HIT for Medication Safety in Critical Access Hospitals

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ABSTRACT

Purpose: Plan for the implementation of medication-related health information technology (HIT) in Florida's critical access hospitals (CAHs). **Scope**: Little is known about the status, needs, or impact of HIT on medication safety in CAHs. Partners included all 12 Florida CAHs, University of Florida College of Pharmacy, UF & Shands, Shands Healthcare, Florida Office of Rural Health, and Florida Medical Quality Assurance, Inc. **Methods**: Methods included an on-site HIT survey, and two planning conferences. The survey supplied an assessment and description of current HIT, HIT needs, barriers to implementation, quality improvement activities and impact of HIT, and pharmacy/medication use information. The first planning conference was a vendor fair to impart product information and reach consensus regarding HIT system(s) desired. The second conference focused on HIT and medication safety, medication-related JCAHO accreditation requirements, current HIT status and obtaining a commitment of matching funds for HIT implementation. **Results**: HIT in CAHs can impact medication safety at all nodes of the medication use process, from prescribing to administration. HIT status varied among CAHs, thus, implementation efforts and support must be individually tailored. Implementation should concentrate on bringing all CAHs to an equal level. Medication-related HIT implemented must address lack of full time pharmacy staff. HIT desired included three phases of implementation: first, pharmacy information management systems, then automated dispensing cabinets, then smart IV pumps. Barriers to HIT implementation included limited funds, staff resistance to change, staff adaptation to HIT and workflow changes, time constraints on small staff, facility/building barriers and lack of IT support.

Key Words: health information technology, medication safety, critical access hospitals

PURPOSE

The purpose of this project was to plan for the implementation of medication-related health information technology in Florida's critical access hospitals to improve patient safety and reduce medication errors.

Specific aims achieved were:

- Assessment and description of the CAHs pharmacy management systems
- Assessment of barriers to HIT implementation
- Consensus of the CAHs in regard to HIT systems desired
- Identification of potential HIT vendors and solicitation of bids/proposals
- Consensus of at least half the CAHs in regard to vendor submitted proposals
- Address at least 7 of the 12 IOM-recommended strategies for reducing medication errors
- Submission of an implementation grant proposal to AHRQ

SCOPE

Background: Health Information Technology and Medication Safety

The Institute of Medicine's publication, Crossing the Quality Chasm: A New Health System for the 21st Century, reported that health information technology has a major role in improving patient safety (IOM 2001). Recent research has shown that health information technology in hospital pharmacies can reduce medication errors.

Anderson et al (2002) used a computer simulation model to show that implementation of a comprehensive medication delivery system designed to detect and prevent ADEs could save 1,226 days of hospitalization and $1.4 million annually, even if the system only prevented 26% of medication errors.

Context and Setting

This project focused on planning for HIT implementation in Florida's critical access hospitals. Critical access hospitals (CAHs) are rural, non-profit acute care facilities that qualify as critical access hospitals under the Medicare Rural Hospital Flexibility Program. The goals of the critical access program are to improve access to health care services, to promote regionalization of health services and to foster the development of rural health networks. To qualify as a CAH, hospitals must be rural, public or non-profit facilities that provide outpatient, emergency and limited inpatient services. The distance from the nearest hospital must be no greater that 35 miles (15 miles if mountainous or secondary roads only), or the hospital must be state-certified as a "necessary provider of health services" for local residents. CAHs can have no more than 25 beds (with up to 35 total beds with "swing" beds for skilled nursing care), and an annual average hospital stay of no more than 96 hours (4 days) for acute patients, excluding respite/hospice. CAHs must be part of a referral hospital network, are subject to EMTALA (Emergency Medical Treatment and Active Labor Act) rules, may use midlevels for coverage (if MDs are available by phone immediately and in person within 30 minutes) and must have emergency services available 24 hours a day, seven days a week. CAHs can improve their financial stability through enhanced Medicare reimbursement that is cost-based for Medicare eligible patients.

As of April 2004, there were almost 900 certified CAHs located throughout the United States (http://www.ncsl.org/programs/health/cawgreen.htm). Florida currently has twelve critical access hospitals (See Table 1 below).

Table 1. Critical Access Hospitals in Florida

CAH	City	County	Became a CAH
Calhoun Liberty Hospital	Blountstown	Calhoun	6/2001
Campbellton-Graceville Hospital	Graceville	Jackson	11/2000
Doctor's Memorial Hospital	Bonifay	Holmes	7/2002
Florida Hospital, Wauchula	Wauchula	Hardee	5/2000
Gadsden Community Hospital	Quincy	Gadsden	6/2001
George E. Weems Hospital	Apalachicola	Franklin	6/2001
Hendry Regional Medical Center	Clewiston		10/2004
Lake Butler Hospital	Lake Butler	Union	4/2001
Madison County Memorial Hospital	Madison	Madison	CAH status pending
Northwest Florida Community Hospital	Chipley	Washington	6/ 2003
Shands at Live Oak	Live Oak	Suwannee	7/2000
Shands at Starke	Starke	Bradford	10/2004

Participants

Participants on this project included all of Florida's twelve critical access hospitals, with Doctors Memorial Hospital in Bonifay, Florida, serving as the lead applicant. Other project participants included the University of Florida College of Pharmacy, Department of Pharmacy Health Care Administration, UF & Shands Pharmacy Department, Shands HealthCare Information Services, Florida Department of Health, Office of Rural Health, and Florida Medical Quality Assurance, Inc. These organizations were subcontracted by Doctors Memorial Hospital.
The project also had two consultants: Patrick Antonelli, MD, from the University of Florida College of Medicine, Chief Medical Information Officer of Shands, Assistant Dean, Clinical Informatics; and Robert Pannell, Critical Access Hospital Program Coordinator from the Florida Department of Health's Office of Rural Health.

METHODS

Health Information Technology On-site Survey

On site HIT surveys were conducted in all of Florida's critical access hospitals to assess current HIT status (systems in place, connectivity with other providers/agencies, financial resources), HIT needs and desires (desired level of data sharing, ongoing HIT support services, greatest unmet HIT needs), and barriers to HIT adoption. The survey also assessed continuous quality improvement activities currently in place and how health information technology could assist in these activities, and staff views on the importance of various HIT

components in regard to patient safety, productivity, or financial performance. Pharmacy-related information was also collected, including the CAH's prescription order workflow, hospital formularies, staff knowledge of different kinds of pharmacy HIT available, and the pharmacy HIT currently in place. The onsite survey was performed by the Principal Investigator, a statistician, Tom Johns, Manager of Clinical Operations at Shands Hospital and Alyson Widmer, Director of Clinical Applications, Shands Healthcare Information Services. A copy of the HIT survey can be found in Appendix A.

Planning Conferences

Two conferences were held as part of the project's planning process. The first was an HIT Vendor Fair that took place on January 26, 2005. Vendors were selected if critical access hospitals already had their products in place, if their technology was appropriate for small hospitals with small patient censuses and/or if their IT systems could collect data that can be audited, analyzed and used to detect and prevent medication errors. Vendors were given one hour each to present on their pharmacy HIT systems. Personnel representing eight critical access hospitals attended the vendor fair: (1) Doctors Memorial Hospital, (2) Campbellton Graceville Hospital, (3) Calhoun Liberty Hospital, (4) George Weems Hospital, (5) Gadsden Community Hospital, (6) Madison County Memorial Hospital, (7) Lake Butler Hospital and (8) Hendry Regional Medical Center. Also in attendance were Robert Pannell, Critical Access Program Coordinator, Florida Dept. of Health, Office of Rural Health; John Kupkovits, HIT Consultant, Florida Medical Quality Assurance, Inc.; and project personnel Abraham Hartzema, Thomas Johns, and Jessica De Leon.

