Patient Safety Applications of Barcode and RFID Technologies

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EXECUTIVE SUMMARY

The recent focus on patient safety in U.S. hospitals has yielded a flood of new technologies and tools aimed specifically at improving the quality of patient care at the bedside. This has been accomplished by integrating the physical process of care delivery with medication information and software applications that provide clinical decision support, and quality and safety checks. Error reduction at the bedside is the lightning rod of industry efforts to address patient safety. Among technology approaches, barcoding solutions have risen to the top of industry preference due to their relative ease of implementation, demonstrated return on investment (ROI), and broad array of applications.

Barcode solutions are being deployed in a variety of healthcare applications, including producing hospital wristbands and labeling for pharmaceutical unit-dose medications, IV mixtures, lab and pathology specimens, blood products, asset tags, file labels and more. Barcodes can be matched with radio frequency identification (RFID) tags to create two-tiered identification, resulting in more robust point-of-care, patient-specific medical media. Pharmaceutical companies can locate and track each dose of medication produced in vast batches. Hospitals can monitor and utilize equipment with greater efficiency, and healthcare staff can more efficiently create and maintain healthcare records.

The application of RFID technologies in hospitals has been modest, however, primarily due to cost issues. Like most electronic technologies, RFID unit costs have fallen dramatically within the past few years, but have not yet reached the "tipping point" of economic rationality for cash-conscious hospitals. In the 2008 Annual HIMSS Leadership Survey, 15 percent of respondents said their organization uses RFID and 43 percent anticipated using it within two years.[i] To date, RFID in healthcare has been limited primarily to asset management and supply chain applications. Ultimately, a mix of both technologies—RFID and barcoding— will provide the optimal return on investment (ROI) for most healthcare providers.

From an ROI perspective, barcoding has been proven to generate not only clinical benefits but also measurable financial benefits. If each adverse drug event (ADE) adds an additional $8,750 to the cost of a hospital stay (a figure cited by the Institute of Medicine [IOM]), and there are an estimated 400,000 in-hospital preventable ADEs per year in the United States, the annual cost, in 2006 dollars, is $3.5 billion.[ii] In addition to the cost-avoidance aspect of patient safety that barcoding provides, barcode data greatly improve the accuracy of charge capture, pharmaceutical inventory management, drug utilization and best practice compliance.

The market for healthcare barcode solutions is ripe with opportunity, not only in terms of patient safety, but also in terms of unmet demand for broader applications of the technology within healthcare organizations. Integrated medication management, automated identification, asset management and inventory control are just a few industry opportunities that are poised for growth. According to the American Hospital Association, more than half of all hospitals have fully or partially deployed barcoding for at least one reason, and 26 percent of hospitals already use barcoding for pharmaceutical administration.[iii]

INTRODUCTION—CREDENTIALING HAS STRICT REQUIREMENTS

In 1999, the Institute of Medicine (IOM) issued a landmark report entitled "To Err is Human," that described the prevalence of widespread and often preventable medical errors throughout the U.S. healthcare industry. The IOM report stated that preventable medical errors cause up to 98,000 deaths and 770,000 adverse events in the U.S. each year. Since the IOM Report was published, subsequent industry evidence has revealed that the problem not only persists—it appears to be getting worse. In fact, a 2003 study conducted by HealthGrades, Inc. found that nearly 200,000 patient deaths each year are attributable to medical errors—twice the worst-case forecast in the IOM report. A 2006 follow-up to the 1999 IOM study found that at least 1.5 million preventable ADEs occur each year: 400,000 in hospitals, 800,000 in long-term care settings and approximately 530,000 among Medicare recipients in outpatient clinics.

In each of these studies, ADEs have been identified as a primary cause of preventable medical errors and one of the single greatest threats to patient safety. The term ADE describes drug administration errors that take a variety of forms, including incorrect drug selection, incorrect dosage or frequency, and negative drug interactions. ADEs can result from the wrong medication being prescribed, the wrong medication being distributed by the pharmacy, or the wrong administration of the medication at the bedside. A 2002 report from the Archives of Internal Medicine found that almost one in five medication doses administered in hospitals is given in error. The two most common errors cited were medication dispensing at the wrong time (43 percent of incidents) and omitting a dose (30 percent). Seven percent of errors were found to be potentially harmful. In a 300-bed facility, this translates into 40 potentially harmful errors each day.[iv]

In the wake of these reports and their message that the issue of preventable medical errors remains unsolved, the U.S. healthcare industry has focused its collective attention toward developing tools, technologies, and techniques to promote patient safety. Industry leaders have taken note—for the second consecutive year, participants in the Annual HIMSS Leadership Survey placed a high priority on using IT to reduce medical errors and promote patient safety. This priority was ranked first in 2007 and second in 2008.[v]

