (described above) divided by all orders (which included written, verbal, and telephone orders). These were then averaged across providers to create hospital-specific saturation rates.

Results

The grant activities involved an array of approaches to meet the project goals. The primary results from each of these approaches are summarized here.

Readiness Issues

Semi-structured interviews about the readiness process prior to implementation were conducted with about 20 individuals who were most involved in the process of implementation. Interview questions focused on what changes were taking place in hospital processes as a result of the readiness process, which changes were the largest, and how the CAHs were handling these changes. A number of changes were described that are innate to any EHR implementation, such as inventorying and procuring all needed hardware and organizing staff training. However, a well-designed implementation process includes careful examination of all processes of care that will be impacted by an EHR system. Trinity Health has a readiness process that coordinates careful review of care processes and makes necessary changes in anticipation of implementation. This avoids taking inefficient paper processes and hardwiring them into electronic workflow. The changes that were driven by the readiness process included coordinating review of all documentation forms, examining all order sets and building new ones where necessary that streamlined care processes, and reorganizing the medication administration process to take advantage of CPOE, pharmacist review, and bar coding capability. A further set of changes occurred as a result of specific aspects of this EHR[10] project. For example, the suite of vendor solutions chosen required interfaces between Dairyland (now Healthland), Cerner, and Fletcher Flora systems. This in turn required examination of multiple steps including the registration process and approaches to assuring access security. Also highlighted were changes necessitated by requirements specific to critical access hospitals. For example, CMS reimburses CAHs on a per diem basis for inpatients, and on a percentage of charges for outpatients. This necessitated a process to create new encounters for patients who are admitted (inpatient status) from the

emergency room or from observation (outpatient) status during the same episode of care. Orders must be on the correct encounter to enable accurate billing, and processes were designed to minimize the amount of rework from a billing perspective while maintaining the integrity of the patient's medical record. Registration was another issue, which necessitated an approach tailored to each hospital. Some hospitals hired 24/7 registration clerks and other trained night-shift nursing staff to provide this function after hours. Other staffing issues revolved around the use of agency staff and locums who need secure access to patient records and fast, efficient on-site training. These interviews were very informative in capturing perceptions at each CAH about the many steps involved in preparing for activation of a comprehensive clinical information system.

Creating a Shared Formulary

One major goal of the EHR[10] project, like most EHR and CPOE implementations, was to enhance medication administration. In the EHR[10] project, this involved multiple processes, including creating a shared formulary, achieving 24/7 pharmacist review of medication orders, and enhancing medication ordering and dispensing. Described below are the principal findings from these major project activities.

Historic differences in individual prescribing practices and local preferences created substantial variation in the number of items and specific content of the seven CAHs' formularies. As part of the EHR[10] project, the CAHs agreed to create a shared formulary that was compatible with the MMC-NI formulary. The fundamental expectations of creating the shared formulary was that by combining the pharmaceutical and clinical expertise of the seven CAHs and MMC-NI, it would be possible to develop a common formulary that would enhance the continuity of care among the seven CAHs and MMC-NI, facilitate higher patient care quality and safety, reduce formulary associated costs, and minimize the expense of separately building and maintaining electronic order sets as part of the pharmacy information systems implementation and management.

The process to develop a shared formulary began in February of 2007 and was completed by August, 2007. As a result of the agreement to create a shared formulary, a workgroup comprised of pharmacists from the seven CAHs and MMC-NI met by teleconference on a weekly basis. This work was coordinated by a pharmacist employed by MMC-NI. Once the initial charge was given to the group, the first step was to obtain a detailed list of each hospital's (MMC-NI and the seven CAHs) formulary items for the previous year. Next, these formulary lists were compiled into a single list. Once the initial list of approximately 3,400 formulary line items was identified, an analysis was performed to identify the number of hospitals listing the exact same formulary items.