Consensus was reached by those in attendance that a pharmacy HIT platform consisting of a pharmacy information management system, automated dispensing cabinets and smart IV infusion pumps would provide an HIT system that would help avert prescribing, transcribing, dispensing and administration errors in these rural facilities.

Proposals and bids were received from the HIT vendors selected to attend the January 2005 vendor fair. Bids were received from six pharmacy management information system vendors; three dispensing cabinet vendors and one vendor of smart IV infusion pump technology. In subsequent communication with the vendors, the proposals were further refined. Upon receipt of the vendor proposals, unique packages were prepared and forwarded to the CEO/CFO of each of the CAHs. Vendor Fair notes and an HIT survey administered to CAH personnel at the vendor fair are in Appendix B and C.

The second planning conference was held in February 2005. This meeting to discuss the proposed infrastructure and the vendor proposals was scheduled in conjunction with the annual meeting of the Florida critical access hospital CEO/CFO meeting. Because the limited staff of critical access hospitals makes it difficult for personnel to leave work to attend conferences, this meeting was scheduled to coincide with an existing meeting of critical access hospital administrators, held annually in Tallahassee, Florida. In attendance were the CEOs and CFOs from eight of Florida's critical access hospitals: (1) Calhoun Liberty Hospital, (2) Campbellton-Graceville Hospital (3) Doctors Memorial Hospital, (4) Florida Hospital Wauchula, (5) Gadsden Community Hospital, (6) George Weems Hospital, (7) Lake Butler Hospital and (8) Madison County Memorial Hospital. Also in attendance were the Director of the Florida Office of Rural Health, Robert Pannell, project partner and Director of the Florida Critical Access Program, and representatives from Dixon-Hughes, an accounting firm working with critical access hospitals. Project representatives present hosting the conference included Abraham Hartzema, Principal Investigator, Thomas Johns, Co-Investigator from UF & Shands Pharmacy and Kathie McDonald, Co-Investigator, Florida Medical Quality Assurance, Inc.

The first goal of this meeting was to update the hospital CEOs in regard to the structure and status of the ongoing medication safety program, including this HIT planning project. Attendees also were taught about the causes of medication errors and the role health information technology can play in reducing medication errors at various stages of the medication use process (i.e., prescribing, transcribing, dispensing, and administration). The benefits of health information technology, e.g., reduce medication errors, improve staff satisfaction, save staff time by eliminating the transcribing of medication administration records and counting narcotics and improved charge capture, were discussed, as well as pharmacy-related requirements for JCAHO accreditation and the current status of health information technology in Florida's critical access hospitals. Thomas Johns and Abraham Hartzema also presented information on health information technologies available and product descriptions, focusing on the vendors that had submitted proposals as part of the vendor fair held in January 2005 (i.e., Alaris, Cardinal, CPSI, Dairyland, HMS, Mediware, Omnicell, and Mardon). The presentation concluded with review of the AHRQ HIT Implementation grant, focusing on obtaining a financial commitment of

the CAHs. The slide presentation from this meeting is included as an attachment. The outline of this presentation is in Appendix D.

RESULTS

Planning of HIT investments as pursued within the AHRQ planning grant (P20 HS015325-01) was based closely on identified high-priority areas that can be impacted by HIT implementation: (1) medication accessibility, (2) access and use of drug information and decision support systems, (3) access and integration of patient information, (4) procedures for order review when pharmacist not present, (5) availability of formularies and safety precautions in drug storage, and (6) reconciliation of medications for seamless care.

After a well executed planning process and careful consideration of the current and future HIT needs of the Critical Access Hospitals (CAH), the partners, in collaboration with the CAHs, decided on a pharmacy HIT (pHIT) platform that includes a pharmacy information management systems (PIMS), automated dispensing cabinets (ADCs), and smart infusion pumps with guard-rail technology. pHIT was selected to address (1) order review and dispensing, (2) transcribing and drug administration, (3) and the establishment of a continuous quality improvement infrastructure to prevent medication errors committed at every node involved in drug use. Further consideration was given to pending national patient safety standards such as the requirement for 24-hour concurrent medication order review by pharmacists. The three selected components address various quality deficits.

1. PIMS reduce prescribing and dispensing errors in integrating patient and drug-related information in clinical decision support systems.
2. PIMS reduce transcribing and administration errors because they allow printing of medication administration records.
3. ADCs reduce dispensing errors in restricting access to medications not released by prior medication order review. If drugs and dosage forms are isolated in individual drawers, ADCs nearly eliminate the risk for confusion of sound-alike or look-alike medications.
4. Smart infusion pumps eliminate administration errors within preset screening parameters. If linked to PIMS and integrated with barcode technology, administration errors are almost impossible.

The selected pHIT components provide a comprehensive set of safety features that will greatly impact CAH medication safety. More importantly, they take into account the lack of full-time pharmacist coverage in CAHs, by providing tailored decision support to nurses when performing functions that are typically overseen or performed by pharmacists.

Table 2 illustrates the current HIT in the participating CAH as assessed during the on-site HIT surveys. Only four hospitals have a fully employed pharmacist on-site (with Wauchula using remote-order review provided by its parent facility). None has 24-hour pharmacist coverage, and only three have a PIMS. Two hospitals will implement the PIMS from their parent facility. Two CAHs utilize automated dispensing cabinets and one uses one cabinet, which is not interfaced with a PIMS. Two hospitals use Baxter Colleague volumetric pumps that have the capacity for upgrades to guardrail technology.

Table 2. Current HIT and Pharmacist Capacity in the Critical Access Hospitals

CAH	Full-time Pharmacist	24hr/7day Rx Review	Pharmacy MIS	Dispensing Cabinets	Smart IV Pumps	JCAHO-accredited
Hendry Regional Medical Center	X		X	X	X	X
Northwest Florida Community Hospital	X		X			X
Doctor's Memorial Hospital	X					X
Campbellton Graceville Hospital						
Gadsden Memorial Hospital	X					X
Calhoun Liberty Hospital						X
George Weems Hospital						X
Florida Hospital, Wauchula	X		X	X	X	X

Shands at Starke			Purchased, not installed	X		X
Lake Butler Hospital						
Madison County Memorial Hospital						
Shands at Live Oak			Purchased, not installed			X
# of CAHs	5	0	3	3	2	9

It is evident from this baseline assessment that the level of HIT implementation in CAH varies greatly, which has two consequences. First, the level of support (financial and operational) will need to be tailored to each institution's needs. Second, our primary goal is not to advance CAH beyond current safety standards but rather to establish an equal standard of medication safety technology across all institutions. The level of interaction with each facility will therefore vary.

Table 3. Medication Use Process Steps and Opportunities for Improvement

	Opportunity 1	**Opportunity 2**	**Opportunity 3**	**Opportunity 4**	**# times mentioned by CAH**
Prescribing	Provide clinical information	Drug interaction/ duplicate checking	Allergy, lab, other interaction checking	Apply best practices	7
Order communication	Improved legibility	Appropriate drug, dose form	Decreased turn around time	Consistent information on order, Pharm profile, and MAR	8
Product Labeling, Packaging, Naming	Exact patient and order info on label	Legibility	Provision of additional info such as storage, expiration info		Not specifically asked
Compounding	IV in-compatibility checking	Decreased contamination with robotics	Safety of pharmacy personnel		Not specifically asked
Dispensing	Access to meds 24 hours	Order – medication checking	Legibility of Pharmacy Pick lists/ labels		12
Distributing	Access to meds 24 hours	Order – medication checking	Audit trails		Not specifically asked
Administration	Drug – patient – time matching	Legible MARs matched to order	Automated IV pump capabilities	Documentation of administration	6
Education	Take home instructions	Educational materials	Multi- lingual printing		Not specifically asked
Monitoring	Recalls	Drug usage management	Disease management		Not specifically asked

As stated earlier, this project found pharmacy health information technology should be implemented in three phases in the CAHs, prioritizing the areas of greatest need and focusing on the health information technology that will have the greatest impact on reducing medication errors.