FDA REGULATION AND INDUSTRY GOALS

In recognition of the urgency of patient safety issues, government agencies and industry regulators have established goals and guidelines to reduce medical errors. On February 25, 2004, the U.S. Food and Drug Administration (FDA) issued a Barcode Rule that requires drug manufacturers, re-packers, and re-labelers to apply unit-dose barcodes containing products' National Barcode (NDC) numbers to the immediate package of most prescription drug products, including biological products. While the rule imposes no requirements on hospitals, it does encourage hospital compliance. The FDA estimates that "the barcode rule will result in more than 500,000 fewer adverse events over the next 20 years, thereby reducing medical errors by 50 percent."[vi] An estimated $93 billion is likely to be saved by reducing healthcare costs, patient pain and suffering, and lost work time due to adverse events.

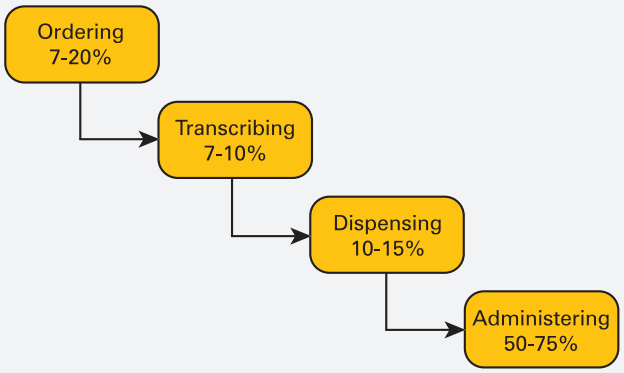
The Joint Commission, a healthcare regulatory agency, has established a set of National Patient Safety Goals, which require that healthcare personnel check two patient identifiers when providing care, treatment or services. Barcoded wristbands easily accommodate two identifiers and can improve accuracy and safety by enabling correct identification of patients prior to medication administration, specimen collection, surgery, patient transfer, x-rays, or performance of other diagnostic tests. The U.S. Department of Defense requires that its suppliers mark their medical and surgical products with a UPN barcode. Large pharmaceutical companies like Pfizer, large health plans like Kaiser Permanente, and large health systems like HCA have also taken a leadership position in implementing barcode solutions.

PATIENT SAFETY AT THE POINT OF CARE

The recent focus on patient safety has yielded a flood of new technologies and tools aimed specifically at improving the quality of patient care at the bedside by integrating the physical process of care delivery with medication information and software applications that provide decision support, and quality and safety checks. In the hospital environment, patient safety tools and technologies must translate into the correct administration of medications at the bedside, and from a strategic perspective, the key element of patient safety at the bedside is the process of medication administration.

The cornerstone of medication administration safety is the principle of the "Five Rights"—right medication, right dose, right time, right patient and right route. These describe the elements of an optimal patient medication administration process. Information about the patient and the medication at the point of care is critical to the success of such a program, and must be accessible in a concise, on-demand, and process-specific manner in order to expedite rather than impede the clinical activity of hospital staff. Figure 1 depicts the stages of medication management during which errors typically occur—and can be prevented. Without technology, it is at the final stage of this process, during which the nurse administers the medication, that no "second check" is available to ensure the "Five Rights" of patient safety.

Figure 1: Incidence of Medication Errors



Sources: California Healthcare Foundation; Ohio Valley General Hospital

Industry efforts to address patient safety are focused on error reduction at the bedside. Among technology solutions for medication errors, barcoding solutions have risen to the top of industry preference due to their relative ease of implementation, demonstrated ROI and broad array of applications. Barcoding is also viewed by healthcare CIOs and clinicians as a forerunner of more comprehensive patient safety initiatives such as e-prescribing, computerized physician order entry (CPOE) and the electronic medical record (EMR). With such technology tools, healthcare organizations can achieve true digital and clinical transformation of patient care—and make healthcare "faster, better and cheaper."

HOW BARCODING WORKS

Barcodes record text information in an encoded format, and the barcode serves as an index key in clinical databases. In a medication administration application, barcode architectures often include a barcoded wristband issued to the patient at the time of admission. Nurses' ID badges and medications also carry barcodes. At the time that a medication is administered, all three barcodes are scanned at the bedside. This assures an identical match between patient and medication, and also identifies the practitioner administering the medication. The system is supported by software that references expert databases to comply with the "Five Rights" of patient medication administration. In other clinical applications, hospitals and health systems use barcoding to "tag" unlabeled unit-dose medications, manage clinical inventory and assets, and record interventions for each patient receiving medications. Hospital pharmacies scan unit-dose packaging to improve security, build an audit trail and automate inventory record keeping.