The primary work of creating a shared formulary was carried out through the decision making process used by the pharmacists to determine specific items for inclusion and exclusion. Developing clear decision criteria and ensuring understanding of those decision criteria and rules by all participants up-front was essential. The decision rules included three elements: 1) all shared formulary items must be in the MMC-NI formulary; 2) specific formulary items used by five or more of the CAHs and MMC-NI would automatically be included without further discussion; and 3) a combination of consensus with occasional voting was used to discuss all remaining items. As expected, the give-and-take required by the third decision rule element created the greatest challenge.

Because a majority of the pharmacists were not full-time employees of the hospitals they were representing, they received additional payment from the hospitals to participate in creating the shared formulary. To facilitate these discussions, the list of formulary items (based on generic names) was sent out prior to the call to enable pharmacist review, and initial vote as to their inclusion. During the calls, items nominated for discussion were reviewed in terms of clinical need, frequency of use, dosage level options, opportunities for therapeutic and/or generic substitution, costs, and local provider preferences. Using this process, a final shared formulary comprised of 803 items was created.

Once the shared formulary was identified and added to the electronic formulary database, each CAH then made its own decision about stocking levels, based on services the hospital provided. If the service was provided at the CAH hospital, the pharmacy was expected to stock the formulary medication. A consideration for stocking additional items was that those items would not be automatically included in the CPOE system or Pharmacy Information System. Thus if providers decided to prescribe any of these "non-shared" formulary items they would have to enter those orders using a free text entry.

As the weekly reviews of items for inclusion in the shared formulary progressed it became clear that there was a need to standardize a number of policies and procedures related to medication management throughout the system, and well as having an ongoing forum for future decisions related to adding or deleting items from the formulary. Thus a Regional Network Pharmaceutical and Therapeutics Committee (Regional P&T Committee) was formed after the shared formulary process started, and began regular meetings in May 2007. The purpose of this Regional P&T Committee is the integration and management of the formulary and associated processes to support the EHR platforms and technology throughout the network. All subsequent requests for changes in formulary composition for both MMC-NI and the seven CAHs are reviewed and decided upon by the Regional P&T Committee.

Transitioning to the shared formulary required developing facility-specific plans for phase-out / phase-in of the changing formulary items. In particular, the hospital Charge Master and medication ordering or CPOE system needed to be updated to reflect these changes. While tedious, updating the Charge Master and loading the medications into the pharmacy and CPOE software was made much easier because these were done as shared tasks, spreading the costs across all facilities. However, formulary costs were increased for several of the participating facilities due to costs of adding new items to the formulary plus an inability to use up or sell back to the pharmaceutical suppliers the specific items being deleted from their formularies.

At the beginning of the process to create a shared formulary the number of line items in the seven CAH's original formularies ranged between 667 and 1351, with an average of 845. The new shared formulary resulted in a total of 803 items. Stocking of all 803 items was not uniform across the seven hospitals. On average, the hospitals did not stock 103 items in the new shared formulary (13%). There was considerably less variability in the number of items added to supplement beyond those contained in the shared formulary (range 1 – 46). In comparing the original to the revised final CAH formularies, the number of items increased in two and decreased in five of the hospitals. The change in number of items in the original to final formularies ranged from an increase of 61 (8.6%) to a decrease of 565 (-41.8%), with an overall average decrease of about 129 items (-6.6%). Thus while the new shared formulary contained 803 items, the final formularies actually stocked by the CAHs ranged between 592 and 786 (mean = 717) items.

Open-ended telephone interviews were conducted with participating pharmacists and DON/CNOs to learn more about the major challenges and lessons learned related to developing and using a shared formulary. Lessons learned from the interviews identified ten categories of essential ingredients for success: meeting logistics, facilitator to manage the process, organizing the review process, management support, stakeholder participation, working collaboratively, decision making process, clarity of charge, meeting the needs of unique services, and adjusting to a shared formulary.

Achieving 24/7 Pharmacist Coverage for Medication Order Review

Ideally medication order reviews occur before medications are administered. Thus to optimize both quality and safety, order reviews need to be conducted as soon as possible after medication orders are placed. Medication orders needing review include initial orders, changes in existing orders, changes of patient care status, and discontinued orders. Prior to EHR[10] implementation, none of the CAHs had 24x7 pharmacist verification services. One of the goals of the EHR[10] project was the creation of 24x7 capacity for pharmacist's medication order reviews.

