Using Barcode Medication Administration to Improve Quality and Safety

Findings from the AHRQ Health IT Portfolio

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Background

Errors associated with medications are the most frequent cause of adverse medical events.[1] The Institute of Medicine has estimated that every year there are more than a million injuries and almost 100,000 deaths attributed to medical errors.[2] These errors are costly; one estimate puts the cost of adverse drug events (ADEs) at $2 billion a year.[3] While computerized physician order entry (CPOE) has been shown to prevent 55 percent of order errors,[4] many errors occur in the dispensing, transcribing, and administering stages of the medication process.[5] Although the standard is for nurses to check the 'five rights' of medication use—right patient, right medication, right dose, right route, right time[6]— only 34 percent of dispensing and 2 percent of administration errors are caught prior to reaching the patient.[7]

Thus, hospitals have substantial incentives to focus on improving their systems of medication administration. Barcode medication administration (BCMA) and electronic medication administration record (eMAR) technologies are two ways to improve inpatient medication safety by automating the process of medication checking, and making the medication administration record electronic. Research has demonstrated successful reductions in the rate of medication administration and dispensing errors after the implementation of barcoding systems,[8-14] especially when the barcodes are affixed to medications at the level of the unit-dose.[8,9]

Although there is substantial evidence and industry support in favor of BCMA and eMAR,[10] adoption in the United States is still low. In 2005, only 5 percent of hospitals reported having any sort of BCMA system.[11] In addition, only 35 percent of medications in a typical hospital have medications labeled at the level of the unit-dose.[12] In an effort to increase patient safety and increase adoption, the Food and Drug Administration (FDA) released a rule in 2004, mandating that drug manufacturers put linear barcodes on their medications at the level of the unit dose.[13] These manufacturers' requirements ease the burden on hospitals wishing to pursue BCMA, obviating the need to attach barcodes to medications themselves.

Despite the benefits of these technologies, low adoption persists due in large part to the complexities associated with implementation. Organizations must build buy-in among hospital staff, select vendors, prepare for changes in workflow, train nurses and pharmacists, find technical support, and evaluate the systems' impact on quality of care. Experiences from the AHRQ projects should provide lessons learned to ease implementation for other organizations considering medication administration technologies.

Scope

Since 2004, AHRQ has awarded over $260 million in funding for research in health IT. The AHRQ health IT portfolio consists of grants and contracts to support planning, implementation, and evaluation of various information technologies that were intended to improve the quality, safety, and efficiency of health care delivery. This portfolio includes a National Resource Center for Health IT (NRC), which was created to support AHRQ-funded projects in adopting and evaluating health IT. The NRC has established an infrastructure for collecting, analyzing, and disseminating best practices and lessons learned from its portfolio of health IT projects.

This report focuses on grants in AHRQ's health IT portfolio that are implementing or evaluating barcoding technologies to improve care for patients, increase efficiency, and contain costs. The analysis presented here provides a snapshot of these funded activities. The scope of this discussion is limited to challenges faced by grantees in developing, implementing, or evaluating barcoding interventions. The report does not include an evaluation of the projects' final outcomes. AHRQ has encouraged individual grantees to disseminate information about the final results of their work through peer-reviewed journals, trade publications, and other vehicles.

The authors reviewed original grant applications to identify barcoding medication administration implementation projects within the AHRQ health IT portfolio. For each project included in this analysis, we contacted the lead investigators to schedule interviews. These interviews became the primary data source for this report. Interview questions were developed in advance and were shared with the lead investigators. This format enabled us to question the investigators about core project design elements, key challenges, lessons learned, and future directions. The stories of these projects are presented below.

Profile of the AHRQ Health IT Portfolio

Grantee Characteristics

The subset of grantees who have implemented or are in the process of implementing BCMA and barcoding technologies are concentrated in the Midwestern United States, with the majority coming from rural areas (Table 1). Although this geographic clustering was not planned, it is not surprising that the majority of these AHRQ-funded projects were implemented in rural settings because of the Agency's funding priority in rural communities.