Phase 1 of HIT Implementation: Pharmacy Information Management Systems (PIMS)
It was found the first pharmacy HIT needed by the CAHs are pharmacy information management systems (PIMS). The pharmacy management system is the corner stone on which the implementation of other HIT depends. They allow pharmacists to establish a patient profile that contains relevant patient information such as gender, age, weight, and other clinical parameters. Pharmacy management systems provide decision support that screens and alerts for drug interactions, incompatibilities, drug allergy interactions, and inappropriate dose.

A pharmacy management system with decision support software such as First Databank can reduce the rate of errors by preventing errors and adverse events, facilitating more rapid responses to an adverse event and providing data on adverse events. Pharmacy management systems can also improve communication, make information easily accessible, require the provision of key information, assist with calculations, perform real-time checks, and help with monitoring. Only three of the CAHs currently have an operational pharmacy management system. The cost of such systems, $40,000 or more, has been a barrier for financially strained CAHs.

Selection of pharmacy information management systems. The following considerations were used to develop criteria for the selection of PIMS systems and to design its implementation. First, we utilized recent experience with the implementation of a new PIMS at UF & Shands teaching hospital. While this software offers one of the most advanced decision support capabilities, the hospital has restricted its alert systems significantly. This decision was made in consultation with McKesson and First DataBank, which both cautioned that information overload and the large proportion of clinically irrelevant alerts may quickly induce alert fatigue and induce frequent overrides.

While it is recognized that pharmacotherapy in a tertiary care hospital is more complex, the level of customization necessary to develop a hospital-specific set of alerts that is well-balanced in respect to sensitivity and positive predictive value (proportion that is clinically relevant). Alerts that mostly flag appropriate therapy (false positives) in tertiary care hospitals may further be appropriate in the CAH. For example, use of multiple opioids is indicated for cancer pain and leads to many false positive alerts at our teaching hospital. However, this patient type is rare in CAH and multiple use of opioids may in many instances correctly flag a medication error. In order to facilitate a successful implementation of a decision support systems, it is therefore deemed to be necessary to customize alerts based on CAH patient type and formulary, utilizing UF resources to facilitate alert customization, as most CAHs will lack the necessary capacity.

Second, given the lack of 24-hour pharmacy coverage in all hospitals, the PIMS should be useable by pharmacists and nurses, such that nurses can enter medications during off-hours and pharmacists use the system during work hours or when entering orders from remote sites. With different levels of pharmacotherapeutic knowledge among different types of personnel, the sophistication of decision support would therefore need to be tailored to the current software user. For example, alerts for nurses who enter orders off hours would be restricted to life-threatening or severe errors that do require action. Alerts that flag more subtle errors that may not pose significant patient harm but present a suboptimal therapeutic choice and require more involved judgment would be restricted to pharmacists.

Third, in order to customize alerts not only in respect to the type of healthcare professional who interacts with the system but also to reduce the number of clinically insignificant alerts in general, the pharmacy software would need to be flexible enough to review and manipulate the drug information behind the decision support software. Furthermore, the task to review and optimize alert selection is simplified if the implemented pharmacy software (CDSS: clinical decision support software) is identical across all hospitals. To facilitate interfacing as well as maintenance, contracts vendors with financial packages and ATD software installed at the CAHs were selected to participate in the vendor fair, in addition to vendors that offer freestanding PIMS. Although vendor selection may differ according to the needs of the hospitals it is expected that the same CDSS is implemented in most hospitals because of the added benefit of alert customization by UF & Shands faculty.

Last, all vendors will meet communication protocol standards HL7 Version 2.2 or higher. For offsite concurrent medication order review, hospitals need a persistent connection to the internet with static IP address, and a firewall and/or router in place capable of terminating a 3DES IPSEC tunnel. As part of the planning process vendors were examined on compatibility with Federal Health Interoperability Standards. All vendors were also requested to the availability of standard interfaces with the existing financial, laboratory, ATD, and other systems in place in the hospitals.

Phase 2 of HIT Implementation: Automated Dispensing Cabinets (ADCs)

This project's planning process revealed automated dispensing cabinets should be the next step in HIT implementation in the CAHs. Automated dispensing cabinets are machines that allow drugs to be dispensed at the point of care, and can be accessed by non-pharmacy staff. Physicians or pharmacists enter prescriptions into a central pharmacy server to be reviewed and approved. Upon approval, the pharmacy information system sends an electronic message to the automated dispensing system to release the medicine. Reviewed and approved medications are then accessed upon positive identification of the nurse, the machine directs staff to

the correct automated drawer or compartment that contains the medication, and staff verifies the medication before administration. Dispensing cabinets can track all medications used, automatically generate a refill request when supplies fall below a preset level, and automatically bill patients through linked management systems. Besides improved cost capture, an additional benefit of automated dispensing cabinets is that access can be regulated from a remote site. This allows for 24hour/7days a week concurrent prescription order review by pharmacist, a key feature for CAHs because no critical access hospital had concurrent review of orders 24 hours per day, seven days a week, and the majority have pharmacists available to them only a few hours per week. Thus, mote prescription order review was done retrospectively. Vendors of automated dispensing cabinets included in this project were Omnicell, MedDispense and Pyxis.

Our review of the CAH medication safety found deficiencies in the pharmacy infrastructure and dispensing process. Pharmacies were often not organized to avoid dispensing errors (e.g., separate storage of high risk medications, look-alike drugs, flagging of different dosage or sustained release forms). These deficiencies appear even more pronounced when nursing staff who are not familiar with the pharmacy inventory and subtle pharmacological differences, dispense drugs. Frequently reported dispensing errors included confusion of sustained and immediate release dosage forms or drug dose. Automated dispensing cabinets address these dispensing errors two-fold. First, they raise awareness about the availability of various dosage forms as the entire hospital formulary is listed. Second, they allow access to only one compartment, this minimizing choice and reducing confusion from sound-alike, look-alike medications.

Another positive aspect of automated dispensing cabinets is the limited access to drugs in general and to narcotic drugs in particular. Hospital pharmacy access policies in CAH are often challenged by nursing staff shortage during off-hours and the part-time employment of pharmacy staff. Use of automated dispensing cabinets would reduce the necessity for nurses to access the hospital pharmacy and limit the access to controlled substances for the entire hospital staff.

Phase 3 of HIT Implementation: Smart IV Infusion Pumps

Smart infusion pumps contain a standard data set that includes parameters for infusion fluids and a clinical decision support system. If a nurse enters an infusion rate that conflicts with the parameters stored in the standard data set, the smart pump will provide an audible signal (soft stop). A soft stop signal indicates that the rate can be overridden. If the infusion rate is endangering the patient, the pump will provide for a hard stop signal that cannot be overridden. Furthermore, smart infusion pumps keep a trail of rule violations. Collection and review of these rule violations can facilitate quality improvement programs and delivers information about the effectiveness of smart pumps. It allows tracking of “near miss” programming errors that are averted and could have resulted in patient harm. The smart pump technology does so by recoding the steps leading to an alert. It also records programming changes made as result of the alert. The software documents how many and what type of medication errors are prevented and helps identify processes for improvement.