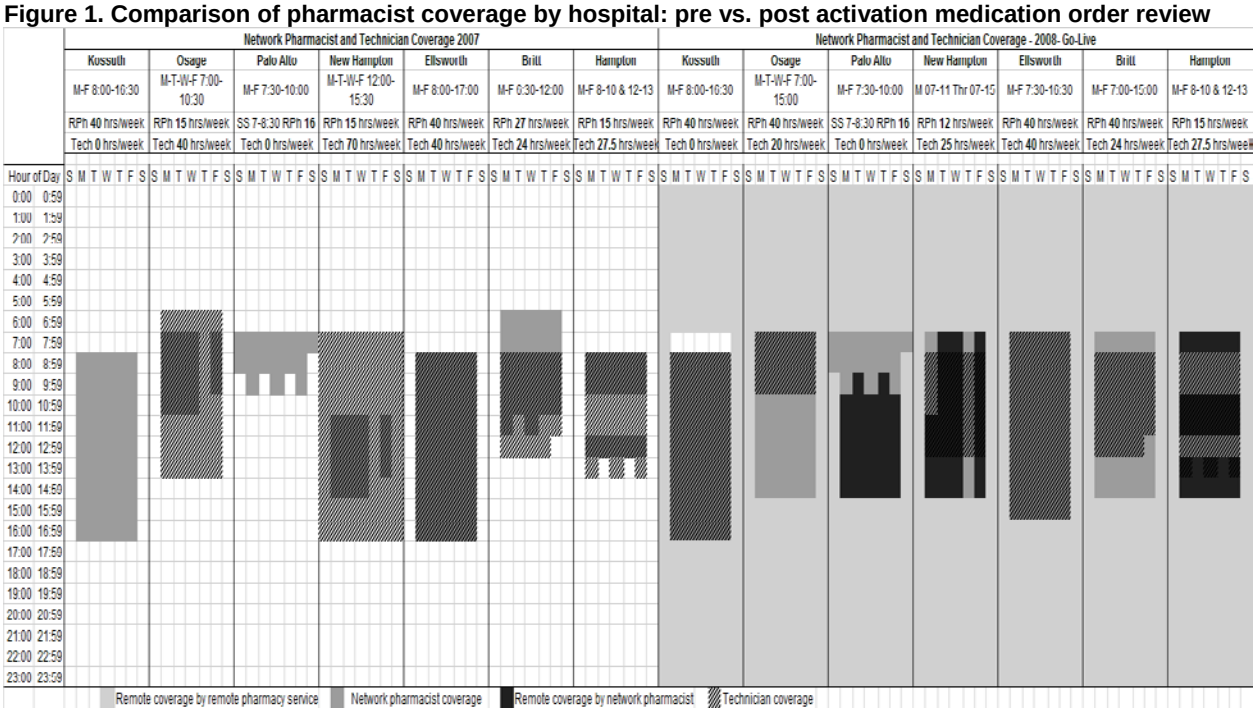
Prior to implementation, the CAHs used a variety of approaches for pharmacy coverage. In particular, the pharmacists included two full-time MMC-NI employed pharmacists, two other full-time MMC-NI employed pharmacists working in more than one facility, and three part-time retail-based pharmacists. Pharmacist on-site coverage varied widely across the seven CAHs and ranged between 15 and 40 hours per week (mean = 24 hours), with only one CAH having on-site pharmacist coverage on the weekend. While two CAHs did not have pharmacy technician support, the other five had pharmacy technician staffing support ranging between 24 and 70 hours per week to augment their part-time pharmacist coverage. Pharmacists were responsible for verifying provider orders, dispensing medications, and providing general oversight to pharmacy operations. Pharmacy technicians were predominately used to assist the pharmacists in medication dispensing and billing for medications administered to patients.

