Title: Patient Safety Improvements through Real-Time Inventory Management

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Background knowledge
Acute care hospitals are constantly challenged with improving patient safety and utilization of resources. In particular, administrators are taking note of the Cath Lab, as it is often considered to be the most technologically advanced of the interventional suites, frequently holding the largest budgets for advanced medical equipment and supplies. With significant investments in lab renovations and new build-outs, cardiovascular suites are now designed to expand the number of services offered, thus increasing the need for accurate and efficient management of newly purchased equipment and supplies.

Local problem
The need to effectively manage an ever growing volume and complexity of inventory for interventional suites had reached a new level of urgency at Mercy. With advances in medical equipment resulting in many new product releases every year, all with time sensitive expiration dates, the task of managing expirations and recalled products had become a daunting task for our staff. A team consisting of an inventory manager and one inventory tech was responsible for managing the 2,200 medical items ranging from $100 to $32,000. Although our inventory staff is detail oriented and understands the importance of their role, it was unrealistic and unfair for the hospital to expect that they could flawlessly keep track of all these items with a system that was largely based on manual processes.

With thousands of products on the shelves, we knew we could no longer afford to put patients at risk by not having the level of product visibility needed to meet the Joint Commission’s patient safety requirements. Our greatest concerns lay with expiration tracking, recall management and ensuring the right product is available at the right time.

Intended improvement
The goal of the project was to automate the process of controlling and managing physician preference items to gain accurate, timely information on product availability and expiration tracking with the underlying goal of improving patient safety. In addition to information access, the automation of inventory management tasks would free up a significant amount of clinical time whereby nurses and techs could spend more time in the room, caring for patients.

My role as an Administrative Project Analyst/Certified Six Sigma Black Belt was to be the project manager. I had executive support from Al McClatchey, VP Mercy Heart Hospital, as well as the leadership in the Cath Lab, including Pam Behnke-Schaad, RN, Cath Lab Director; Nancy Turner, Inventory Manager, Cath Lab; Bill Zika, Inventory tech, Cath Lab; Members from the IT Special Projects team and Materials Management were also instrumental in the success of the project.

As a Six Sigma Black Belt, I am trained to collect data, turn it into useful information and then make smart business decisions based on the information. To accomplish this, I needed to automate the inventory management process to collect accurate data to use in making important decisions related to product availability and lot and serial # tracking. I longed for a technology that could accomplish this goal. With the availability of RFID inventory solutions, my dream has become a reality.
Planning the intervention

In 2008 alone, Mercy Medical Center performed over 20,000 surgeries, nearly 14,000 Cath lab procedures and over one quarter million radiology procedures. With such a large number of medical procedures being performed, we must stock a wide array of products. The hospital needed a solution that could track the over 2,200 medical items ranging from $100 to $32,000 and help improve product mix for physicians while reducing inventory levels, find a more accurate and efficient means for tracking expiration dates, eliminate stock-outs and decrease product waste and increase charge capture.

Prior to implementing an RFID system, the Cath lab had been using a barcode-based inventory management system that was manual and time-consuming. Managing inventory took a commitment in time from all members of the lab. The inventory clerk had to manually count the items on the shelves, while also reviewing expiration dates and making marks on product packaging of those products due to expire within a specified timeframe. These manual processes were preventing us from having accurate information in which to base ordering and billing decisions and created a complex workflow that forced clinicians to be away from patient care.

We found a proven solution in WaveMark, Inc. with its Clinical Inventory Management solution that is used by labs around the country. We began our relationship with WaveMark by conducting a pilot of intelligent cabinets tracking high value products used in cardiac catheterization procedures. Post-pilot the department expanded its use of RFID to include coverage for all coronary, peripheral high dollar products as well as CRM devices like pacemakers and ICD’s. With built-in RFID readers, these cabinets track items placed on the shelves and then update the inventory status every 20 minutes. WaveMark CIMS web-based software works in tandem with these cabinets to independently analyze and manage inventory, eliminating the need for manual intervention from staff.

System Overview: How RFID System Works

WaveMark CIMS is a real-time inventory management solution providing hospitals like ours with complete visibility into inventory disposition. To collect and make this information available, WaveMark installs RFID enabled cabinets in the hospital to store and track all products. Each product box is tagged with a passive RFID tag and registered in the WaveMark database. Each tag contains its own unique ID number. The ID numbers are associated with a bar-code number applied by the device's manufacturer before shipment; hospital employees scan the bar code with a bar-code reader, and that data is correlated with the RFID tag numbers.