Several makers of infusion pumps are in the process of developing smart pump technology; Alaris was the vendor of smart infusion pumps included in this project. Alaris was selected because the quote for the Alaris pump system was piggybacked on a favorable quote received for UF & Shands Healthcare. Also, Alaris has several superior configurations for the pump including a wireless technology. The minimum investment advice provided to the CAH was for 5 Medley 8000 pumps with seven channels. This was based on an average five-bed occupancy rate of the CAHs. The CAHs selected the Medley pumps as the most suited for their nursing environment.

Institute of Medicine Recommendations to Reduce Medication Errors

This project aimed to address at least seven of the twelve Institute of Medicine recommendations for reducing medication errors. The choice of pharmacy information management systems, automated dispensing cabinets and smart IV pumps can address the following recommendations: (1) implementation of standard processes for medication doses, dose timing, and dose scales (e.g., dosing parameters built into smart IV pumps), (2) standardize prescription writing and prescribing rules (e.g., automated dispensing cabinets can regulate prescribing because of inclusion of entire hospital formulary), (3) use of pharmaceutical software (e.g., obtaining drug information from pharmacy information management systems), (4) implement unit dosing (e.g., automated dispensing cabinets can be stocked with unit doses), (5) ensure the availability of pharmaceutical decision support (e.g., implementation of pharmacy information management systems), (6) make relevant patient information available at the point of patient care (e.g., PIMS linked to patient data, lab data, etc.) and (7) improve patients' knowledge about their treatment (e.g., printed, bilingual patient education materials).

Barriers to HIT Implementation

This project surveyed CAH personnel to uncover barriers to HIT implementation. By far the most pressing barrier to HIT implementation for the CAHs is funding. CAHs have limited financial resources, which often must be allocated to meet the institution's basic needs, such as structural improvements. Other barriers associated with limited institutional budgets included paying for physical alterations that may be required to implement HIT, such as upgrading or installing red outlets, electrical lines, phone cables, etc. Even hospitals that already had a pharmacy-related HIT in place, such as Hendry Regional Medical Center, financial constraints are a barrier to upgrading equipment and systems and/or interfacing with other IT systems, such as laboratory.

The second most frequently mentioned barriers to HIT implementation were personnel-related. These included staff resistance to change, especially for long-term employees accustomed to a long-standing and specific workflow. Other barriers includes employee "burn out" because of increased training needs and changes in work flow, staff aversion to change, staff level of willingness to learn and use HIT, and staff ability to adapt to new technology.

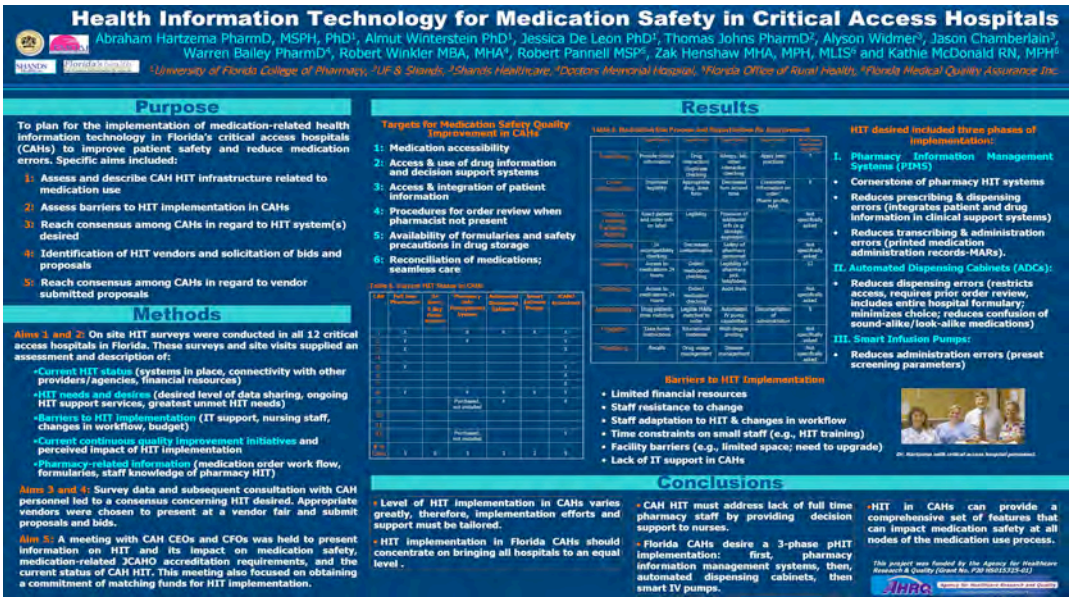
Staffing concerns were also mentioned as a barrier to HIT implementation. The small staff size at CAHs means employees often serve in multiple capacities and face restrictive time constraints. Thus time needed to implement HIT, such as time spent on initial set up and staff orientation and training, were seen as barriers to implementation.

Finally, barriers to HIT implementation in CAHs also included limited space in the hospitals for HIT equipment, and concerns about the lack of IT support personnel in the CAHs.

Despite these barriers, nursing and pharmacy personnel, as well as CEOS of Florida Critical Access Hospitals, voiced strong support for the implementation of pharmacy health information technology in their facilities, and all critical access hospitals committed funding for implementation. An implementation grant is submitted to the Agency for Healthcare Research and Quality for funding consideration.

PUBLICATIONS AND PRODUCTS

Poster: Health Information Technology for Medication Safety in Critical Access Hospitals; **Presented at:** AHRQ's Annual Patient Safety and Health IT Conference, Washington, DC.



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Appendix A: Health Information Technology On-site Survey

REVIEW OF HEALTH INFORMATION TECHNOLOGY
IN FLORIDA CRITICAL ACCESS HOSPITALS

Hospital Name: _____

Position/Title of Person Interviewed: _____

Interviewed by (circle all that apply): Hartzema Johns Widmer Winterstein

1. Is your hospital part of a larger hospital system or network? Yes No If y**es**, what is the name of the hospital system?

   What computer systems does the parent hospital or corporation use? Are these systems in place at your facility? Yes No

   What kind of HIT support does the parent hospital or corporation provide?

   Does your parent hospital system or corporation provide remote site 24/7 pharmacist prescription order review? Yes No

2. Does your rural health network provide HIT services and/or support? Yes No **If yes**, what kinds of HIT services does the Rural Health Network provide?

   What computer systems does your Rural Health Network use?

   Is your rural health network connected via computer systems to share patient data among providers in the network? Yes No **If no**, does your Rural Health Network have plans for such connectivity?
   Yes No

3. Are the health care providers in your community connected via a computer system? Yes No

   If yes, what computer systems are used by community providers?

   What kind of information is available to the community providers?

   If no, what other means of communication with the primary care providers to provide continuity of care?

   What is your perception of the acceptance of computer technology by community providers?

4. What data would you like to share with your Rural Health Network, referring providers or referral tertiary hospital?

5. Does your hospital have a centralized service or department that is responsible for addressing HIT needs and issues throughout the hospital? Yes No **If no**, how are the hospital's HIT needs addressed?

5. Does your hospital own or operate off-site outpatient clinics or rural health clinics?
6. **If yes**, do these off-site clinics have access to your hospital's computer systems? Yes No

   If yes, what kinds of information are shared with these off-site clinics?

   Does your hospital provide HIT support for these clinics? Yes No

   If yes, what kind of support is provided?

7. What support does your hospital currently have available in regard to health information technology (e.g., information technology staff/personnel, contracted services)?

8. Describe the current financial resources that are available to your hospital for health information technology.

   What are the origins of these financial resources?

   Do you believe these resources are adequate to keep the hospital competitive in the health care marketplace? Yes No

9. What is your hospital's Medicare utilization rate, i.e., your Medicare discharges as a percent of your total discharges?