Because of the limitations in availability of on-site pharmacy coverage, as part of the EHR[10] project, 24/7 pharmacist review was achieved by partnering with remotely located pharmacists. Through the EHR system, both on-site and remote pharmacists were given access to the medication orders, the Pharmacy Information System, and other patient-specific clinical data in patients' EHRs in each of the CAHs. Pharmacist verification was facilitated by the development of a standardized formulary that was accessible through the Pharmacy Information System. Following implementation of the EHR and CPOE systems the pharmacists employed locally by the CAHs continued to provide first order medication reviews during their usual scheduled work hours. To move to 24x7 first order medication reviews, the CAHs issued a request for proposals to potential remote site pharmacist review services. Six bidders responded and following a review process the successful bidder was Mercy Medical Center-Dubuque (MMC-Dubuque).

MMC-Dubuque, like MMC-NI with its network of seven CAHs, is a member of Trinity Health, and had implemented the same Cerner-based EHR, CPOE, and Pharmacy Information Systems. MMC-Dubuque began providing remote medication order review services for the seven study CAH's in 2008. These remote review services are provided from 15:00 to 07:00 on weekdays, and on a 24-hour basis for weekends and holidays. Currently all after hour, weekend and holiday first order medication reviews for acute care CAH inpatients are being reviewed

remotely. Figure 1 compares the pre- and post-activation pharmacy review coverage for the seven CAHs.

Figure 1. Comparison of pharmacist coverage by hospital: pre vs. post activation medication order review



Off-site reviewed orders include new, changed, and discontinued medication orders for the inpatient care setting plus change of level of care related orders. If the medication order is entered in the CPOE system directly by the prescriber, the system automatically notifies the MMC-Dubuque pharmacists that an order is ready for review. Operationally, a dedicated computer screen is used to separately process all off-site reviews. Orders are typically reviewed within 60 minutes of when they are entered into the system. The reviewing pharmacists have remote access to the EHRs in each CAH in order to review the patients' lab results and other clinical data. If additional information is needed telephone calls to the prescribing physician or CAH nurses are made. After completing the clinical review, the pharmacist selects the appropriate medication to dispense from the CAH's formulary. Each formulary item is represented by a unique stock keeping unit and has an associated National Drug Code number. It is these National Drug Code numbers, embedded in bar codes that are used for the subsequent dispensing and bar code medication administration processes.

Initially the seven CAH's estimated expected annual volumes of remote medication order reviews to range from 2834 (about 9% of all medication orders) to 10,076 (33% of all medication orders). Experience to date suggests that these estimates were too low and that the actual annual volume of remote medication order reviews was about twice what was expected. After implementation, medication order reviews were conducted by 14 different remote pharmacists, plus the local pharmacists working in each CAH. On average, about 58% of the medication order reviews were completed by the remote pharmacists.

Enhancement of Medication Ordering and Dispensing

Because smaller and rural hospitals lack full-time on-site pharmacists on a 24x7 basis, it is common practice for nurses to retrieve medications in their absence. Automated dispensing cabinets have been recommended as a means of decentralizing pharmacy dispensing functions as well as minimizing the need for nurses to retrieve ordered medications. Another benefit of automated dispensing cabinets is that there is no need for direct observation by a pharmacist when medications are removed. Each of the seven CAHs invested in the use of automated dispensing cabinets as a way to improve their medication dispensing processes. Access to all automated dispensing cabinets is electronically controlled and requires identification of both the nurse withdrawing the medication and the patient for whom the medication is being dispensed. In addition, retrieving controlled medications from the automated dispensing cabinets requires a blind count be performed and the documentation of wasted medications requires another user to "witness" the amount wasted by entering their password into the automated dispensing cabinets when prompted.