The intelligent cabinets have built-in RFID antennas that read tagged items on the shelves every 20 minutes and feed the data to the WaveMark database. The cabinets come in varying form factors to accommodate different sized products. Because the cabinets automatically read all the tags numerous times daily, the system has a near-real-time count of inventory levels, which continually change whenever an item is removed or put into the intelligent cabinets. This enables us to track which stents are pulled out for patients, which are ultimately used and which are put back. Typically, more than one stent is pulled for a patient because physicians don't know the exact type and/or size of stent that will be used until the implantation begins. Once the physician decides to use a product, the clinicians wave the tagged box at the Point of Service reader in the control room which records usage of the item. If the item is expired or on recall, there is a loud sound, alerting the user to the problem. This alert enhances our ability to protect everyone at the time it matters most, the point of implantation.

Once the procedure is completed, techs return the unused stents to the cabinets. Sometimes, however, unused stents aren't returned to the cabinets and turn up missing. By checking the WaveMark web-based reports, inventory personnel can determine when the stents were removed, making it easier to track them down.
Outcomes
In December 2005, as a result of a supplier representative’s introduction of WaveMark to Mercy Medical Center’s Cath Lab, a jointly sponsored trial began that resulted in the large-scale commercial roll-out now implemented. The initial installation was just one RFID cabinet, in the Cath Lab, reading only one supplier’s tagged product. In this scenario, the supplier provided key product data to the RFID system to ensure products could be accurately tracked. In addition, the supplier provided partial funding for the pilot project in an effort to better understand the success of RFID for supply chain management.

The trial was lead by a team from the hospital, the supplier and the RFID vendor, all collaborating on the new and streamlined workflow RFID technology afforded all parties. The trial was met with great success as the lab director, along with other constituents were able to see exactly how many and where products were located in the cardiovascular suite. A 40% reduction in waste was recognized from expired products alone. This new visibility enabled a larger mix of products to accommodate physician preferences and efficient tracking of lot, serial and expiration dates to improve patient safety.

One of the key lessons learned was “we didn’t know what we didn’t know.” We had a strong hunch that products were unaccounted for, but had no way of getting accurate data to support the suspicion. On average, we found that we had 12 unaccounted for items per month, annualized at close to $200,000 of lost revenue. With RFID, all tagged items are now accounted for and products no longer remain missing for very long.

As a result of accurate information being readily available, the clinical workflow has been greatly streamlined and is improving staff satisfaction. No longer must clinicians manually count items and conduct data entry on products currently on the WaveMark system. A time study was conducted and we calculated that the use of RFID reduced the manual labor time by 70%, the equivalent of 1.5 hours per day for 5 days. With the automation of these once manual tasks, nurses and techs are spending more time where they want to be, with patients.

The array of reporting tools available allows the lab managers to smooth ordering patterns, fulfill physician preferences with a greater variety of products, and provides multiple alerts of expiring products. When it comes to patient safety, the reports and alerts can literally be lifesavers. With products expiring all the time, and not just at the end of the month, it makes it virtually impossible to manage this manually. The abundance of reports and audible alerts ensures we capture expired items before they ever reach a patient and keep us compliant with the Joint Commission.

Barriers Encountered
Our greatest challenge was the fear of the unknown. RFID technology is quite new in hospitals, with the preponderance of installations using active RFID technology that is used for tracking capital equipment throughout the hospital. Passive RFID is a better fit for inventory management and is a completely different type of application. WaveMark standardized on high frequency RFID, which was recently announced by ANSI as an HIBCC standard for use in medical settings to avoid any interference with implantable devices. There was some confusion among clinical and administrative staff regarding RFID and its reliability. Therefore, it was incumbent upon the team to devise and execute an audit process that would provide evidence of passive RFID’s accuracy within a Cath Lab environment. Weekly audits comparing a hand count with the cabinet-generated count were conducted, all with 99.9% accuracy.