TABLE 1: CHARACTERISTICS OF PROFILED PROJECTS

Grant	Region	Rural/ Urban Projects	Software Vendor(s)
Improving Healthcare Quality via Information Technology	Northeast	Rural	MediTech
Improving Patient Safety/ Quality with HIT Implementation	Midwest	Urban	Epic
Nursing Home IT: Optimal Medication and Care Delivery	Mountain	Rural	Optimus
HIT-based Regional Medication Management Pharmacy System	Midwest	Rural	MediTech BMB, Accuscan
Project InfoCare	Midwest	Rural	Pyxis, CabBands
CCHS-East Huron Hospital CPOE Project	Midwest	Urban	Cerner
Medication Management: A Closed Computerized Loop	West	Rural	Siemens
Barcoding for Patient Safety in Northern Michigan	Midwest	Rural	Cerner
Comprehensive IT Solution for Quality and Patient Safety	South	Rural	Epic, Pyxis
Tulare District Hospital Rural Health EMR Consortium	West	Rural	HMS
Improving Health Care through HIT in Morgan County, IN	Midwest	Rural	Meditech

Technologies

While all of the projects implemented some type of barcoding, the specific interventions and their existing health IT differed. The grantees are at various stages of implementation and have implemented a range of vendor systems.

Findings

The grantee interviews provided detailed information about the successes, failures, and lessons learned from the AHRQ-funded implementation projects. The grantees identified various issues and challenges in the areas of technology, implementation, and organizational considerations; these are described in more detail below.

Technology Considerations

Stand-alone Versus Integrated System

The majority of grantees reported preferring applications that were interoperable with their other IT systems (i.e., an integrated application) rather than a stand-alone, best-of-breed application. With best-of-breed systems, many grantees described the difficulty and cost of building interfaces between products from different vendors, including the challenges of inducing the different vendors to collaborate. One grantee described the process as "getting bounced from one vendor to another" when trying to solve technical glitches. Two grantees further voiced their support for integrated systems, arguing that it is the only solution for resource-constrained small and rural hospitals. This grantee stated:

> "If you have a large IT staff, and you can address and manage multiple interfaces, then you can gain a lot of advantage by going to a best-of-breed solution. But truly integrated systems require less maintenance. So, the decision in the small hospital is to go with the integrated system."

Pilot Testing

Several grantees noted areas in which pilot testing facilitated a more successful implementation. A common theme among grantees was the difficulty in finding a scanner that could read all barcodes encountered in a given facility. Two grantees reported having to discard the first scanner they purchased after implementation because it could not read the majority of barcodes being used in their hospital. They recommended conducting a pilot test of new scanners to ensure that they will meet the needs of the organization.

Conducting pilot testing on the scanner before fully committing to its purchase helps to reduce the risk of needing to abandon one scanner in pursuit of a more appropriate one. However, the grantees cautioned to not expect full compatibility from any one scanner; one grantee considered their implementation a success after finding a scanner that could read 90 percent of barcodes in their facility.

One grantee recommended piloting wristbands before committing to a given brand because some wristbands last longer than others. For example, if the wristband is waterproof, or if the size is adjustable, it will last longer or be less apt to get lost. The safety benefits of a BCMA system are lost if wristbands are lost or become unreadable. One grantee reported the utility of piloting the technology for durability even for a short period of time. They assigned 25 staff members to wear the wristbands for a 24-hour period and chose their brand based on this pilot. In addition to testing durability, actively involving the nursing staff increased the buy-in and enthusiasm for the BCMA project.

Several grantees suggested piloting the process and technology with smaller units and/or units with low acuity-cases before rolling out to busier units with high-acuity patients. These pilot units provide the opportunity to correct glitches and assess impact to workflow, before proceeding to larger and more complex areas of the hospital. One project adopted this strategy, going live in a small 17-bed unit one month before the full roll-out to the rest of the hospital.

Technology Rollout

When implementing any new technologies, consideration has to be given to how they will be rolled out—both in terms of the order of implementation and the location of and timing for the roll-out. The grantees did not come to a consensus regarding the order in which to implement medication administration technologies. Many grantees reported that BCMA and eMAR are interconnected, and therefore should not be implemented separately. One grantee explained that implementing the systems simultaneously would prevent the staff from having to learn "a series of new processes, instead of just one new one." In contrast, other grantees believed that the two technologies are distinct, and that a sequential implementation was more appropriate. Even within this group, opinions were mixed as to the optimal order of implementation.