The number of automated dispensing cabinets and their use varied among the CAHs. All but one of the CAHs implemented an automated dispensing cabinet located in its emergency department. Emergency department based devices are being used for first dose medications, and to provide up to a 72-hour supply of medications. As such it provides a limited after-hours retail pharmacy presence in the emergency department. All facilities reported using one or more automated dispensing cabinets on their adult medicine/surgery units. On nursing units, the devices were used by most CAHs to dispense all scheduled and PRN medications. In most CAHs the traditional medication carts and wall units are no longer being used.

Interviews were conducted with pharmacists and DON/CNOs at each of the CAHs. All interviewees reported that the automated dispensing cabinets were generally well received by the pharmacists and nurses using them. The pharmacists reported that using the devices reduced the amount of time it previously took to dispense medications using the traditional med cart and wall systems. In several instances the automated dispensing cabinet time savings were reported as allowing the pharmacists to spend more time on clinical pharmacy-related work. Among the other advantages reported were the automated documentation of when medications were removed from the cabinets, the name of the nurses or pharmacists who removed the medication, and the intended recipient of the medications. These units improved narcotic and controlled substance monitoring in particular. Currently, when nurses withdraw narcotics or other controlled medications from the automated dispensing cabinets, data related to the nurse's identity, date and time of medication withdrawal, medication being retrieved, and the identity of the intended patient are automatically recorded. Finally even though none of the hospital pharmacies were a great distance from the nursing unit, having the automated dispensing cabinets on the nursing units is viewed as a convenience for the nurses.

Bar code medication administration technology is effective at reducing medication administration errors by providing increased accuracy in verification of the five rights prior to administration: right patient, right medication, right dose, right time, and right route. Aside from reduction in medication administration errors, bar code medication administration has also been found to be effective in ensuring accurate identification and verification in blood transfusions, increased accuracy of patient specimen collection and laboratory data, improved accuracy of medication error reporting, increasing the accuracy of pharmacist intervention records, increasing accuracy of medication administration records, and streamlining the medication

inventory process. Thus, a final piece of the planned EHR[10] project was the transition in early 2009 to bar code medication administration devices to be used by nurses for medication administration. All of the CAHs implemented a bar code medication administration system that is interoperable with the EHR platform. Use of the bar code medication administration (BCMA) not only automates verification of the five rights, but also transmits documentation related to administration in real-time to the electronic medication administration record which was implemented during EHR activation.

All interviewees indicated that the use of the bar code medication administration devices and process have been generally well received by the nurses. Several CAHs have reported that bar code medication administration use has already prevented medication administration errors. A review of the automatically generated bar code scanning rate reports has indicated that the target of 90% of medications being reviewed was being met. Implementation of the bar code medication administration devices lagged the EHR implementation by several months. Although it was originally planned for activation to occur with both the EHR and the bar code medication administration at the same time, the bar code medication administration implementation was delayed to resolve interface and programming issues. Interestingly, all of the interviewees indicated that this delay turned out to be an advantage because it reduced the number of transition issues being addressed at the same time. Respondents clearly indicated that transitioning to the EHR was a much larger and more disruptive change to nurse workflow than the subsequent addition of the bar code medication administration.

Staff Perceptions before and after Implementation

The staff perception survey was administered to employees at each hospital three times – twice before and once after implementation. In general, responses indicated a high level of agreement and thus positive perceptions of the processes and quality of care in these hospitals. Analyses indicated significant differences across waves for five items. As might be expected, the largest changes over time were seen from the immediately pre-activation to the post-activation perceptions. It should be noted that despite the major changes associated with the implementation of an EHR and CPOE systems, along with the automated dispensing cabinets and barcode medication administration, staff perceptions were not adversely affected.

To explore whether separate staff categories (i.e., providers, registered nurses, and other-clinical staff) differed, analyses compared their mean responses. Significant interactions were found for three questions, with the provider group showing significant declines in their responses from Wave 2 to Wave 3. In contrast, registered nurses and other-clinical staff showed relatively consistent responses across Waves 2 and 3. To further explore the pattern across provider groups, analyses compared physicians and midlevel providers in terms of their responses across time. They showed significant differences to four items. To two questions, the physicians had lower overall responses than did midlevel providers. To the other two questions, the midlevel providers showed increased responses at Wave 3, in contrast physician respondents reported less positive responses.