BARCODING FOR PATIENT SAFETY

Barcodes of various types are deployed in producing hospital wristbands, as well as in the labeling of pharmaceutical unit-dose medications, specimens, blood products, IV mixtures, patient-chargeable medical supplies, surgical supplies, asset tags, file labels and more. Barcodes can be matched with RFID tags to create two-tiered identification and more robust point-of-care, patient-specific medical media. Pharmaceutical companies can locate and track each dose of medication produced in vast batches, equipment can be monitored and utilized with greater efficiency, and healthcare staff can more efficiently create and maintain healthcare records.

Wristbands

Wristbands containing one- or two-dimensional barcodes are issued to patients upon hospital admission. Prior to administering a medication at the bedside, a nurse scans the patient's (Joint Commission and HIPAA compliant) barcoded wristband to confirm the patient's identity; the scan acts as a key to open the patient's record in a centralized medical database where each patient record contains indications, advisories and restrictions concerning care administered to that patient. Once the accuracy of the patient/medication has been confirmed, the nurse scans his/her badge to record the time and source of the medication administration. In a study conducted by the U.S. Veteran's Administration, this method of medication administration was found to reduce the incidence of medication errors by 86.2 percent.

Unit-Dose Medication

Barcodes accurately identify medications by type, recommended dosage and frequency of administration at the unit-dose level, thus providing nurses with a "second check" and decision support tool in the administration of patient meds. Nurses can combine the information contained in the unit-dose barcode with the patient wristband to ensure the "Five Rights" of patient safety.

Specimen Collection

Barcode systems compare specimen collection orders, stored in a handheld or bedside laptop, with information scanned from the patient wristband, and confirm that the specimen container is the correct one for the tests ordered. A new barcode label for the specimen container is printed at the bedside with the time and date of collection, helping to minimize the potential for labeling errors. In the lab, barcode tracking technology can eliminate processing errors, starting at sample collection and continuing through the process of accession, testing and results reporting.

Blood Administration

One of the Joint Commission's National Patient Safety Goals is to improve accuracy in positively identifying patients prior to drawing blood or administering blood products. The FDA estimates that there are 414 annual blood transfusion errors. A study by Sharma et al has shown that nearly 80 percent of blood transfusion errors are related to bedside or labeling errors.[vii] A barcoding system for blood administration can reduce such errors by as much as 90 percent. Point-of-care bedside barcoding applications are being integrated with blood product administration activities to combine patient identification, medication and blood product verification. Phlebotomy and blood banking are current focal points of barcoded blood administration, and operating room (OR) barcoded blood type/patient confirmation is currently in development.

Track-and-Trace Systems

In compliance with the FDA rule requiring barcoding of unit-dose medication packaging, anti-counterfeiting barcode technology is being developed and deployed in pharmacies, hospitals and elsewhere to improve tracking and tracing. Barcoded lot numbers, expiration dates and unit-dose identifiers help healthcare manufacturers, distributors and consumers manage medications throughout the supply chain.
Track-and-trace systems are the key component of anti-counterfeiting programs, by providing an accurate drug "pedigree" that is a secure record documenting the drug's source and date of manufacture.

Pharmacy

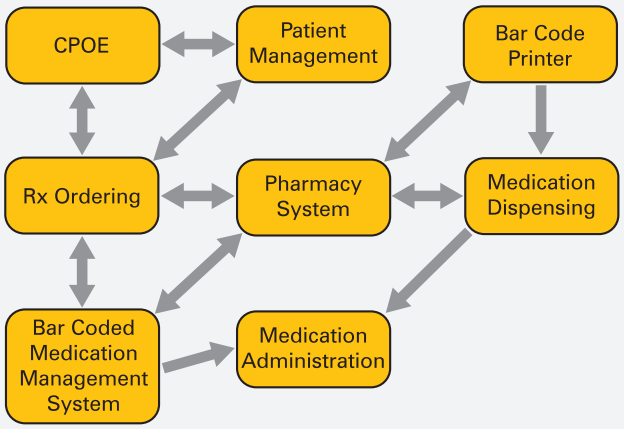
Today, some medications still arrive at the hospital pharmacy without a barcode—which requires the pharmacy to produce its own barcode label. Pharmacies use barcoding to tag unit-dose medications derived from bulk items and mixtures. For many medication fulfillment processes in the pharmacy, barcode printers and automated dispensing equipment produce on-demand, unit-dose barcodes that are legible, secure and cost-effective.