Secondly, the question of laying an automated inventory system over an existing manual process feeding a Lawson materials management system raised questions about process change and flow. WaveMark was able to demonstrate that 90% of data that goes into the WaveMark system is collected automatically – not scanned in or manually keyed in. As of June 2008, that two-way interface to the Materials System is
operational and sends RFID-generated requisitions directly into the MMIS, eliminating at least an hour a day and the errors associated with manual product ordering.

Technical challenges were minimal, in that the RFID system came with all the necessary hardware and components to complete the system. At installation, WaveMark delivered and set up the smart cabinets, placed the necessary RFID tags on the products, registered them into the database and trained users. From then on, the cabinets continuously report on the product disposition. All hardware is owned by WaveMark, thereby reducing the obstacle presented by a lengthy capital cycle and the fear of buying obsolescent technology.

**Challenges Faced**

Prior to using RFID, the hospital had been using a bar-code based inventory management system, which was imprecise because it relied on inventory data collected manually. Even with its shortcomings, staff was comfortable and familiar with the current process and were complacent to adjust to its limitations. I was not. As a quality professional, I knew there had to be a better solution to address our needs of accurate information and real-time product visibility.

Having been through the evaluation process before, the hospital was able to easily narrow its selection criteria. The introduction of the RFID system ultimately implemented was made by a medical device supplier, whom was also evaluating the use of RFID for similar reasons of inventory control. Having limited knowledge of how RFID was used for inventory management, a fair amount of due diligence was necessary, requiring direct communication with the RFID vendor from the onset. Internally, the collaboration across departments (cath lab, materials management, finance) was necessary and critical to understand the adjustments in workflow, the patient safety improvements and the financial outcomes. Although there was some resistance to change, RFID quickly proved itself worthy.

The first phase included six RFID enabled storage cabinets in the hospital's peripheral vascular storeroom, five in the cardiac storeroom and one apiece in its four catheterization procedure rooms. The vendor provided the installation of cabinets and the RFID tagging of existing inventory. The medical device supplier whom recommended the system provided their products pre-tagged, while inventory staff was responsible for tagging subsequent orders as they were received. POS interrogators were placed in two control rooms, where hospital personnel document each patient's case. The cabinets and the POS interrogators work together to collect data on inventory levels and usage tracking to feed into the system’s database for real-time analysis of inventory status.

**Summary** Because the use of RFID has afforded so many benefits, its use has been consistently expanded to track more products in more labs. We expanded our use of WaveMark CIMS to include the tracking of products in the EP Lab, for a total of 2200 items each ranging in cost from $100-$32,000.

One of the initial goals in implementing a technology was to provide visibility into how much of each product is available and where exactly it is located, so we could ensure the physicians had the right products for the right procedure to adhere to the Joint Commission’s time out procedures. Not only did it accomplish the right-sized inventory goal, target inventory levels were reduced by 25%, for a dollar savings of almost $400,000 annually. For example, the use of the Bulk Buy calculator has saved the department almost $300,000 in preparing the right shopping list based on accurate usage data.

A significant portion of the Cath lab inventory is consigned product, which does put the onus on us to properly track expirations as well as usage to properly reconcile items used or returned. Consignment does have its advantages as a method of product management but there is still a need for hospital staff to
monitor and reconcile consignment agreements and actual inventory levels. We stay right on our contracted levels because of the visibility we get from the RFID system which avoids the problem of owning stock above consigned levels or owing the sales rep a PO for items below par.

We are now relieved of the stress of manually tracking expiration dates whereby the RFID system automatically tracks expiration dates as well as lot and serial numbers. There is a compounding alert system at the Point of Service stations to ensure expired products never reach a patient. This has contributed greatly to our ability to ensure a high level of patient safety outcomes. In addition to the patient safety improvements of real-time expiration tracking, we have saved over $30,000 and recognized a 40% reduction in waste from expired products.

Improved clinical workflow also has a direct impact on patient care -- with nurses and techs spending less time on administrative tasks, they are able to provide more direct care to patients. RFID and an intelligent, web-based system, has been an invaluable technology for enabling our ongoing efforts to safeguard patient safety.

**Interpretation**

Upon installation, an abundance of information became immediately accessible, requiring the proper interpretation to truly understand the value of this new found visibility. The RFID system continuously tracks the status of products as they are stored and removed from the cabinets and the POS readers track the usage of products, with the resulting information presented in the form of reports in a web-based view. If the reports are not properly interpreted and the information applied, then the system provides little value. This reality was the primary reason for the differences between observed and expected outcomes.