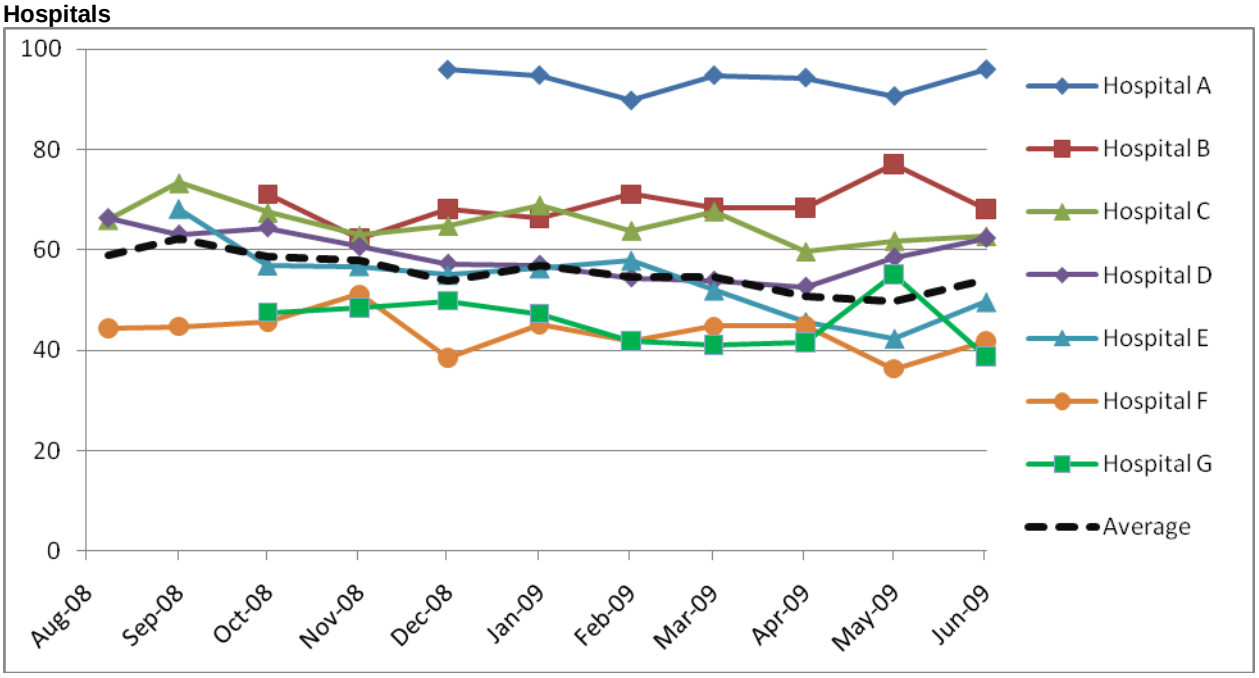
The hospitals differed in their employee's response patterns to the perception survey items. Significant interactions were found for five questions, with employees at one particular hospital showing significant decreases in their responses from Wave 2 to Wave 3. The other six hospitals showed similar response patterns across time. Analyses comparing Cohort 1 (three hospitals that

experienced activation in July) and Cohort 2 (four hospitals which experienced activation in September) uncovered few differences.

CPOE Adoption

Rates for providers at each of the seven EHR[10] hospitals were averaged to compute monthly CPOE rates. These are shown in Figure 2 along with an average across the seven EHR[10] hospitals. As shown in the figure, the average CPOE rate was 60% initially after activation but decreased slightly to about 55% over the year after activation.

Figure 2. Monthly computerized provider order entry (CPOE) rates at the seven EHR[10] Critical Access Hospitals



Perceptions of Anticipated and Realized Benefits

Interviews with the DON/CNO and the Clinical Liaison at each of the seven CAHs about the anticipated and realized benefits of the EHR implementation revealed several themes. Expectations that were matched with results included ease of data access in processing as well as increased continuity of care and staff accountability as outcomes. The process of data access was expected, and did become faster in many areas, although some user-friendly modifications are still desired. The need for easier transfer of patient data both inter and intra hospital was met as the ability to send complete records including all patient data, charts, and labs increased drastically. Finally, staff accountability for patient care in terms of actions, medications, and education was expected to and did increase through the use of computer security and action tracking.