10. What do you view as the greatest unmet HIT needs in your hospital?

    What are your hospital's plans for meeting these needs?

11. Do you purchase, lease or rent health information technology equipment? Yes No

    If yes, circle all that apply: Purchase Lease Rent

    If you lease HIT equipment, is the leaseholder an OEM, a wholesaler or a financial institution?

    Could you describe the details of this lease agreement (e.g., time, services arrangements, updates, etc.)?

12. What are the barriers to the adoption of health information technology that will have to be addressed to implement health information technology in your hospital (e.g., financial resources, human resources, work flow, cultural barriers)?

13. What is the greatest barrier to the implementation of pharmacy health information technology in your hospital?

14. Does your hospital use computers for patient care? Yes No **If yes**, what clinical and clinical support services are computerized (e.g., patient admissions, medical records, laboratory data)?

15. What continuous quality improvement (CQI) activities are in place at your hospital? How would health information technology assist in your CQI activities?

16. Does your hospital have any recommended clinical guidelines in place? Yes No

    If yes, could we have a copy of these guidelines?

17. What are the outcome measures you would like to improve upon in your facility? Please be as precise as possible (e.g., reduce number of unauthorized entries to the pharmacy, diversion of controlled substances, reduce nursing time devoted to controlled substances, recovery of lost charges, drug administration, safety and documentation, IV functionality, etc.?)

18. Does your hospital have a formulary? Yes No If yes, can you supply a copy of your formulary?

19. Can you estimate the number of prescriptions filled per day in your hospital? If you can, please estimate prescriptions per day by drug class.

20. Please describe the current technology present in your hospital that supports pharmacy related activities.

21. How would you assess the importance of each of the following health information technologies for your hospital? Also, how would they impact patient safety, productivity or financial performance of your hospital? Please be precise.

    a. Interface with admissions/discharge:
    b. Interface with laboratory:
    c. Interface with billing department:
    d. Interface with other departments (e.g., radiology, nutrition, etc.):
    e. Bar coding (patient ID bands):
    f. Computer-generated medication administration records (MARs):
    g. Fax machines at patient care areas used for prescription order entry:
    h. Pharmacy management system:
    i. Pharmacist decision support system (national database):
    j. Computerized physician order entry with decision support:
    k. Online drug information resources:
    l. Automated dispensing systems (e.g., Medsure, Pyxis):
    m. Pharmacy barcode systems (e.g., labeling applications):
    n. Intelligent IV pumps:
    o. Production reports (cart fill, IV, etc.):
    p. Purchasing and inventory:

22. Describe your hospital's prescription order workflow, starting from when medications are ordered through their administration to the patient. If a workflow outline is available, please attach separate sheet(s).

23. Are there other kinds of health information technology to improve medication safety that you know of? Yes No **If yes,** what other kinds of health information technology do you know of?

    Would you be interested in acquiring such technology? Yes No

24. Have you previously been involved in group purchasing or contracting? Yes No

    If yes, what buying organization do you belong to?

    What has been your experience with group purchasing or contracting?

    If no, are you supportive of group purchasing or contracting for HIT? Yes No

    What do you see as the obstacles to critical access hospitals group purchasing or group contracting health information technology?

Observer Notes:

Appendix B: HIT Vendor Fair Notes

Pharmacy HIT Vendor Fair
January 26, 2005 University of Florida

As part of the AHRQ HIT Planning Grant, an HIT Vendor Fair took place on January 26, 2005, at the UF Hilton. Vendors were selected if critical access hospitals already had their products in place, if their products were suitable for small hospitals, and if their technology was appropriate for small hospitals with small patient censuses, if their products were already being used in critical access hospitals, if their IT systems could collect data that can be audited, analyzed and used to detect and prevent medication errors. Vendors were give one hour each to present on their pharmacy HIT systems.

Vendor attendees included: Omnicell, Alaris, CPSI, HMS, Mardon, and Mediware. Three other vendors were invited but did not attend: Cardinal, Amerisource Bergen and Dairyland. A meeting with representatives from Cardinal to discuss their dispensing cabinets (Pyxis) and remote prescription order review (Cardinal is the only company that is allowed by law to conduct remote order review in Florida). Confusion on the part of the Amerisource Bergen rep caused him to miss the meeting, but contacted us with regrets the day of the fair. Dr. Hartzema will contact him with a request for proposals. Dairyland representatives declined attendance, but were given the opportunity to submit a bid.

CAH and other attendees included:

Name	Title	CAH or Organization
Warren Bailey	Director of Pharmacy (Doctors Memorial)	Doctors Memorial Hospital, Bonifay
	Consultant Pharmacist	Campbellton Graceville Hospital
Elicia Coley	Director of Pharmacy (Gadsden Community Hospital)	DasSee Health Systems: Calhoun Liberty Hospital, George Weems Hospital and Gadsden Community Hospital
Ted Sanders	Director of Pharmacy	Doctors Memorial Hospital, Perry
	Consultant Pharmacist	Madison County Memorial Hospital
Deena Hames	Chief Financial Officer	Madison County Memorial Hospital
Melissa Meyer	Business Office Manager; IT Supervisor	Madison County Memorial Hospital
Janice Greene	RN, CNO	Madison County Memorial Hospital
Gene Mills	Director of Pharmacy	Lake Butler Hospital
Patty Deguio	Director of Nursing	Lake Butler Hospital
Sandra Woodall	Director of Pharmacy	Hendry Regional Medical Center
Robert Pannell	FLEX Program Coordinator	FL Dept of Health, Office of Rural Health
Abraham Hartzema	Planning Grant, Principal Investigator	UF, Pharmacy Health Care Administration
Jessica De Leon	Planning Grant, Co-Investigator	UF, Pharmacy Health Care Administration
Tom Johns	Planning Grant, Co-Investigator	Shands at UF, Pharmacy
John Kupkovits	HIT Consultant	Florida Medical Quality Assurance, Inc.

Omnicell™

Products:

- *Omni Linx Rx*: physician order management system using scanned and faxed prescription orders; used adobe Acrobat; can also use web cam for direct viewing of medication
- *Pharmacy central*: software and carousel
- *Safety Pak*: unit dose, computer controlled, bar codes
- *Secure Vault*: for controlled substances
- *Safety Med*: software, we choose hardware; bedside

Modules can stand-alone or be integrated with other systems.

Cabinet systems: Omni Rx, medication profiling, provides list of previously approved orders; drug information database; both touch screen and key board entry; charge capture is another important feature – capture charges that could have been lost (18-30% revenue added from improved data capture); cabinets are adaptable according to need; Omnicell personnel will analyze inventory and suggest custom cabinet based on hospital's specific needs; "sensing lids" can alert to unauthorized access; cabinet can include refrigerated units; return bin to return drugs to pharmacy and will alert there are returns to be retrieved; rated in higher in customer satisfaction than Pyxis

Technical Info:

- Uses First Databank (at bedside system, not cabinet)
- Linked to Clinical Pharmacology
- All systems work with servers; system is backed up at night; battery backup, should be plugged into generator plug
- Info can be accessed through desktop computers
- Include printable patient education in English and Spanish
- They do not provide support for server or database
- Server can reside anywhere and be connected to remote computers; model for Doctors Memorial and Campbellton Graceville where one pharmacist serves as full time Director of Pharmacy in one hospital and part-time consultant pharmacist in the other hospital; cold be accessed from home as well

Installation: Pre installation meeting, Set up, Training of staff
Ideally would be linked to billing
Purchase or lease

Q & A
Q1: where should priorities of implementation be?
A1: (1) dispensing cabinets at nursing station medication available 24/7 with or without presence of a pharmacist; (2) medication or management (Omni Linx Rx)(3) clinical checks at bedside

Q2: Does bedside system track patient profiles?
A2: no, does not have info on past admissions, just for current admissions, but Omni Linx Rx tracks previous visits

Q3: Which systems require wireless technology, which is an implementation barrier for some hospitals?
A3: the only system that requires wireless technology is the bedside system, i.e. Safety Med.

