RFID in Healthcare: The Applications, and Obstacles, Are Many

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RFID is peaking interest in healthcare, but the technology will travel a long and winding road on its way to widespread adoption.

Radio frequency identification (RFID) is both an enabling and disruptive information technology that has the potential to improve good business or workflow processes across many industries. While pioneers like Wal-Mart and the US Department of Defense have plunged headfirst into RFID by fully incorporating the technology into their supply chains and logistics, the adoption of RFID in the practice and delivery of healthcare is proceeding more cautiously.

There is no doubt that RFID has a place in healthcare. It offers technological advantages over bar-coding, which has already been shown to improve patient safety. Early uses include workflow optimization, asset tracking, and security. Yet gaps and challenges remain in achieving its widespread adoption. High costs, competing standards, and an uncertain relationship to bar-coding are among the slowdowns. Through early implementations the industry is in the midst of understanding RFID's impact, as well as the specific requirements that healthcare needs to place on the RFID industry.

Current implementations will also shed light on RFID's potential impact on HIM, where it will affect the data management process and increase the amount of data to be managed.

Sample RFID Healthcare Implementations

Widespread adoption of RFID may face hurdles, but early implementations are under way in hospitals across the country. Initial uses include patient identification, patient workflow, infant security, surgical site verification, and real-time asset management, as shown in the dozen implementations identified here.

Location	Application	Tag Type
• Bon Secours Richmond Health System • Legacy Salmon Creek Hospital, WA • Presbyterian Hospital in Albuquerque, NM	Asset management with real time location information	active tags
• Hospital of the University of Pennsylvania	Asset management with indoor positioning technology	active tags
• Mississippi Baptist HMC	Patient workflow	active tags
• Massachusetts General Hospital	Asset management with mobile supply cabinet tracking	active tags
• Presbyterian Hospital, NC • Doctors Hospital of Dallas	Infant security	active tags

• Hackensack University Medical Center, NJ • Beth Israel Deaconess Medical Center, MA • Trinitas Hospital, NJ	Patient identification by mapping medical record number to the patient	FDA-approved implantable chip
• Mercy Hospital, MN	High risk patient tracking in ER to ensure security	active tag wristbands
• Georgetown University Hospital, DC	Verification of blood transfusion label with patient label at point of care	passive tags with handheld readers
• Jacobi Medical Center, NY	Patient identification	passive tags with handheld readers
• Palm Beach Orthopedic Institution, FL	Surgical site verification	passive tags with desktop readers
• Beth Israel Deaconess Medical Center, MA	Asset tracking with indoor positioning technology	Wi-Fi-based active RFID tags
• Washington Hospital Center, DC	Asset tracking with indoor positioning technology	active ultrawideband (UWB) tags

Applying a Supply Chain Technology

Generally, technology progresses through early-adopter industries and eventually becomes leveraged within more conservative areas such as healthcare.[1] Historically, the healthcare provider industry has been slow to embrace new technologies because it must balance patient safety, quality of care, and financial constraints under a fragmented delivery system. Current healthcare applications of RFID technology reflect this pattern. As hospitals begin to implement RFID pilot projects, a better understanding of where the technology can improve healthcare processes is emerging, as are the requirements and challenges specific to the healthcare provider sector.

RFID will significantly affect HIM because it enables the information management process and is expected to increase the amount of information to be managed. For example, small active RFID tags can track paper patient charts, making it easier to locate critical information. Patient wristbands with an active RFID tag can simplify data entry of patient information for various processes. There also is great potential for RFID to add a rich layer of identification, location, and time information that can be associated with the health of a patient and from which important information can be extracted and used to drive critical clinical decisions. RFID will become an integral part of the health information network, and the information derived from it will expand the content of the health record.

Five functional areas of RFID technology have resulted in application development and implementation within the healthcare provider industry: asset management, patient safety at point of care, workflow optimization, increased security, and electronic pedigree for pharmaceuticals.

Asset management. Active RFID can be used to track mobile assets such as wheelchairs and IV pumps by providing both identification and near real-time location information. The technology can significantly reduce costs by increasing asset visibility, reducing loss and theft, and improving inventory control. It can also contribute to increased patient safety by improving logistics, making sure that healthcare providers have the tools they need when they need them.

Patient safety at point of care. Bar-coding has been widely used to successfully reduce medical errors in such areas as medication management and transfusion medicine.[2] RFID can provide the same functionality without requiring line of sight between tag and reader. At this time, these applications tend to use passive tag technology with a handheld reader. However, as active tag technology becomes more sophisticated it is expected that it will eventually replace some of the passive tag applications, providing functionality well beyond bar-coding mimicry.