Barcoding is an extremely adaptive technology whose total applications in the hospital environment have yet to be fully explored. Today, barcoding in hospitals encompasses many areas of clinical and business activity, including:

- Patient registration
- Patient identification
- Patient tracking
- Patient charge collection and billing
- Medical record document assimilation and indexing
- Physician and caregiver order entry
- Laboratory specimen tracking and verification
- Radiology—film tracking
- Medication administration verification
- Blood transfusion verification
- Respiratory therapy treatment at the bedside
- Dietary management
- Supply chain management
- Receiving
- Storage and unit labeling
- Picking and internal transfer
- Replenishment order
- Cycle counts
- Annual equipment inventories
- Preventative maintenance
- Linen inventory and distribution
- Sterile reprocessing
- Security
- Employee identification

In addition to the stand-alone applications of barcoding, systems can also be linked to CPOE and EMR systems, and pharmaceutical and supply systems. This allows institutions to access financial information and to drill down to the patient level to report on the cost of providing care, as shown in the following illustration.

Figure 2: Integrated Medication Management



At the bedside, integrated medication management links barcode scanning, clinical knowledge databases, wireless networking and patient record technologies. Reporting capabilities from such input can include real-time queries on patient care activities, pharmaceutical and supply usage trends, and internal performance benchmarks. This capability can contribute to the development of standardized care paths by tracking and reporting on pharmaceutical, equipment and supply usage by various patient groups.

WHO BENEFITS FROM BARCODE SOLUTIONS FOR PATIENT SAFETY?

First and foremost, the patient benefits from barcoding because it helps in preventing ADE-related patient pain, suffering and extensions of hospital stays. Throughout the healthcare value chain, manufacturers, distributors and providers of healthcare products and services have a professional responsibility to adopt best practices, enact processes, and deploy tools and technology solutions that positively impact patient care. That's a lofty concept, but in many cases technologies like barcoding must be sold on the basis of benefits that can be measured by traditional clinical and financial metrics. Today, there are clear regulatory and business drivers serving as a catalyst for barcoding adoption, particularly in the hospital and pharmaceutical verticals.

Hospitals

The FDA estimates that purchasing barcoding equipment and training staff on the technology will cost about $53.1 million, but will result in 413,00 fewer ADEs in the next 20 years and will avoid related hospital stays, saving an estimated $41.4 billion.[viii] In addition, hospitals are expected to avoid litigation associated with preventable adverse events (reducing malpractice liability insurance premiums), and increase receipts from more accurate billing procedures (in excess of the barcode implementation and maintenance costs, according to the FDA). Hospitals also benefit from the marketing and patient preference benefits associated with quality care and industry leadership in the adoption of new technologies and clinical processes. Less obvious, but of vital importance, are the collateral benefits of barcoding to nursing and pharmacist productivity, charge capture, inventory management, asset utilization, commodity tracing and tracking, and the market value of patient safety leadership.

Pharmaceuticals

Since April 2006, the FDA has required that pharmaceutical manufacturers barcode their products at the unit-dose level. As a result of the FDA's mandate, benefits are being realized in a number of areas, including patient safety, brand protection and fraud detection, supply chain, and return and recall processes.

BUSINESS CASE

Return on investment is never far from any serious consideration of a new technology deployment, and barcoding has been proven to generate measurable clinical and financial benefits. According to a 2006 report issued by the Institute of Medicine, each preventable ADE adds about $8,750 to the cost of the hospital stay.[ix] An article published in the journal Legal Medicine reported that approximately 30 percent of all malpractice suits involve drug-related injuries. In addition to the cost-avoidance aspect of patient safety that barcoding provides, barcode data greatly improve the accuracy of charge capture, pharmaceutical inventory management, drug utilization and best practice compliance.

Worldwide, fraudulent pharmaceuticals pose serious health risks and cost manufacturers more than $32 billion annually.[x] Barcoding of pharmaceuticals establishes their pedigree, combats drug counterfeiting and creates an audit trail through the value chain. Drug makers who implement barcode and RFID control systems can reduce diversion by 18 percent in the first year and lower inventory holding costs by 6 percent, according to a study by A.T. Kearney. Recent studies have shown that 68 percent of lab errors are related to pre-analytical procedures, and about half of those errors are the result of misidentification of the patient or mislabeling of the specimen. Barcoding can reduce such errors by one third.[xi]

BARCODING VERSUS CPOE

Barcoding is not the only patient safety technology available to hospitals; there are several alternative strategies, including e-prescribing, electronic patient records and CPOE. As shown in the following illustration, barcode systems are faster and cheaper to implement and offer a higher ROI for patient safety.