The interviewees reported specific situations in which the expectations of staff members were not on track with outcomes in critical areas of system use and results. In some instances, staff members' (including physicians and nurses) expectations of time savings after making the transition to electronic documentation and charting systems were not realized. Interviewees reported that after extensive use data entry did become faster, however the system did not and was not expected by staff to save time in the future. The steep learning curve of the EHR system impeded any expected time savings at the onset, and although documentation of patient information is said to be clearer in many instances, it continues to be time consuming for those with direct patient contact. The need for staff during the transition was predicted before implementation and Super Users were common, but hospitals did not anticipate the extended need for supplemental staff, especially in the area of nursing. The lack of time savings and increased amount of time for documentation meant many nurses reported not having adequate time for both patient care and data entry. On the positive side, staff communication was facilitated through proper, legible documentation as opposed to previous verbal or handwritten orders.

There was less discussion about anticipated benefits to patient safety than expected. However, interviewees did report that patient safety increased dramatically in these hospitals via use of bar coding devices that warn staff of potential medication errors. There was an expressed expectation that these CAHs would soon have a competitive advantage in the recruiting of new physicians and nurses. This expectation was not realized as the differences in EHR systems between training hospitals and CAHs makes the transition difficult for incoming staff members. Although residents or recently trained nurses may express a desire for the availability of this technology, its benefits are not ample enough to push individuals to relocate to rural areas.

In summary, understanding the dynamics of EHR implementation can be facilitated by viewing the EHR in two lights, process level changes and outcome level changes. In general, they expressed a desire and anticipation of outcome related changes, but interviews indicated that the most impactful changes occurred at the process level.

Conclusions: Lesson Learned

Seven CAHs as part of the Mercy Health Network-North Iowa, in partnership with MMC-NI and Trinity Health, combined clinical and technical expertise as well as financial resources to make it possible to successfully implement a highly sophisticated, comprehensive, integrated EHR system with CPOE, evidence-based care guidelines, decision-support tools, and an enterprise-wide master patient index that allow appropriate providers access to clinical information for care provided in any of the partners' facilities.

The short-term goals that were set at the beginning of the grant were all achieved, including to: 1) Provide all clinicians with rapid, round-the-clock access to accurate, complete, and current patient information; 2) Enable physicians and other clinicians to follow standard, evidence-based practices using uniform data standards at the point of care in all delivery sites; 3) Allow confidential and secure exchange of patient information across diverse health care setting; 4) Enhance clinicians' ability to communicate and coordinate patient management within each health care site, across Mercy Health Network-North Iowa facilities, and beyond; 5) Improve tracking and monitoring of clinical quality by pooling patient information across the network; 6) Provide administrative staff with standard, integrated, automated tools for patient registration, scheduling, billing, and claims that will improve organizational efficiency and financial

performance as well as provide more timely care to patients; and 7) Generate significant organizational learning about the effectiveness of this collaborative implementation process and integrated EHR system.

The EHR system was successfully implemented. Surveys administered before and after activation to staff at all hospitals and interviews with key informants indicated that much of the success of implementing such a comprehensive, sophisticated clinical information system occurred because of the networking of the seven CAHs with the support of the rural referral hospital that owned or managed them (MMC-NI), which in turn was owned by Trinity Health. The readiness process developed by Trinity Health provided the structure and core to the project management approach used during the implementation at MMC-NI in 2005 and the subsequent implementation in 2008 at these seven CAHs. Yet this implementation experience at seven networked CAHs required further refinement to fit the unique requirements of these small rural hospitals. This project developed approaches to customizing the Trinity Health readiness process to fit their specific needs.