Workflow optimization. RFID can rapidly retrieve identification and location information about a tagged entity in near real time. Active RFID systems have the capability to capture time-stamped location data over time and associate it with tagged equipment, staff, and patients. The data can be used to generate a history of movement and subsequently analyzed to optimize specific processes. Since data can be written to and stored in the RFID tag, other types of information could potentially be captured, such as environmental conditions or use data. Currently, the location information from patient and staff movement can be used to better understand workflow, eliminate bottlenecks, and improve efficiency and process synchronization. RFID may also allow staff to respond more quickly to critical events and to optimally resolve resource requests.

Increased security. The use of RFID also includes surveillance-type applications where boundary checking is critical. When a tagged entity crosses the established boundary, the RFID application triggers notification, alerts, or even actuators like locks or alarms. Tagging can prevent infant abductions or the unauthorized departure of high-risk Alzheimer or psychiatric patients. Tagging assets can prevent theft.

Electronic pedigree for pharmaceuticals. An RFID-enabled electronic pedigree for pharmaceuticals could potentially reduce counterfeit in the nation's drug supply. The Food and Drug Administration (FDA) endorses this concept as an Electronic Product Code (EPC)/RFID solution "to increase the safety of medications consumers receive by creating the capacity to track and trace a drug from the manufacturer all the way to the pharmacy."[3] Technically, this functional area is a pharmaceutical industry effort. However, it will eventually affect the provider industry as the tagged pharmaceuticals make their way down the supply chain and into provider facilities. In particular, the liability issues for end users like hospitals, pharmacies, and physicians need to be explored.

Long Road Ahead

As with many information technologies, obstacles exist on the road to widespread adoption. These issues must be resolved before RFID can be embraced.

Cost

One of the biggest barriers to adoption of RFID technology is its cost. As with any new technology, RFID must address a particular business problem and have a demonstrable return on investment; however, calculating that return is a challenge. The technology itself has a large price tag, and additional investment may be required at the implementation level, such as changing work processes, training, and ongoing system support. Quantifying benefits such as improved efficiencies in care processes and workflow is difficult, as is measuring cost reductions such as decreased medical errors.

Even though RFID holds the potential to become more cost efficient, to improve business processes, and to increase patient safety, the investment must compete with other priorities, including investment in bricks and mortar as well as technologies with more direct application to clinical care and greater certainty for increased revenues, such as new imaging equipment.[4]

Complicating the economic issue is whether RFID and bar-coding are competing or complementary technologies. RFID provides more functionality at a significantly higher cost. Currently RFID tags average $0.40 per passive tag and $20.00 per active tag, compared with bar-code labels at $0.001 per unit. Although it is predicted that the cost of RFID will drop significantly as the technology improves and the level of adoption increases, it may never be as inexpensive as bar-coding.

Furthermore, in certain applications such as point-of-care verification and specimen management, bar-coding may provide more than an adequate solution. The current ambiguity of where each technology fits in the overall scheme of improving patient care makes it difficult to move forward. As operations research and experience continues in the clinical environment, the technology pathways should become clearer.

Standardization

A major challenge facing the RFID industry is standardization. The standardization process has been complicated by the emergence of competing standards from the International Standardization Organization (ISO) and EPCglobal/GS1, which are driven by divergent interests.[5]

The air-interface standards (the communication protocol between tags and readers) have been largely resolved by ISO 18000, and the EPCglobal standard itself has gone through the ISO process. However, the air-interface is specified over a range of frequencies. High frequency (13.56MHz) is emerging as the preferred standard for item-level tagging and other hospital applications such as patient wristbands. However, EPCglobal is supporting only the ultra high frequency, which is not suited for item-level tagging, specifically for healthcare products.

Data formats have also been largely defined under ISO, enabling suppliers to migrate from existing bar code ID standards to RFID. The EPCglobal approach diverges from ISO, using the Object Naming Service approach so that key data are centralized.

The Health Industry Business Communications Council is one of the leading standards-setting bodies in defining the organization of application data on the RFID tag and the protocols for transferring from the tag to the application.[6] The council conforms to and leverages the ISO standards wherever appropriate, thus its standards fall under the ISO framework. The International Society for Blood Transfusion manages application-level standardization for blood products.

For the immediate future-in which most RFID healthcare applications operate in a closed-loop environment-the lack of standards is not problematic. However, looking toward interoperability of RFID systems across an enterprise, standardization will be essential. It is anticipated that there will be multiple accepted standards, depending on the application, and that the work done by these standards organizations will move at a pace commensurate with the need for interoperability.

Data Processing and Integration

RFID tagging has the potential to generate a tremendous amount of data that will be of considerable interest to HIM professionals. Questions of how to filter, process, mine, and archive the collected data needs to be addressed. Furthermore, RFID is not a stand-alone technology. Rather, the data generated by the RFID systems will need to be integrated with a number of healthcare systems such as hospital information systems, picture archiving and communications systems, lab and pharmacy systems, and eventually, the electronic health record. Several pilot projects will address these issues.