FIgure 3: Comparison of CPOE & BCMA

	CPOE	BCMA
Implementation Cost	$7.9 million	$1.9 million
Ongoing Annual Cost	$1.3 million	$180,000
Implementation Time	3+ years	6 months
Implementation Risk	High	Low
Payback Period	10+ years	<2 years

Source: Bridge Medical

Representative cost data describing the total cost of ownership of barcoding systems is difficult to obtain— there are simply too many variables, including the number of nurses to be equipped, the extent of infrastructure and systems architecture investments, training, maintenance and other factors. The FDA has estimated that the average hospital will spend $448,000 to implement a computerized medication administration system, but according to HIMSS, the projected cost for a hospital to implement barcoded medical administration (BCMA) systems to read and capture barcode data at the bedside is slightly less than $2,000 per bed (including hardware, software, data management systems, service costs and user training), with operating expenses of approximately $1,000 per year. For a 200-bed hospital, this translates into acquisition costs of $400,000 and annual operating costs of about $200,000. When contrasting these figures with the CPOE base cost of $2 million to $5 million, the business case for barcoding becomes even more compelling.

NOTES FROM THE FIELD

Barcoding as a tool of patient safety has proven to be an unqualified success at hospitals across the country, in ways that can be measured in both clinical and economic terms. In some cases, barcoding has served as the forerunner of "closed-loop" patient safety initiatives that include e-prescribing, CPOE and EMR applications. In other cases, barcoding has been implemented as a stand-alone solution to patient safety at the point of care. In still other situations, barcoding is being deployed in new clinical applications. A few examples:

Atlantic Health System (Morristown, N.J.)

As of 2005, Atlantic Health System had embraced barcode technology but had not yet standardized on one barcode symbology across the enterprise. The health system sought a symbology that could ultimately support bedside specimen collection, blood administration and a range of additional applications. Wristband reliability was also a concern. Labels tended to come off the wristbands or get damaged, requiring caregivers to create replacement bands, which increased the potential for errors. In fact, at one location, as many as 15 percent of glucometer test results were being attributed to the wrong patient due in large part to this issue.

Since implementing dedicated thermal wristband printers and wristbands, the health system has seen significantly improved barcode read rates and wristbands now remain intact throughout the average patient's stay. Atlantic rolled out bedside barcode medication administration in the summer of 2007. In addition to helping caregivers ensure the "five rights" of patient medication administration, implementing barcoding at the point of care has enabled the health system to increase the accuracy of charge capture by enabling staff to charge patient accounts at the point of administration rather than when medication is dispensed by the pharmacy.

Aurora Health Care (Milwaukee, Wis.)

Barcoding is part of a larger patient safety initiative at Aurora Health Care, an integrated healthcare system with 13 hospitals and more than 100 clinics. With the long-range plan of leveraging electronic medical records and computerized physician order entry to establish a closed-loop, integrated point-of-care medication administration system, Aurora has implemented bar-code-based automated identification.

Seeking to ensure that it labels all medications, Aurora has deployed on-demand thermal barcode printing in a wide variety of settings, including hospital pharmacies. The health system is also transitioning to a centralized medication repackaging operation for all hospitals, which will enhance labeling efficiency. For patient identification, Aurora has identified and implemented a barcode symbology and wristband material combination that is easy for nurses to scan, less disruptive to the overall patient experience and durable enough to withstand the everyday challenges of the hospital environment.

There are many operational benefits to medication and patient auto-identification. For example, Aurora's method of processing charge credits resulting from medications returned to the pharmacy is more efficient and more accurate than previous manual methods. Most importantly, however, Aurora has successfully laid the foundation for closed-loop medication administration, which will help reduce the incidence of medication errors and further enhance patient safety across the organization.

Hamilton Medical Center (Dalton, Ga.)

Every year, more than 160,900 adverse events occur in hospitals nationwide because of sample identification errors. The possibility of errors like these prompted Hamilton Medical Center to deploy a patient safety strategy that utilizes barcode technology for phlebotomy services. At the time, the phlebotomy staff was handling more than 1,000 specimen labels each day. By labeling specimen containers at the bedside, the 282-bed hospital hoped to eliminate the potential for error as well as many of the inefficiencies associated with manually printing, sorting and organizing specimen labels in the lab before starting rounds. Hamilton was already issuing barcoded patient identification wristbands in the admissions department, which provided the foundation for the lab's barcoding efforts.