Evaluation indicated that the extensive and well-orchestrated readiness process was a key factor in successful implementation. Review and restructuring of care processes and workflow occurred and was hardwired into the EHR system. Processes that were dictated by the systems being implemented included activation of specific vendor solutions, a two-stage implementation process with a staged phase in of read-only capability prior to activation, extensive testing of cut-over, consistency of documentation forms, clinical decision support including evidence and alerts, role-based security access, management structure of readiness leader, orchestrated project management approach, use of super-users, and extensive system-supported assistance during activation. A major process to align the pharmacy formularies was achieved by collaboration across the seven networked hospitals. Processes that varied somewhat across the seven hospitals included staffing during training, approaches for implementing 24/7 registration and pharmacist review of medication orders, and review of order sets.

In summary, a successful implementation of a comprehensive clinical information system occurred at seven networked CAHs through a combination of on-site, networked, and system-wide support.

List of Publications and Products

Peer-Reviewed Publications

Wakefield DS, Ward MM, Loes JL, O'Brien J, Abbas N. Creating a shared formulary in seven critical access hospitals. *Journal of Rural Health*, in press.

Papers Submitted to Peer-Reviewed Journals

Wakefield DS, Ward MM, Loes JL, O'Brien J. A network collaboration implementing technology to improve medication dispensing and administration in critical access hospitals. Submitted to *JAMIA.*

Wakefield DS, Ward MM, Loes JL, O'Brien J, Sperry L. Achieving 24x7 pharmacist medication order review in critical access hospitals through a network collaboration. Submitted to *Journal of Health System Pharmacy*.

Papers in Preparation

Halbesleben J, Ward MM, Wakefield DS, Mills T, Loes JL, O'Brien J. CAH staff perceptions of patient care processes and quality before and after implementation of a clinical information system. In preparation.

Loes JL, Ward MM, O'Brien J, Wakefield DS. Networked approach to implementation of EHR in seven critical access hospitals. In preparation.

Ward MM, Loes JL, O'Brien J, Wakefield DS. Health information technology issues unique to critical access hospitals. In preparation.

Ward MM, Prater K, Loes JL, O'Brien J, Wakefield DS. Anticipated and realized benefits of EHR implementation in critical access hospitals. In preparation.

Ward MM, Wakefield DS, Mills T, Loes JL, O'Brien J. Relationship between CAH staff perceptions of patient care processes and quality and EHR implementation outcomes. In preparation.

Presentations at Research Meetings

Loes JL, Ward MM, Wakefield DS, O'Brien J. Staff perception survey before and after EHR/CPOE implementation. Presented at the AHRQ Annual Meeting, September 16, 2009.

O'Brien, J., Ward, M., Wakefield, D., Loes., J. Implementing an EHR to connect a rural health network. Presented at the AHRQ Annual Meeting, September 16, 2009.

Wadle A, Legget S, Williams A. Becoming connected: Implementing an electronic health record across the Mercy North Iowa network. Presented at the Iowa Healthcare Collaborative annual meeting, November 2008.

Wakefield DS. Implementing shared formulary and E-based medication order review as essential steps in developing "closed loop" medication process in critical access hospitals. Presented at the AHRQ Annual Meeting, September 16, 2009.

Ward MM, Bahensky J, Nyarko K, Li P. HIT Implementation in critical access hospitals: Extent of implementation and business strategies supporting IT use. Presented at the AcademyHealth Annual Meeting, June 28, 2009.

Invited Presentations

Loes J, Abbas N, Barnes O'Connell A. Follow the bar-coded road (to safe med administration). Presented at the Iowa Chapter of Health Information Management System Society meeting, May 14, 2009.

O'Brien J, Loes J, Curtis S, Lee T. Developing and implementing an electronic health record system to connect a rural health network. Presented at the Iowa Hospital Association Governing Board Forum, April 14, 2009.

Zwiefel L, Mumford S, Elbert D. Moving into the electronic world: Implementation of technology across seven network sites. Presented at the FLEX User Group meeting, January 2009.