Q4: What systems are best for EDs and clinics?
A4: dispensing cabinets in the ED are often the first cabinets implemented. Suggest having a cabinet large enough to serve as both ED and night cabinet – one cabinet two purposes.

Q5: What are access options?
A5: can configure dispensing only to release pharmacist approved drugs, or can allow certain staff to have higher access with override options

Q6: What does the system supply in regard to medication safety alerts?
A6: allergies on screen; can require an override reason; requires blood pressure checks when necessary; requires pain assessment

Alaris™

Product:

- Smart IV infusion pumps
- "Guardrail" software technology – allows the programming of a minimum and maximum dose; alerts to doses outside these limits. Captures data for continuous quality improvement, explore root causes of errors
- "Medley" and "traditional" units; Medley can be upgraded like a computer

Targets safety at the administration stage
60-90 days to implement

Implementation plan:
Phase 1-device at bedside; stand alone, no network connection needed; can download data on laptop by syncing with each pump
Phase 2-devices and server; server can be linked to several hospitals

How many units needed? 1 brain per bed
Can have bar code meter added to module

Financial info: There are lease options; traditional model costs less than Medley

CPSI™

Software: Their pharmacy application is not a stand-alone; must have their "base" package that includes admission, insurance, medical records must first be in place to install pharmacy package; DOS-based system

Implementation: Pre install – information gathering (formulary, daily routine, pharmacy); plan of action
Install-hands on and classroom training; implementation; can stay another week for some jobs
Follow-up-make sure all staff are trained; address any changes since implementation

Product Info: MicroMedx, quarterly updates; Dose range based only on age; Can be integrated with Pyxis, clinics, ED, Omnicell; Pharmacist can have remote access; Security levels can be established to limit access
Fax orders to other location for remote review and entering into CPSI system

Mediware ™

Windows based
Uses First Databank: Alerts-allergies and dose alerts; Updated monthly; Custom changes can be shielded from monthly updates; Can filter alerts by severity, or have different individuals see different severity levels (e.g., pharmacy vs. pharmacy tech);

Two levels of security

In- and outpatient data
Connects with automated dispensing machines; bi-directional
New version of First Databank has an intervention module: Can look at cost savings; Can look at outcomes of ; interventions; Can have automatic stop orders; Can set up templates to fill in (without creating from scratch); Can copy and paste order to reduce transcription errors

HMS™

Madison County Memorial and Doctors Memorial have HMS systems in place
Windows based
Their focus is on smaller hospitals (25-75 beds; range of business is 145-400 beds)
System is fully integrated with billing, ADT, lab, nutrition dept.
They currently ser 43 CAHs
They are an employee owned company

Pharmacy module: clinical history profile; clinical screening and patient education nursing access; link to laboratory; integrated with billing; e-MARs; third party interface (telepharmacy. Dispensing cabinets); HL7; User control filed that control what different staff members can access; Medispan is their clinical database; Alerts color coded by severity; Easy updates, approx. 15 minutes; Allergy reactions/symptoms are prompted; Can track cost savings if medication is changed; Can pull past medical histories forward (or can turn off if you want ; y new information); Includes default drug info (e.g., dose, route) that can be used or turned off; Can control whether unreviewed orders are sent to dispensing cabinets; Can control returned drugs; Narcotic tracking with sign out sheet that can be reconciled with pharmacy records

Mardon™

Lake Butler Hospital has Mardon system
Product:

- Designed for rural health systems

- Simple back up system

Model for HIT Implementation in CAHs: Hendry Regional Medical Center in Clewiston, Florida, has become the 13th CAH in Florida and has joined the medication safety project. Their current pharmacy HIT can serve as a model for other CAHs: they have a full time pharmacist on site during the day (Sandy Woodall). After hours they have Cardinal conducting remote prescription order review. This system includes a web camera inside the pharmacy so nurses can show the actual product being administered to the remote pharmacist. They have automated dispensing cabinets interfaced with their pharmacy information system. Tom Johns and Abraham Hartzema are planning a site visit to Hendry Regional Medical Center to observe their pharmacy HIT system in action.

Appendix C: Vendor Fair CAH Staff Survey

Name:_____ Hospital:_____

Automated Dispensing Machines

How many automated dispensing machines would your hospital need (please provide a minimum and a maximum number)?

In which departments, wards, etc. would you like to see a dispensing machine located (e.g., emergency, clinics, pharmacy, nurses stations)?

What are your desired features for an automated dispensing machine?

What is the technical infrastructure currently present in your hospital (electrical wiring and outlets, computer wiring, electronic networks, other health information technology systems already present)?

What do you see as the barriers to implementing an automated dispensing machine in your hospital?

What do you see as the benefits of implementing an automated dispensing machine in your hospital?

Other comments?

IV Pumps

How many IV pumps would your hospital need (please provide a minimum and maximum number)?

In which departments, wards, etc. would you like to see IV pumps located (e.g., emergency, specific wards)?

What are your desired features for IV pumps?

What kinds of medications or solutions would you expect to use in the IV pumps (e.g., antibiotics, saline, etc.)?

What do you see as the barriers to implementing IV pumps in your hospital?

What do you see as the benefits of implementing IV pumps in your hospital?

Other comments?

Remote Prescription Order Review

How many fax machines are currently present in your hospital, and where are they located?

How many fax machines are needed for transmission of prescriptions for remote prescription order review (please provide a minimum and a maximum number)?

Where should fax machines be located in your hospital for transmission or prescriptions to a remote prescription order review service?

What do you see as the barriers to implementing remote prescription order review in your hospital?

What do you see as the benefits of implementing remote prescription order review in your hospital?

Computerized Physician Order Entry (CPOE)

Where should terminals be located for computerized physician order entry (e.g., pharmacy, physicians' offices, nurses stations, etc.)?

What do you see as the barriers to implementing CPOE in your hospital?

What do you see as the benefits of implementing CPOE in your hospital?

Other comments?

Connectivity

What are your priorities in regard to connectivity between systems (e.g., connections with laboratory data, billing department, or admissions department?

What do you see as the barriers to connecting your hospital's various HIT systems?

What do you see as the benefits of connecting your hospital's various HIT systems?

Other comments?

Appendix D: Presentation to CAH CEOs and CFOs, February 16, 2005: Planning for Health Information Technology (HIT) in Critical Access Hospitals

I. The Team…

- Department of Health, Office of Rural Health
- Florida Medical Quality Assurance, Inc.
- University of Florida, College of Pharmacy
- UF & Shands Healthcare

II. Accomplishments PY 1 & PY 2

- Culture of medication safety
- Formation of Medication Safety Committee
- Appoint Medication Safety Officer
- Improve reporting of medication variances
- Establish meaningful quality improvement initiatives
- Enhanced networking through summits and
- Blackboard development

III. Sources of Medication Errors

- Prescribing Errors
- Transcribing Errors
- Dispensing Errors
- Administration errors

IV. Medication Errors and HIT

- Prescribing Errors: Pharmacy Management System
- with Clinical Decision Support Tools
- Transcribing Errors: Pharmacy Management System
- through Medication Administration Record (MAR)
- generation
- Dispensing Errors: Dispensing Cabinets
- Administration Errors Dispensing Cabinets (Clinical
- Pharmacology), Smart Pumps

V. Benefits to the CAHs
- Reduction in medication errors and increase patient safety
- Improved nursing staff satisfaction
- Reduction in staffing time for counting narcotics and MAR transcribing
- Improved charge capture (18-30% of revenue)