Phlebotomists now collect samples and generate patient-specific labels at the bedside using a mobile thermal printer and a personal digital assistant (PDA) device. Hamilton reports that the system saves staff members an average of 45 minutes per day, as they no longer have to return to the lab for additional labels as new tests are ordered but instead can view order updates through real-time collection lists on the PDA. Turnaround times have improved and re-draws are down, helping to lower the overall cost of care. Most importantly, by printing labels one-at-a-time at the point of care, Hamilton has virtually eliminated the possibility of applying the wrong label to the wrong specimen. The hospital has also expanded its use of barcoding to the blood bank to ensure that the correct patient receives the correct blood product.

Southern Regional Health System (Riverdale, Ga.)

The hospital laboratory at Southern Regional Health System, a 406-bed medical/surgical facility, performs more than one million billable medical tests each year. Seeking improved efficiencies and a reduction in errors, Southern Regional decided to update its manual specimen labeling process, which required staff to print batches of specimen labels every two hours, sort them and then distribute them to phlebotomists. With a point-of-care specimen labeling system, implemented in September 2005, the hospital aimed to provide positive patient identification, reduce mislabeled specimens and meet the Joint Commission's patient safety recommendations.

Today, Southern Regional's 27-person phlebotomy staff uses a mobile software application running on a handheld device and a mobile printer to support its specimen collection at the point of care. The application is integrated with Southern Regional's laboratory information system. Barcoding and real-time data transmission have significantly reduced the number of steps in the specimen collection process, enabling Southern Regional to decrease staff by 30 percent and reduce the number of labeling errors from an average of two per month to none.

Southwestern Vermont Medical Center (Bennington, Vt.)

An early adopter of healthcare IT, Southwestern Vermont Medical Center (SVMC) began implementing barcoding for bedside medication verification in 2007 as part of its organization-wide initiative to enhance patient safety. Even though the incidence of errors was

rare at SVMC, the hospital hoped to decrease the potential for medication transcription and administration mistakes through the use of barcoding and e-MAR technologies.

As part of the initiative, the hospital reviewed both barcode symbologies and print technologies. For patient identification and medication labeling, SVMC opted for two-dimensional (2-D) barcodes over linear barcodes, as they provide more flexibility than linear codes. To ensure that the printed barcode labels would be durable and reliable enough to produce the consistently high scan rates necessary for ongoing patient identification and medication verification, the hospital selected direct thermal printers to produce their patient identification wristbands. SVMC had previously used laser printers to output adhesive-backed barcode labels, which were then attached to wristbands. However, the wristbands were easily damaged and fell apart quickly.

In addition to installing printers at admission, SVMC located five direct thermal printers on the nursing floors, so staff could generate replacement wristbands on demand. Not only are the barcodes more durable, but the wristband printing process is now much more efficient. By February 2008, bedside medication verification was live in the ICU and in both the east and west wings of the medical center. Within the first two weeks of implementation, the hospital administered 10,000 medications with a 93 percent scan rate.

CHALLENGES AND BARRIERS TO BARCODE SYSTEM INTEGRATION

Barcoding solutions span a variety of areas, including patient management, order entry, medication management, specimen management, asset management, accounting and more. Integration of barcode technologies and tools across multiple systems and technology environments requires interoperative software applications, robust infrastructure, adequate staff resources, process and workflow changes, and culture adaptation. Barcode formats are also an issue, since no standard exists and a number of barcode formats are currently being used in healthcare. In many cases, a single vendor solution cannot satisfy these requirements, requiring hospitals to buy multiple components—scanners, printers and software—from different manufacturers to meet barcode integration requirements. As a result, barcode integration with other clinical systems in the hospital remains challenging.

To achieve true integration of barcode technologies and tools with complementary systems such as CPOE and e-prescribing, interoperability and system architecture issues must be resolved. This is a difficult task, since historically vendors have tended to build proprietary features into their products, in an effort to “lock in” customers. That market dynamic is changing, however, as hospitals demand open system architecture and vendor-neutral applications that can work seamlessly with other products. Similarly, equipment must be multifunctional to avoid duplication and unnecessary capital consumption for related patient safety processes. A case in point is barcode printing solutions.

WHAT WILL DRIVE HEALTHCARE'S ADOPTION OF BARCODING?