The second major consideration is the location of and timing for the roll-out. While there was no universal consensus amongst the grantees whether to roll-out the intervention by unit (phased roll-out) or all units at once (big-bang approach), the majority preferred a phased roll-out approach.

One reason given for phasing in eMAR and BCMA systems unit-by-unit was the need to have enough technical support staff. One project explained that their success was closely correlated with the high-level of IT support they provided their staff, resource support that would not have been possible if they had "gone big bang."

Implementation Considerations

Need to Repackage Medications

The FDA ruled that drug manufacturers must put linear barcodes on their medications at the level of the unit dose.[13] This mandate has made barcoding more feasible for many hospitals. However, there are still instances in which facilities have to barcode medications themselves, such as: in cases of incompatibility with hospital scanners; cases where medications were received without the barcode (despite the mandate); or in instances in which medications have to be re-packaged into smaller doses. One grantee reported that 35 percent of the drugs they received from manufacturers did not have labels. Before purchasing a packaging and labeling machine, they had to manually affix these labels to the medications, a highly time-consuming process. Several other grantees reported purchasing state-of-the-art packaging systems to address the increased workload associated with packaging and labeling. Another grantee described that, in addition to using an in-house system, the grantee organization outsourced the majority of unit-dose barcoding to third-party organizations. While this was an effective solution for this grantee, other organizations may not have the financial resources to contract with an outside vendor.

Training

Grantees emphasized the importance of appropriate and effective staff training. One grantee originally designated two hours of training per nurse, but realized during implementation that this was not sufficient and increased training to four or five hours. In

addition, this grantee realized they had to extend training to other hospital staff including physicians, pharmacy staff, and respiratory therapists. The cost of the additional training ultimately impacted their education budget by increasing it threefold. Yet, despite this increased cost, the grantee considered the training to be integral to their intervention's success:

> "You can't do enough training. Some nurses don't want to touch computers. This is a huge change for them. We did a really good job with education. That's one of the reasons our project was successful."

Grantees emphasized that system training should be integrated with a pilot. One organization developed a "training playground" that was well-received by nurses. The pilot provided the staff with an opportunity to test the system in a safe environment, whereby they would not cause an accidental ADE.

Grantees reported that superusers enhance the training experience, especially during the go-live period. A superuser is a nurse, physician, pharmacist, or any clinical hospital staff who receives extra training on a new health IT system and has demonstrated the ability to provide peer-to-peer support to colleagues. Two grantees reported that their superusers were effective because they were highly visible to the rest of the organization. For example, superusers and technical support staff wore bright shirts and were given memorable names. In one case, a hospital provided their roaming technical support with yellow shirts and named the group the "SWAT team."

In addition to the in-house technical support teams and the superusers, the majority of grantees reported the use of on-site help from their vendors in the days following go-live. Most grantees reported positive experiences with the on-site support, which tended to last between 1 and 3 days.

Organizational Considerations

Culture

As with other health technologies, introducing BCMA and eMAR impacts the culture of an organization. According to grantees, effective implementation of BCMA and eMAR

technologies necessitates a change in provider culture, attitudes, and thought processes. One grantee explained the importance of promoting a cultural shift:

"The nursing teams have started a transition to focus more on a data culture, integrating reports into their daily activities. We are trying to crack the nut of integrating information into clinical decision making. Some teams have been very successful. We try to profile that."

This grantee's perspective illustrates that BCMA and eMAR technologies are not simple tools that can be easily integrated into a new environment. Implementation leaders must plan for social and cultural changes that will accompany the introduction of new technologies.

Similarly, grantees found that the introduction of BCMA and eMAR technologies led to substantial changes in their hospitals' social systems. Many grantees described increased communication between their pharmacists and nursing staff following implementation of BCMA and eMAR. Respondents described this as an "intertwining" process. In addition, one grantee reported that the pharmacy's needs became "everyone's needs." Many of the grantees noted that this increased interdependence had a positive impact on staff relationships.

According to grantees, effective communication and collaboration among both nursing and pharmacy team members during the planning and implementation processes prevented "turf challenges." One grantee described that relations between the pharmacists and nursing staff were significantly strained because of miscommunication about the information displayed in the eMAR software. Thus, effective communication and collaboration between departments are integral when introducing these technologies.