VI. JCAHO Accreditation and Other Considerations
- 24hr/7day concurrent Rx review
- Controlled access to pharmaceuticals
- Reconciliation of medication records
- Computerized prescription order entry (CPOE)
- Barcode technology
- POC: patient information

VII. Funding for HIT Implementation
- AHRQ funding available up to $500,000 / year for a three year period
- AHRQ funding provided as much as matched funds made available
- Matching funds may exceed AHRQ contributed funds
- "A cost sharing of a minimum of 50% of total costs is a condition of award for all recipients of funding from this solicitation. Cost sharing refers to a situation where the recipient shares in the costs of the project. Cost sharing is a requirement for funding because projects funded under this solicitation will have a greater degree of likelihood of success if the recipient contributes to the cost of project. "
- 20% of AHRQ funds allowed for hardware and software
- All matched funding may be used for hardware and software

VIII. Matching Funds?
- In-kind contributions OK, e.g. staff training time
- Use SHIP (Small Hospital Improvement Program) fund trading for matching funds at the individual hospital level
- Request funds from local Foundations ($50,000-$100,000)
- Cost recovery includes Medicare, Medicaid (4-16%) – leased hardware/software
- Cost recovery assures sustainability
- Financial resources contributed by CAHs (binding letter of commitment)- funds stay in the hospital

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Appendix E: FMQAI Strategic Plan

Health Information Technology (HIT) holds the key to the quest for higher quality and greater medication safety in the care of patients in the Critical Access Hospital (CAH) group. The goal of this project is to implement a model that applies basic HIT infrastructure to the medication use process to improve patient safety and reduce medication errors.

Where errors originate

The National Coordinating Council for Medication Error and Reporting and Prevention defines a medication error as " any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing; order communication; product labeling, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use."1

[1] National Coordinating Council for Medication Error and Reporting and Prevention website, www.nccmerp.org/aboutMedErrors.html

The following table will describe these primary events in the medication use process and describe responsibility for where the error may originate:2

	MD	RPh	RN	Patient
Prescribing	X			
Order communication	X	X	X	
Product Labeling, Packaging, Naming		X		
Compounding		X		
Dispensing		X		
Distributing		X		
Administration			X	X
Educations	X	X	X	
Monitoring	X	X	X	
Using				X

Each of these steps represents not only an opportunity for error but also an **opportunity to improve patient safety**. All errors are not equal in the potential harm they may cause to a patient. For example, it can be argued that medication administration errors such as IV administration errors may be more significant than prescribing errors, most of which are "caught" by other individuals in the process. Also, frequency for each error type will vary. To assess the greatest potential for impacting patient safety we must examine the significance of the error and the frequency of occurrence. To begin, let us describe each of these process steps and describe how technology may be applied as a tool to facilitate improvement.

Prescribing

During the prescribing process the physician will evaluate the patient/condition, incorporate all relevant variables (age, sex, co-morbid conditions, etc.), evaluate treatment alternatives, and develop a treatment plan of action appropriate for that patient. In a paper-based system, the physician is dependent on what the patient says, what can be found in the paper chart, and on the physician's memory to apply the treatment plan.

If automation is incorporated into this process, the physician will have, during the interview process, additional information that may be obtained from pharmacies, specialists, and other provider entities that are not included in the typical paper chart. By retrieving the patient's electronic record the physician may review pertinent diagnostic and treatment records to assess the success of historic treatments and assess to some degree the patient's compliance with the treatment regimen.

As the physician develops the next phase of the treatment plan, orders may be written electronically that will check drug orders against allergies, interactions, and co-prescribing duplications. The system will alert the physician as to these potential problems and allow the physician to proceed as planned or change the treatment depending on the interpretation of these warnings. More advanced decision support systems will additionally apply best practices templates and take into account patient specific variables and local preferences that may influence the plan. As a result the physician is in a position to make a more informed and current judgment as to the appropriate plan of action while avoiding situations that will place the patient's safety in jeopardy.

Communicating Orders In the manual system the decided-upon treatment plan is hand written in the patient's chart and/or verbally communicated to a licensed professional for documentation. The written order is then faxed, copied, scanned, or transcribed again to a manual requisition. The requisition is then delivered to the pharmacy. Each of these steps introduces possibility of error due to illegibility and delays the time a first dose is administered to the patient.

By using an electronic order entry system, order legibility and timeliness will be improved. Taken a step further, if the physician enters the order (Computer Physician Order Entry – CPOE), all errors of legibility and verbal miscommunication are eliminated. Because the system will only have formulary items available potential problems arising due to brand names can be eliminated.

A last, but significant advantage is that with pharmacy management systems, the order is exactly transferred to the pharmacy labels, profile/pick list and the nursing MAR so all are working from the same information.

Labeling, Packaging, Naming

[2] Timothy Dotson, RPh, MBA, MSEd, FHIMSS in a report to Central Florida HIMSS*, "CPOE's Place in a Portfolio of Medication Safety Projects"*

Manual systems make it difficult to enforce standards, consistency, safety, storage, and expiration information. Each label is created singly or in batch but there may be differences between batches or items may be left off labels. First dose labeling may be different from ongoing unit dose labeling.

Many of these problems can be overcome by use of packaging machines and purchase of dosage forms with pre-printed information. This label can be supplemented by a computer-generated label with the CPOE and patient information printed from the order entry system.

Compounding

Today, serious errors in compounding take place primarily in the IV preparation process. In the manual system errors can originate through misreading the handwritten order, incorrectly transcribing the order to the Pharmacy IV profile, incorrect preparation or introduction of incompatible ingredients, or use of diluents that cause problems (e.g. dextrose in a diabetic) for the particular patient.

An automated system will directly create the IV profile from the electronically entered order, print compounding lists, determine incompatible or damaging ingredients, calculate diluent/ingredient amounts and produce labels specific to that patient-administration event.

Compounding of IV medications may also cause harm to the person who compounds the IV as a number of ingredients are toxic. A robotic compounding machine can improve the accuracy of the doseform and provide safety to pharmacy or nursing personnel who compounds the doseform.

Dispensing

Manual systems require the pharmacist and technician to read and interpret patient orders from hand-written profiles. Additionally, relevant patient clinical information such as allergies may be missing. The technician and pharmacist after interpreting the order, number of doses needed, and dosage form, gather the medications from bins and place in the patient's unit dose cart or place in the delivery vehicle for first doses. Errors can occur in any of these steps.

By use of automated dispensing machines or robotic solutions, packaging and distribution of individualized patient medications may be delivered to the patient. IV solution production if automated can eliminate calculation and compounding errors.

In the critical access hospital environment, there is often not a pharmacist or technician available to dispense medication when needed. An automated dispensing machine, if interfaced to a pharmacy management system, can perform many of the tasks the pharmacist and technician would typically perform. The need for pharmacist review is not eliminated, but the criticality of performing this at dispensing time is reduced.

Distributing

Manual systems usually depend on human delivery of dosage forms from the pharmacy to patient location. As mentioned above, in the CAH environment, there is often not a pharmacist of technician available. For security purposes, additional intentional barriers are placed in the access to medications. Selection of the appropriate dosage form is left to the interpretation of the nursing staff with no pharmacist review. If the IV medication must be compounded, the nurse must calculate the diluent and usually cannot compound in a sterile environment.

As described under dispensing, the medication distribution can be tied directly to the electronic order and via secure supply cabinets, be procured directly at the patient's location at the time the dose is needed. Certain distributions, for example narcotic medications, can be tracked as to when, how, and by whom obtained. Dispensing cabinets are available 24 hours a day 7 days a week.

