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RFID AND ITS IMPACTS TO THE HOSPITAL SUPPLY CHAIN

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ABSTRACT

A radio frequency identification device (RFID) is a type of information technology used to improve supply chain management through an enhanced visualization of products. The RFID market in the U.S healthcare industry has been projected to be approximately \$297 million and has been expected to grow at a rapid speed. RFID had a great impact on the hospital supply chain. It has been demonstrated that 30% of large healthcare organization that had IT budgets over \$100 million had already deployed RFID technology. RFID is the latest technology to reduce costs by tracking both equipment and employees. This technology can also reduce medical error, thus creating a safer environment for patients.

INTRODUCTION

According to the National Coalition on Health Care (NCHC) report in 2009, the total national healthcare expenditure is expected to increase seven percent per year over the next decade. It is projected to reach \$4.4 trillion in 2018, which equals 20% of the United State (U.S) gross domestic product (NCHC, 2009). Information Technology (IT) systems are considered a potential means to reduce hospital administrative costs and improve clinical performance such as patient safety and quality of care (Menachemi, 2006; Andre, 2008).

While the hospital supply chain lags behind in applying the latest technology to operation, its counterparts in the retail and manufacturing industries had come to automation (Chowdhury, Chowdhury, and D'Souza, 2008). The benefits of adopting the latest technology are difficult to ignore. Sixty-nine percent of hospital executives that responded to a recent survey stated that supply chain automation is an area of strategic importance for their organizations (Carpenter & Hoppszallern, 2007).

Radio Frequency Identification Devices (RFID) is the latest technology that enables tracking and monitoring of any activities that are carried out using invisible radio waves over distances that range from less than a centimeter to those that span hundreds of meters (Butters, 2006). RFID has been widely used in tracking items such as pallets or cartons within a supply chain or warehouse. With mandates from Wal-mart and the Department of Defense requiring suppliers to begin tagging items, and the push from the Food and Drug Administration (FDA) to tag pharmaceuticals to prevent counterfeiting, the use of RFID technology is slowly making its way into the healthcare market (Young, 2005). The FDA issued a recommendation that all pharmaceutical industries implement RFID tagging of all drugs by 2007 (Wicks, Visich, & Li, 2006).

Besides the tagging of pharmaceuticals, RFID has also been used in other areas: personnel and patient tracking (Swedberg, 2010), equipment tracking and patient charts (Janz, Pitts, & Otondo, 2005), as well as patient admission and registration (Banerjee & Gouthaman, 2005).

RFID has the potential to track physical items—products, equipment, and even humans-- in real time (Sade, 2007). For example, in the pallet stacked with cartons, a suitably placed antenna would be able to read the RFID tags on every carton in the stack almost instantly without requiring them to be visible.

In the RFID environment, the barcode technology is being replaced with an RFID tag, and the barcode scanner is swapped for an RFID reader. The tags are, essentially, smart labels and, in most cases, have a chip and an

antenna as their main components. The radio waves generated during the reading process are able to penetrate many materials and therefore can be employed where tags are not visible to the eye (Schraag, 2006).

There are two types of RFID. One type of RFID can transmit information. Another type of RFID, which is called a "passive" device, can be read by a nearby, powered machine. Both types are small and cheap enough to be utilized everyday in society. Everything from security and convenient cards such as ATM debit/credit cards, to anti-theft devices on goods in shops, and hospitals are starting to become aware of their potential (Tainton, 2008). At several hospitals worldwide, patients heading for the operating room wear an RFID wristband, so that even when under the influence of anesthesia, their full identity, including a picture, can be downloaded into a Personal Digital Assistant (PDA) held nearby (Berwick, 2008).

The use of these devices in health care represents another promising development in information technology. The use of these disposable wristbands can almost wipe out surgical errors such as performing a procedure in the wrong area of the patient (Williamson, 2006). Secondly, being able to keep track of products and equipment and utilizing them to their fullest potential is an asset of RFID (Korn, 2007). Finally, the use of these devices could thwart those trying to counterfeit products and drugs. This will make it extremely difficult and very costly for counterfeiters to reproduce hospital supplies and try to pass or sell them as genuine products because they can be easily detected via RFID environment. The World Health Organization estimates that five to eight percent of global pharmaceuticals are counterfeit. Particularly, the pharmaceutical industry reports that it loses \$2 billion per year due to counterfeit drugs (Sager and Socolar, 2005).