Aside from the immediate need to manage expirations and recalls, RFID provided a wealth of information with which we could make sound financial decisions. It was concluded that a certain amount of historical data –about 3 months --was needed to enable the proper execution of decisions that would justify the financial benefits of the investment.

While independently departments were having success with applying the information, a means to integrate the data with existing hospital systems became an obvious necessary step. During an audit using the system, the hospital analyzed four months of data collected from the RFID enabled cabinets and POS readers, as well as the patient billing system. In doing so, it was discovered that several items had been scanned for particular patients but never charged for. We found out, after the fact that the items couldn't be used for those patients, and while they were supposed to be returned to inventory, they weren't. We might have been able to return those items to the vendor, but didn't. And now, those are lost dollars.

To prevent such a problem, the hospital recommended an integration of the RFID system with its materials and patient billing systems. Thus, whenever a product is pulled from a cabinet and actually used, it will automatically be charged to a patient bill. This integration would also provide an electronic record of the exact item used on a particular patient, which can be compared with actual inventory at any given time. That would make it easier for the hospital to track items pulled from the shelves but ultimately not used or returned to inventory.

The opportunity cost of not using the RFID system was substantial compared to the cost of the intervention. The system immediately paid for itself and is fully funded through its ROI. In the first year, we recognized a hard dollar savings of more than $500,000 in reduced waste, improved charge capture and adjusted inventory levels. Soft savings in labor was also immediately recognized.
Conclusions
The implementation of RFID and real-time inventory and usage tracking has great practicality in specialty labs where critically important or high-dollar value consumable medical supplies are used. This has been demonstrated by the expansion of the system to track additional products in the Cath lab, as well as products in the EP lab. It is likely that this technology will also be implemented in the operating room.

Financial Considerations
Contrary to most information technology solutions, this system is available on a subscription basis and requires no upfront costs or maintenance fees. The absence of capital equipment costs continues to make this a cost-effective solution. With the ease of use in downloading the data from the system, we can “marry” the information from several other data systems to analyze data financially and statistically. The information is invaluable when you are talking about multi-million dollar inventories.

Prior to implementation and upon subsequent expansions in implementation, an ROI analysis was conducted, providing a thorough evaluation of the financial cost savings the system provides. The subscription cost of the system is an operating expense, not a capital equipment expense and immediately paid for itself and continues to be funded through ROI savings.

Just 18 months after the initial implementation, including 2 expansions of the system, an impressive 568% ROI was recognized. The biggest savings areas came from improved charge capture due to automated usage tracking and savings in product costs by executing bulk buy opportunities. Inventory reduction by right-sizing inventory levels and elimination of waste also contributed to cost containment. We continue to monitor and implement new areas to achieve better inventory management and patient safety. Next steps are to expand into other areas of the hospital where inventory is shared with the Cath Lab. The ROI for this expansion will continue to support the funding for this endeavor as we move forward through 21st Century technology in Healthcare inventory management.

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Appendix

Figure 1. How RFID Works

Figure 2. RFID Implementation Timeline
Figure 3. Joint Commission Time Out Protocol

Joint Commission Universal Protocol UP01.01.01..."time out"

Purpose:
To conduct a pre-procedure verification process

...to review and verify that any required...implants, devices, and or special equipment for the procedure are available

Figure 4. Setting Target Inventory Levels for Time Out Protocol

By analyzing actual product usage, WaveMark CIMS helps hospital staff adjust inventory to needed levels.
Figure 5. Reduction in Target Inventory Levels

Figure 6. Product Expiration Tracking

$31,705 savings by reducing the # of expired products
Figure 7. Product Expiration Alerts

Automatically view expiring products and their location

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On average, 12 items per month are unaccounted for:

- Drug-Eluting Stents: 46%
- Bare Metal Stents: 19%
- Ballons: 26%
- Other: 9%

Figure 8. Automated RFID Usage Tracking Captured $193,968 in Potential Lost Revenue in Unaccounted for Items.

Figure 9. Manual labor savings

Comparison of the number of steps using various inventory systems:

- RFID reduces manual labor by 70%

RFID Inventory Solution vs Barcode System