Administering

As mentioned in the beginning of this section, medication administration errors may represent the most significant error as they are seldom realized until patient harm has occurred. Many of these errors go unreported. Proper administration requires the correct medication, dosage form, and administration to the correct patient at the correct time. The nurse is usually working from a manually created MAR (medication administration record) with all the potential inaccuracies of transcription, legibility and interpretation.

Automated systems, including bar coding technology, can match the bar coded medication, MAR, and patient armband to increase the accuracy of administration. If administration is a charge capture point, charges will be automatically captured to the patient's record at this time. Automated IV pumps can assure accurate rate of administration, check for precipitated solutions, and accommodate large volumes, piggyback and syringe dosing. For certain medications such as patient controlled analgesia medications, frequency of dosage request can be controlled and recorded automatically.

Educating

In the CAH environment, the pharmacist rarely sees the patient. Patient education is dependent on the physician or nurse to remember not only to educate the patient, but also to remember the significant information that should be communicated. Communication is typically verbal and patient compliance may be dependent on understanding. Language barriers and the stressful environment of hospitalization may preclude effective communication.

By using computer generated educational tools, written information can be given to the patient in addition to verbal communication. If the patient or clinician also has access to the Internet there is a wealth of information available from expert resources.

Discharge instructions including appropriate patient package insert information can be printed at discharge for all medications the patient will take at home. This document can also be used as a part of the patient health record and shown to the patient's primary physician at the next office visit.

Monitoring

Patient population studies and quality improvement data are difficult if not impossible to extract from paper documents. The recent recall of the drug Vioxx is a perfect example of a rapid need to identify and communicate to all patients taking this medication. Chart reviews are labor intensive and subject to the skills and experience of the extractor/reviewer. Reporting requires use of other tools such as spreadsheets to analyze the data.

Automated systems, especially repository type systems, greatly facilitate extraction of data from across patient populations for analysis and reporting. Extracted data can be analyzed and compared to industry best practices methodologies to ascertain if optimal care is being provided. And as mentioned above, an instance such as the Vioxx recall necessitates competent retrieval and reporting tools.

Patient medication safety issues and use of HIT to facilitate improvement

HIT has the potential to decrease the incidence of medication errors arising from every step of the medication use process. Some of the critical access hospitals surveyed already have separate reporting for their medication variances in order to focus on root cause analysis and trending. As part of the HIT implementation quality improvement process, we will develop a medication variance report for use by all the participating CAHs that breaks down this analysis by each step as listed in the table below. We propose that the CAHs begin tabulation of their medication variances for a period of one quarter prior to implementation of HIT. After implementation of HIT the variances should again be measured. This breakdown of variances would enable us to measure improvement gained by use of HIT.

Availability of pharmacist support

Today, most of the Critical Access Hospitals do not have 24-hour pharmacist support available 7 days a week. This was mentioned as a significant issue. When support is available, it is often provided remotely and the communications employed are antiquated. In some cases communication is verbal via phone (not documented) and in some cases faxes are employed. These communication methods are only useful when the CAH has negotiated for this remote support from a pharmacy or regional hospital. In some cases there is no such support. The primary impact of inadequate support is lack of timeliness in verification of orders, review of patient medication profiles, and dispensing activities. When no pharmacist is available for order review or to answer questions the nurse is, in some ways, functioning as a pharmacist.

It is probably safe to say that in the case of the CAH, remote pharmacy support will always remain an economic reality of the CAH environment. In this case, automated pharmacy management systems with order communication and interfaces to dispensing systems offer significant advantages over phones and faxes. The pharmacist, though he/she may be at a remote location, can interact with the system as though located in the CAH pharmacy. All communications are real time and all system capabilities such as interaction checking and automated profiling are available. The pharmacist can verify the order against the online profile and flag the system for dispensing. In that manner, the pharmacist is "on site" even though he/she may be fifty miles away!

Conclusion

In the Critical Access Hospital environment, the application of HIT can be a very effective tool in improving quality and patient safety as CAHs have limited resources. By supporting all steps of the medication use process to a greater degree than is possible in paper systems, HIT can effectively influence error and adverse event reduction. By providing capabilities remotely to pharmacists the pharmacist can function as if he/she were

on site. In essence, the nurse or other clinicians is no longer acting on their own but is better supported by systems and pharmacists than possible in paper systems.

By using the Variance Report tool the effect of HIT can be measured and serve as a basis for ongoing support of quality and safety improvement in the CAH.

Vendor Product CQI Capabilities

Alaris is a vendor that promotes a software product that enables the user to track data for Continuous Quality Improvement (CQI) measurement. The MedleyTM System with Guardrails® Software allows for tracking of "near miss" programming errors that were averted by recording steps leading to an alert, and programming changes made as a result. This system can track the number and type of medication errors prevented. This CQI data can be downloaded into a centralized server to analyze the most recent averted errors. If this "Smart Technology" were implemented, the CAH could adopt a quality indicator to measure the percent of averted errors such as: Total number of errors averted/Total numbers of doses administered. This indicator could further be broken down into the type of error.

Rxe-sourcesm provides a remote pharmacy service whereby many interventions and clarifications can be made which reduce medication errors. This service can also impact patient care by providing timeliness with order review and entry resulting in less delay in getting medications to patients during off hours. Errors of omission and delay are an important component to measure for CQI. We propose that the CAHs begin tracking dose times pre and post the implementation of a 24/7 remote pharmacy. The CAH can adopt a quality indicator to measure the effectiveness of incorporating a remote pharmacy provider by incorporating an indicator such as: Average time to administration and/or total number of errors of omission/total numbers of doses prescribed. In addition, if adopting the Rxe-sourcesm a possible quality indicator would be: Total number of clarifications/Total number of orders reviewed.

CPSI is a medication administration verification vendor, which offers point of care solutions through bar coding to reduce medication errors. The features of CPSI enable CQI measurements such as the percent of orders stopped due to medication allergies (or other factors), the percent of interventions and adverse drug events.

Dairyland HealthCare Solutions Pharmacy management system provides for interaction checking for drug/drug, drug/allergy, and duplicate order and medication error flags. This would allow for a CQI measurement of the total number of interactions found/total number of medications checked and the total number of errors flagged/total number of medications given.

MediMAR is medication management system that allows for tracking and report generation of actual errors and near misses. The software insures that the "5 rights" by issuing proactive clinical alerts through warnings that appear at the point of care prior to administration. CQI quality indicators could be established for the total number of clinical alert warnings/total number of doses administered (in a specified time period.) These clinical alerts could relate to the wrong patient, time, dose, drug, or route as well as allergy, dose range, duplication, interaction, missed dose, passed due or early dose time.

The Omnicell Automated Pharmacy Storage and retrieval system manages the complete drug distribution process, which enables tracking, monitoring and controlling the movement of controlle

d substances from a central fault to one or many locations. It ensures the right item is in the right location, minimizing the potential for cabinet dispensing errors. Their SafetyMed RN provides point-of-care documentation of medications ensuring the 5 rights of administration. Similar CQI measures can be incorporated as listed above.

PharmTRAK is pharmacy management software with CQI built in. It can measure a number of items such as administration times allowing for measures of medication omissions and late dosing. Statistical reports can be printed on alerts, which flag the number of adverse drug events to be traced. A quality indicator could be the total number of reported alerts/total number of doses given (in a time period). When errors do occur, these events can be recorded in PharmTRAK and used for root cause analysis. Quality indicators as simple as the total number of errors/total number of doses given can be measured for tracking purposes. Complete modules, worksheets, variance recording, and reporting on cart-fills, night stock/after hours withdrawals, controlled substances, crash cart control, prescribing and charting errors can be tracked and measured by this system.