The use of these devices in healthcare represents another promising development in information technology, but also raises important ethical, legal, and social issues. Particularly, the use of RFID labeling in humans for medical purpose may improve patient safety, but may also pose physical risks, compromise patient privacy, or represent other social hazards.

The purpose of this research study was to describe the impacts and effects of RFID to the hospital supply chain.

METHODOLOGY

The methodology for this literature review followed the basic principles of a systematic search. The goal of the overall research was to identify the most prominent RFID studies published in the last 7 years (2003 to 2010). The research was limited to papers, books, peer-reviewed journals, and nationally and internationally recognized health-related institutional reports.

When completing the online research, the following terms were combined: "RFID," OR "RFID standards," AND "supply chain", OR "hospitals", OR "hospital inventory", OR "inventory management." The following electronic databases were used: ESBCO host, Google scholar, Academic Search Premier, Pub Med, and RFID Journal. There were 34 references listed from retrieved papers that were also examined and 28 published articles that were also used for the study. The literature review was conducted by DFL and HD and validated by AC.

RESULTS

The National Health Expenditure (NHE) is expected to reach \$2.5 trillion in 2009, which accounts for 17.6% of the Gross Domestic Product (GDP) including the \$185 billion of high administrative costs. By 2019, NHE is expected to reach \$4.5 trillion and will account for 19.3% of GDP. Since the average public spending growth rate is 7%, and private spending is 5.2% for 2009 through 2019, the public share of total NHE is expected to rise from 47% in 2008 to 50% in 2012, and then reach about 52% by 2019 (Kaiser Family Foundation, 2009), (Table 1). Consequently, hospitals are looking for ways to reduce expenses. It has been estimated that a 200-bed hospital could save \$600,000 each year from less shrinkage, fewer rentals, deferral of new purchases, improved staff productivity, and enhanced quality improvement. In addition, Advocate Good Shepherd Hospital in Illinois applied RFID in 2003 to help manage inventory and the annual inventory losses were decreased by about 10% (Glabman, 2004), (Table 1).

Wireless and electronic radio frequency communications are important for RFID to identify objects and people equipped with small integrated circuit "tags" that state whether they are active or passive when passing by a network of RFID readers (Gearon, 2005), (Table 1). This was an advancement in the tracking technology, and RFID

produced clear script that was easy to read and hard to misinterpret. A chip that can store up to 256 characters is scanned with an RFID reader, and the patient confirms the programmed information. A second chip can be used if more information is needed (Gawel, 2004), (Table 1). Since RFID can help reduce costs for the hospitals, sales of RFID technology for supply chain applications are expected to grow about 38%, going from \$89 million in sales in 2002 to \$448.4 million by 2007 (Hickey, 2003), (Table 1). On the Information Week 500 survey, 20% of healthcare respondents stated that they have tested and deployed RFID technology (McGee 2004), (Table 1). Also, in 2006, research firm IDTechEx forecasted that applying RFID tags and services in healthcare facilities would grow from the \$90 million to \$2.1 billion by 2016 (Raths, 2008), (Table 1).

Technology vendors claim that by adding RFID components to existing wireless networks with little interference, hospitals could reduce the cost of building an instantaneous tracking system. For about \$100,000, a hospital could track its most critical assets by adding RFID to its wireless system (Scott, 2006). The technology also makes medical care safer and more efficient. For example, the staff at the 30-bed general surgery unit at the Jacobi Medical Center in New York, NY outfitted patients with RFID wristbands that recorded their names, genders, dates of birth, and codes for electronic medical records. Doctors and nurses used tablet PCs equipped with RFID readers to upload this data from a patient's wristband, and the computers then retrieved the patient's record wirelessly from the hospital database (Lok, 2004), (Table 1).

In 2007, the RFID market in the U.S healthcare industry was projected to be approximately \$297 million, and it was expected to grow at a rapid speed. A report showed that 30% of large healthcare organization who had IT budgets of over \$100 million had already deployed some RFID technology, whereas 74% of respondents anticipated investing in RFID in 2007 (Revere, Black, and Zaula, 2010), (Table 1). A Leadership Survey in 2006 taken by Healthcare Information Management and Systems Society (HIMSS) stated that 28.9% of healthcare executive indicated implementing RFID technology for patient and asset tracking was among their top five priorities. This rate rose to 41.6% in the 2007 survey (Healthcare Purchasing News, 2006), (Table 1).