Considering the demonstrated value and economic rationality of barcoding as a patient safety mechanism, rates of adoption remain lower than anticipated. One reason is the ongoing issue of allocating scant technology dollars; clinician resistance and system integration challenges present additional hurdles. There are several obstacles that must be removed in order to spark wider adoption of the technology regardless of its economic attractiveness. These obstacles include:

"No Fault" Reporting

From the nurse and physician viewpoint, technology solutions often translate into layers of process that produce only modest improvements in patient care. Technology solutions in healthcare are routinely over-sold and clinicians are wary of disruptive alterations to established clinical activities. In the case of medication management, automated error detection is sometimes viewed as a punitive measure intended to aid management's attempts to interfere with patient care—or worse, to punish clinicians. To address this issue, barcoded medication management schemes must feature a "no fault" reporting policy in which clinicians— mainly nurses—are encouraged to report errors with the following provisions: 1. there are no penalties for reporting errors in medication administration; 2. error reporting is intended to identify process issues and technology glitches—not to discipline staff; and 3. error reporting will generate stronger decision support tools and medication administration accuracy at the point of care.

Standards

There is at present no single industry standard governing the use of barcodes; this is a significant challenge to the wider adoption of barcode technologies in healthcare. In fact, there are more than 200 barcode symbologies, but only a few are suitable for unit-dose identification. Of these, the RSS family of symbologies was specifically developed to help identify pharmaceutical products. The most commonly used healthcare barcoding symbologies in use today include the Universal Product Code (UPC), which is used to identify medical and surgical products at each packaging level, and the National Drug Code (NDC) identification system that the FDA uses to uniquely identify all pharmaceuticals. Other barcoding schemes in use today include Data Matrix, the ISBT 128, the Healthcare Identification Number (HIN), and the Labeler Identification Codes (LIC) systems, developed by the Health Industry Business Communication Council (HIBCC) to identify trading partners in e-transactions. The GS1 DataBarTM system will eventually replace UPCs globally. The new system will be administered by GS1 US (formerly The Uniform Code Council), a standards organization that provides integrated standards and business solutions for all industries, including healthcare.

Other systems that have been adopted include the EAN.UCC barcoding system, an internationally accepted standard with an estimated 22,000 adherents in the hospital and pharmaceutical industries. Additionally, there is the previously mentioned RSS, an all-numeric barcode symbology that can encode an NDC code in a fraction of the space required for a traditional UPC symbol. The lack of a single all-embracing industry standard is not necessarily a significant hindrance to broad-scale adoption of barcoding tools and technologies—current printers and scanners can support multiple methodologies and barcode symbologies. But integration and interoperability issues will continue to be obstacles to overcome as barcoding is blended with collaborative technologies such as CPOE, e-prescribing and the EMR.

Industry Leadership

Collectively, through advocacy associations such as HIMSS, the National Alliance for Healthcare Technology (NAHIT) and the Institute for Healthcare Improvement (IHI), which have established barcode task forces and patient safety campaigns, the healthcare industry hopes to build the critical mass and industry awareness necessary to "bootstrap" barcode adoption. These grass-roots efforts will generate momentum towards barcode adoption in healthcare. In addition, a number of professional associations, regulators and group purchasing organizations are supporting barcoding.

RFID IN HEALTHCARE

The term RFID (radio frequency identification) describes a wireless identification technology that communicates data by radio waves. Data is encoded in a chip, which is integrated with an antenna and packaged into a finished "tag." RFID tags may be passive (requiring close proximity to a reader, and usually applied to track supplies), or active, in which the RFID tag contains a small battery to allow continuous monitoring (used mostly to track equipment). RFID technologies offer different rewritability options, memory sizes and tag forms, and can be read from anywhere within range of the RFID reader.[xii] RFID labels can hold more data than barcodes, and can be read automatically without any user intervention.

Today, the application of RFID technologies in hospitals is modest, primarily due to cost issues. Like most electronic technologies, RFID unit costs have fallen dramatically within the past few years, but have not yet achieved the "tipping point" of economic rationality for cash-conscious healthcare organizations. RFID in healthcare has been limited primarily to asset management and supply chain applications. Even within this sphere, there's a lot to keep track of. In early 2004, Bon Secours Health System (Richmond, Va.) installed an RFID equipment tracking system to monitor 12,000 pieces of equipment at its three facilities. In less than a year, Bon Secours documented benefits that include capital avoidance (by being able to locate and use otherwise idle equipment) and utilization efficiencies (by distributing equipment where it is needed) among the three facilities. Additionally, the nursing staff gained approximately 30 minutes per nurse per shift in time saved not hunting down equipment. In financial terms, Bon Secours estimates that it has gained a $200,000 benefit per year over and above the cost of the RFID system installation and maintenance costs—and this does not even include staff productivity gains. An interesting side benefit for Bon Secours has been the ability to piggyback a WIFI network onto the RFID project, since both systems use the same architectures and hardware.