Importance of Nurse Champions

According to grantees, after an initial learning period, nurses and nurse managers were satisfied with the new eMAR and BCMA systems, believing that the systems made them better clinicians. Several grantees reported that nurses were more satisfied with the intervention than were pharmacists and respiratory therapists. Grantees suggested that nurses may be more satisfied because they often see the error prevention capabilities of

BCMA and eMAR first-hand, leading them to become strong supporters of the new systems. Grantees suggested that nurses should serve as the intervention's "provider" champions to facilitate staff buy-in. For example:

> "We had one nurse who didn't really think it would work. Then she scanned the drug and saw that she had the wrong drug in her hand. She would never have known [without BCMA] that she made a mistake. I believe that [this situation] may have happened to most of the nurses, and that's why they have become strong advocates for the system. That helps the buy-in."

Hospital Policy Changes

Similar to other health IT implementations, barcoding and eMAR technologies require modifications to hospital policies on medication administration and patient identification. Almost every hospital has detailed policies regarding proper workflows for nurses and other hospital staff. Many of these policies were created in response to accreditation requirements of the Joint Commission,[15] in addition to well-publicized reports by the Institute of Medicine on the pervasiveness of medical errors.[2] Grantees reported that policies around medication administration and patient identification required modification with the implementation of BCMA and eMAR.

Policy revisions included charting issues in patients' rooms, downtime procedures, and the procedures around ensuring the "five rights."[6] One grantee discussed the need to revise policies concerning scanner use, and specifically, when scanners should and should not be used. This team decided to make exceptions for mental health patients as well as "true medical emergencies." In general, the grantees reported minor changes to their policies, in contrast to major modifications.

Workload

Improving efficiency is a key goal for hospitals and health organizations, and many implement new health IT systems in an effort to increase efficiency. According to the grantees, BCMA and eMAR systems had no impact on nurses' workflow, and in some projects, increased workload for pharmacy staff. Many grantees believed that BCMA and

eMAR decreased nursing efficiency in the short term but had no impact over the long term. Three respondents explained that during the first few months after implementation, nurses were less efficient while they learned to navigate the new systems. One grantee reported the need to initially increase the number of nurses, which had financial implications. However, these increased costs diminished over time as nurses become more acclimated to the new technologies and processes.

The grantees agreed that hospitals planning to implement BCMA and eMAR will "need to look for efficiencies elsewhere." They stressed that hospital leadership should not sell the new technology to their staff as a time-saving technology. Grantees described the value of setting realistic expectations:

> "We had heard from other hospitals that had sold [the technology] as a time-saver had suffered, because it did not. You should not sell it that way. You will get more acceptance from the nursing staff [if you do not]."

Many grantees reported that their pharmacy staff's workload increased significantly with BCMA and eMAR because of the added responsibilities of barcoding and labeling medications. One project described the need to dedicate an entire FTE to these tasks alone. Other added responsibilities included entering new barcodes into the computer and updating drug dictionaries. Based on the observed increase in pharmacy work, one grantee suggested that barcode scanning at a small hospital without a full pharmacy department would simply be "too much of a financial burden."

Reporting Capability

For several grantees, one of the greatest benefits of implementing BCMA and eMAR systems was the increased ability to evaluate medication administration in their hospitals. Many applications had the ability to generate reports with detailed information such as when a medication was administered, who administered it, and whether it was scanned or the nurse used an override to manually enter the medication information.

The reporting capability enabled these grantees to monitor the impact of the new systems on quality of care and to discover emerging problems in workflow as they arose. One grantee explained that his hospital's eMAR and BCMA system allowed him to see which nurses chose to override the barcoding process and which clinical situations were mostly likely to prompt such behavior. The reporting capability allowed this grantee to identify a problem: nurses were not scanning medications for IV solutions and curved bottles because they were difficult to scan. Another grantee described how the time-stamps on his hospital's eMAR helped him to realize that a large proportion of medication errors were related to the timing of delivery.

Conclusion

AHRQ has funded a diverse set of health IT projects to examine how applications such as barcoding can improve the quality, safety, efficiency, and effectiveness of health care. The BCMA and eMAR projects described in this report have illuminated a number of important lessons about the challenges and opportunities associated with introducing these applications into real-world clinical settings. It is the hope of AHRQ and its National Resource Center for Health IT that others who wish to implement and use BCMA and eMAR technologies can learn from the experiences of these AHRQ projects.

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