The Heart Center at Columbus Children's Hospital successfully implemented RFID to enable inventory management system to store, track, and manage the utilization of its high cost devices and supplies supporting congenital heart care (MRTmag, 2007), (Table 1). The system used was called iRISupply, developed by Mobile Aspects, Inc., and used an RFID tracking architecture to automate charge capture, inventory management, device expiration management, and other key operational processes within the patient care setting. By implementing the RFID-based technology, the organization attempted to efficiently and accurately automate devices and supply utilization processes without using manual approaches such as paper documentation, stickers, bar coding, or button pushing. This technological solution was expected to create an atmosphere of cost efficiency that would directly benefit patients, as well as the hospitals.

Kaiser Permanente San Jose Medical Center was also known as a successful case that implemented RFID solution to enhance their supply chain management of a 242-bed facility handling 35,000 outpatient visits and delivering 2,225 babies annually (Swedberg, 2010), (Table 1). Kaiser selected Awarepoint's ZigBee-based system with access point that plugged directly into power outlets to locate assets and nurses in an area of 660,000 square feet with 35 floors of coverage. This \$500,000-value project was considered to be a holistic approach to healthcare that would benefit its patients, healthcare professionals and management by providing both managers and caregivers with better data concerning equipment availability, location, and usage. The new system was expected to save the organization \$257,000 annually by reducing theft and increasing utilization of existing equipments (Swedberg, 2010).

Not only did RFID technology assist in tracking inventory, patients, and nurses, but was also utilized in the garment and laundry operations of hospitals. St. Olav University Hospital in Trondheim, Norway, saved several million of dollars by replacing its existing labor intensive system with an advanced RFID garment logistics system to track its 130,000 staff garments such as operating robes, gowns, and trousers, (Texas Instruments, 2007), (Table 1). The hospital management authority expects savings of over \$6 million in costs of space alone. It is projected that further savings of several million dollar in operational costs will be realized due to more efficient data collection for improved logistics management, automated ordering, and time-saving for staff because garments are much easier and quicker to find.

Table 1: Results of studies related to the implications of RFID in hospital supply chain

Author(s)	Year	Type of Study	Keywords	Key Findings
Lok	2004	Literature Review	Efficient Inventory management	RFID tags were put into wristbands to keep track of patrons, patients, and student.
Gawel	2004	Literature Review	Accuracy	An advancement in the tracking technology, RFID produced clear script that is easy to read and hard to misinterpret.
Glabman	2004	Literature Review	Inventory management	Inventory and the annual inventory losses were decreased by about 10% after applying RFID in 2003.
McGee	2004	Literature Review	RFID Information Technology	On the Information Week 500 survey, 20% of healthcare respondents stated that they have tested and deployed RFID technology.
Gearon	2005	Literature Review	Liability	RFID help reduced liability related problems.
Scott	2006	Literature Review	Lower costs Active Tracking Technology	For about \$ 100,000, a hospital could track its most critical assets by adding RFID to its wireless system.
Healthcare Purchasing News	2006	Quantitative Survey Qualitative Literature Review	RFID, Supply chain, patient safety, asset tracking	28.9% of healthcare executives indicated implementing RFID technology for patients and asset tracking is among their top priorities.
Hickey	2003	Quantitative Literature Review	Hospital Supply Chain Costs	RFID can help reduce costs for the hospitals, and sales of RFID technology for supply chain applications would be from sale of \$89 million in 2002 to \$448.4 million by 2007.
MRTmag	2007	Literature Review	RFID deployment, Children hospital	The system uses an RFID-tracking architecture to automate inventory management, device-expiration management and other operational processes.