Other deployments of RFID include:

- Advocate Good Shepherd Hospital (Barrington, Ill.) has utilized inventory RFID tags with the result that inventory losses (previously running at 10 percent annually) were cut in half.
- Holy Name Society Hospital (Teaneck, N.J.) purchased an RFID asset tracking system that allows nurses to use PCs in each nursing unit to locate one of 2,000 tagged pieces of equipment.

There are other intriguing applications of RFID in the patient sphere. For instance, RFID tags can be used:

- in long-term care to track elderly and disoriented patients;
- in the maternity ward to track mothers and babies;
- and for surgical patients who can be tagged to ensure that the right procedure is being performed on the right person at the right time.

One of the more innovative uses of RFID today involves tracking and monitoring surgical equipment. At St. Vincent's Hospital (Birmingham, Ala.), surgical instruments are monitored to determine their location, last sterilization, maintenance record and other key statistics. This technology can further identify individual surgical supply items and their purchase date, description, cost and utilization data. In addition, some healthcare organizations are placing RFID tags on surgical sponges, surgical devices or other materials to help prevent these objects and materials from being left in a patient following surgery.

Other applications of RFID in the healthcare setting include the use of RFID to streamline pathology specimen tracking. Passive RFID tags placed on specimens uniquely identify the sample and maintain a record of each instance the specimen is handled. New information can be written to the tag and/or readers to note the tag's changing location.

The FDA Anti-Counterfeiting Task Force has strongly suggested the use of RFID to safeguard against pharmaceutical counterfeiting and the pharmaceutical industry continues to test RFID technologies to track and trace their products. In one trial deployment, medicine bottles were fitted with RFID tags in order to detect fake drugs moving through the supply chain. Other pharmaceutical deployments include recall management and return management, inventory management, product authentication, pedigree management and sample management. While a 2004 FDA report envisioned that all pharmaceutical drugs within the United States might incorporate RFID tags at the pallet, case and unit levels by the end of 2007, that has not yet happened.[xiii]

There are obstacles to deploying RFID in hospitals, including interference with other devices (such as cell phones and telemetry), user acceptance and privacy (the Civil Liberties Union and Consumer Groups have taken positions against RFID). And, from a business perspective, the return on investment for RFID remains an elusive proposition, due to unattractive price points and tactical deployments in healthcare venues.

RFID vendor Radianse gauges the cost of tags, receivers, software, implementation and training at $1,200 to $1,600 per licensed bed.[xiv] Despite the cost, Gartner predicts that RFID spending worldwide will increase from an estimated $1.2 billion in 2008 to more than $3.5 billion by 2012.[xv] In healthcare, it is estimated that the market for RFID tags and systems will rise rapidly, from $120.9 million in 2008 to $2.03 billion in 2018.[xvi]

CONCLUSION

The market for healthcare barcode solutions is ripe with opportunity, not only in terms of patient safety, but also in terms of unmet demand in broader applications of the technology. Integrated medication management, auto-ID, asset management and inventory control are just a few industry opportunities that are poised for growth. The clinical utility, cost advantages and collateral benefits of barcoding will spur growth of these technology solutions. To the extent that hospitals can receive a "second bounce" from their investment in barcoding and RFID (e.g., barcoding imbedded into CPOE, and RFID architecture that coincidentally provides the backbone of a WIFI network), these technologies will become increasingly attractive. However, industry-wide adoption is unlikely to occur suddenly; widespread adoption of RFID is estimated to be at least 10 years away.[xvii]

Will RFID ultimately surpass barcoding as the primary auto-ID and point-of-care patient safety technology in healthcare? It is more likely that barcoding and RFID will complement each other, based on relative functionality, cost and ease of use. Hospitals will be reluctant to abandon their investments in barcoding simply to introduce a sexier replacement technology—particularly if there is no substantial gain in utility, and certainly not if the ROI equation doesn't add up. RFID will continue to make inroads into healthcare via track-and-trace solutions, first as asset and inventory management tools, then gravitating towards personnel, patient and clinical monitoring devices.

A global leader respected for innovation and reliability, Zebra offers technologies that illuminate organizations' operational events involving their assets, people and transactions, allowing them to see opportunities to create new value. We call it the Visible Value Chain.

Zebra's extensive portfolio of marking and printing technologies, including barcode, RFID, GPS and sensoring, turns the physical into the digital to give operational events a virtual voice. This enables organizations to know in real-time the location, condition, timing and accuracy of the events occurring throughout their value chain. Once the events are seen, organizations can create new value from what is already there.

For more information about Zebra's solutions, visit www.zebra.com.

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