However, it is too early to forecast who will be the driving force, even though it is expected that all current major players will participate in the process as soon as return-on-investment issues are settled.

Interference

Since RFID systems make use of the electromagnetic spectrum, they are relatively easy to jam.[7] In many environments, interference is merely an inconvenience. However, in a clinical environment, it could compromise patient safety. Since electromagnetic interference from devices such as electrosurgical devices and defibrillators can block the ability to read RFID tags, the clinical environment must be carefully examined to understand the impact on RFID. Conversely, it is critical to understand the effects that RFID technology may have on other devices in the clinical environment, such as telemetry or imaging devices.

The FDA is looking at these potential issues because of the implications for patient safety. At this time, it has cleared very few RFID medical devices. It recently added RF interference as a category in the adverse events database but has yet to have any problems reported.

Privacy Concerns

Privacy concerns present a serious potential obstacle to RFID adoption in healthcare. Concerns include the inadvertent transmission or deliberate interception of personal health information and access to any personal information left on discarded tags.

However, there is nothing inherent in RFID technology that cannot be controlled with good system design and adherence to HIPAA privacy and security rules. At the same time, it is essential to educate the public to the value of RFID technology while assuring them that HIPAA can adequately provide privacy and security. Otherwise, prohibitive public policy will limit the efficacy of the technology.

Stability of Pharmaceuticals

If pharmaceuticals are to be tagged with RFID at the item level, it is critical to understand whether the stability of certain drugs can be compromised by extended RF exposure (and, if so, the parameters of the destabilization). At MIT, research is under way to develop a standard method of evaluating long-term RF radiation impact on pharmaceuticals.[8]

Making RFID a Healthcare Technology

RFID pilot projects and full implementations within healthcare are encouraging. The primary goal of the practice and delivery of healthcare is to improve the health and well-being of patients, and RFID has enormous potential to enable more effective processes toward reaching that goal.

Capitalizing on that potential requires that healthcare see RFID as a health information technology-not as a consumer goods technology that can be applied to healthcare situations. It is important to understand that some of the current gaps and challenges are the direct result of a technology that has been developed for the consumer good industry and is now being applied to the healthcare provider industry. Both the RFID and healthcare provider industries must be keenly aware of lessons learned from current clinical RFID deployments so that technical and organizational requirements specific to healthcare can be developed and implemented.

RFID: The Basics

RFID is a wireless identification technology that communicates data via signals in the radio frequency range of the electromagnetic spectrum. Identification data are stored in a microchip attached to an antenna and packaged as a tag. Tags can be attached to or embedded in objects such as individual products, cases, pallets, animals, or even people. A reader queries the tag using an RF signal, decodes the received data, and sends them to a middleware component for data processing or storage. A well-known use of RFID today is automatic toll collecting, in which a tag is attached to a car. When the car drives past a reader, the system identifies the account and collects payment.

RFID falls under a category of technology termed automated data collection, also known as automated data capture, automated identification (or autoID), and automated identification and data capture. Other technologies within this category include bar codes, voice systems, optical character recognition, pick-to-light, laser scanners, CCD scanners, handheld batch and RF terminals, vehicle-mounted computers, and wearable computers.

Compared to these related technologies, RFID offers the following advantages:

- Neither contact nor line of sight is required.
- Multiple items can be scanned and read simultaneously.
- Signals can pass through many optically opaque materials.
- Tags can hold more data.
- New data can be written to a tag (read-write).
- Tags are durable against dirt, temperature, tearing.
- Sensors measuring time, temperature, pressure, and movement can be teamed with tags.
- Longer lifespan.[1]

The functionality of an RFID system is based on two technical characteristics that are critical to consider when designing an RFID application: (1) the method used to power the tags; and (2) the selected operating frequency.

RFID systems can be classified according to the method by which they obtain power. Passive RFID use tags with no internal power source; instead, they convert the RF energy from the reader into a very small amount of usable power. As a result, these tags are cheaper and smaller, and they have an unlimited lifespan in terms of power. However, passive RFID systems offer limited functionality. They are suitable for well-established, rigidly controlled processes.

Active RFID tags have an internal battery, allowing greater data storage, on-tag data processing, increased reliability, and longer read ranges. They can handle dynamic processes, variable movement of tagged assets, and data storage-intensive applications.[2] However, tag cost is significantly higher. The tags are larger than passive tags, and lifespan is limited by the battery.

RFID systems are legally classified as radio systems, and they use unlicensed frequency ranges that have been reserved specifically for industrial, scientific, or medical applications or for short range devices.[3] RFID systems operate in the low, high, ultrahigh, or microwave part of the RF spectrum. The operating frequency determines the speed of communication and the read range. In general, lower frequency radio waves can penetrate metals and water, but higher frequency waves have faster data rates and longer read ranges.

Notes

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