Texas Instruments	2007	Qualitative Case Study Literature Review	Hospital garment and laundry	Further on-going savings of several million dollars in operational costs will be realized due to more efficient data collection for improved logistics management, automated ordering, and time-savings for staff.
Raths	2008	Literature Review	Hidden costs Safety	RFID technology is used to manage assets and optimize operations.
Kaiser Family Foundation	2009	Quantitative Literature Review	National Health Expenditures Administrative costs	National Health Expenditures (NHE) are expected to reach \$2.5 trillion in 2009, which is accounted for 17.6% of the Gross Domestic Product (GDP) including the \$185 billion of high administrative costs.
Revere, L., Black, K., Zalila, F.	2010	Qualitative Literature Review	RFID, Supply chain, Efficiency, Quality, Healthcare, Clinical paths	RFID in the hospitals can make operational improvements throughout their supply chain. RFID can be integrated into areas of internal patient supply chain, serving as clearinghouses of information.
Swedberg	2010	Qualitative Literature Review	Real-time locating system, clinical equipment	The system was expected to save the organization \$257,000 annual savings by reducing theft and increased utilization of existing equipment.
Revere, Black, and Zaula	2010	Quantitative Survey Qualitative Literature Review	RFID, healthcare technology	30% of large healthcare organizations had already deployed some RFID technology, whereas 74% of respondent anticipated investing in RFID in 2007.

In a report by on the use of RFID, it was reported that hospitals incur more than \$11 billion in unnecessary costs as a result of inefficient in the supply management. It has been suggested in this report that the use RFID technology would reduce these expenditures by improving patient safety and supply chain management by increasing the ability to track and locate equipment, as well as improving theft prevention, distribution management, and patient billing (FDA, 2006).

Companies, such as Wal-Mart, CVS, and Target, have also demonstrated the importance of RFID technology in the supply chain management resulting in easier tracking of inventory and an increase in sales due to accessibility to their stock using RFID's (Nagy, George, Bernstein, Caban, Klein, & Mezrich, 2006).

There is concern that RFIDs can interfere with electrical devices, such as pacemakers, EKG monitors, Cardiac Defibrillators and other electronic devices usually used in hospitals. Additionally, when the RFID chip is accessed by the RFID reader, this information can be accessed by other users with similar devices. For this reason, there are privacy concerns which arise from the use of the RFID and the storage of medical information (Fuhrer & Guinard, 2006).

DISCUSSION

Utilization of RFID in the hospital supply chain is beneficial for hospitals that want to lower costs and provide quality services. According to Revere, Black, and Zaula (2010) 74% of respondents anticipated investing in RFID in 2007. The application of RFID tags on medical equipment and supplies results in using time more efficiently. With RFID technology, hospital staff can find the equipment they need whenever they need it. Thus, they will not waste time looking for equipment.

RFID can also create a safer hospital environment for patients and enhance overall patient satisfaction. The safety of operating room procedures can be improved with RFID by making the need to count the items on the surgical tray more reliable. McGee (2004) described that the leading supplier of products and services supporting the healthcare industry, Cardinal Health Inc., is attaching RFID tags on surgical medical products to guarantee nothing would be left inside the patient during surgery. Patient scheduling will be more precise with the deployment of RFID because hospital employees know where the patient is and what the wait time is for needed services. Communication throughout the organization will be more efficient and will result in fewer medical errors. Health care managers expect that this technology solution will help their organizations create an atmosphere of cost efficiency that will directly benefit both patients and the hospitals.

Hospitals are looking for ways to reduce expenses due to higher healthcare costs. Consequently, applying RFID is the best option because it can lower the direct and indirect costs in patient care. Agility Healthcare Solutions CEO Fran Dirksmeier stated that a 500 bed hospital could save \$1 million annually after the utilization of RFID. In addition, Glabman (2004) also pointed out that after the application of RFID, annual inventory losses could be cut by about 10%.

As a result of impact in the pharmaceutical counterfeiting, Congress introduced HR 5939 –*Safeguarding America's Pharmaceutical Act of 2008*. "However this bill failed to pass due to inactivity in the subcommittee and regulatory cost and privacy concerns (Coustasse, Arvidson, & Rutsohn, 2010). There is still optimism that it might be reintroduced in the near future as the application of RFID in the pharmaceuticals chain is estimated to save approximately \$400 million for the distributors and \$1 billion for the manufacturers (Healthcare Distribution Management Association, 2006).

CONCLUSION

RFID has great impacts on the hospital supply chain. It will be a widely-used technology to help hospitals reduce costs by tracking equipments and increasing patient safety. Although there is some concern with this technology particularly the issue of privacy, there is a general conviction that hospitals, by deploying RFID in its supply chain, can minimize medical error, improve quality of care, increase patient satisfaction, and create a safer environment for patients and healthcare personnel alike.

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