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# USE OF RFID IN HEALTHCARE INDUSTRY

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**ABSTRACT**

This paper presents research findings and recommendations on the use of Radio Frequency Identification (RFID) in the health care industry. Five hospitals located in the Midwestern United States were reviewed and the viewpoints of patients, administrators, and system technicians were explored. There is great potential for RFID systems to be utilized in the health care field in order to increase patient security and care, as well as maximize facility profitability. Currently, however, very few hospitals utilize an RFID system, and those that do tend to use it only for one or two of its potential uses rather than the full-scale of benefits it is capable of providing. The myriad uses available from RFID systems indicate tremendous upside potential for most facilities. Management of all medical providers should at least investigate whether this technology would improve their specific facility.

Keywords: Radio Frequency Identification, RFID, hospital, health care industry

## INTRODUCTION

Radio Frequency Identification (RFID) is a state of the art technology that uses electromagnetic fields attached to a tag to identify objects. These tags are typically used for product tracking and product identification. RFID is a growing trend in the health care industry, driven by a greater emphasis on patient safety than has ever been seen before. RFID technology can help ensure that every patient is treated properly and that patients get the services they pay for. Revere (2010) describes two common types of RFID tags, active and passive. Active tags are more expensive, because they have an internal power source and allow two way flow of information, from tag to server and back. Active tags can transmit over 100 feet. Passive tags are less expensive, but must be activated by an outside power source. They are shorter in range than active tags, and only transmit data from RFID to server.

RFID has three primary uses in the medical field: tracking equipment, tracking patients, and tracking staff. Tracking expensive medical machines by way of RFID systems in hospitals has tremendous advantages. Medical equipment that has historically been forgotten in storage is now tagged with RFID and easily found when needed. Hospitals have been able to cut the number of pieces of equipment they need to keep on hand, because each piece can be found when needed. Additionally, the number of staff needed to scour hospitals for lost or misplaced equipment can drop significantly, resulting in significant payroll savings.

The second benefit of RFID in the medical field is to track and monitor patients. At this point in development, RFID is used to control and monitor patient location, to control and document medication administration, and to monitor patient/staff interaction time. However, there is much more that can be done with RFID to further improve patient safety. In the future, it is expected that hospitals will seek to prevent falls by monitoring patients as they get in and out of bed. Even more amazingly, according to Horowitz (2010), new RFID systems could take things a step further and incorporate facial recognition software. This software could determine whether a patient may be having a stroke or experiencing excessive pain by analyzing their facial expressions. Furthermore, RFID could be used with dementia patients in an effort to prevent them from wandering off premises unnoticed.

Billing in hospitals is substantially based on the interactions between staff and patients and the resultant services provided. RFID Technology allows hospitals to closely monitor these interactions and to bill more accurately. In addition, RFID can track patient admission,

discharge, and transportation. Such tracking allows the facility to maximize bed space at any given moment. By tracking patients more closely, hospitals can maximize billing and ultimately increase net profit.

The final application of RFID in hospitals is in tracking and monitoring staff. Called the "Nurse Nanny" by some, RFID systems help hospitals control staff costs and on-the-clock time. In addition, the systems can track how much time staff members are actually spending with their patients, versus doing paperwork or other non-patient-interaction work. From a quality-control perspective, this is important information for hospitals to have, in order to compete most effectively with other hospitals.

## LITERATURE REVIEW

There are many studies that review the potential use of RFID technology in hospital environments. Research often points to the efficiencies that can be gained in the area of equipment and patient tracking. For example, Revere (2010) found that RFID leads to gains in operational efficiency, organization-wide quality, and increased patient-level accessibility. Industries adopting RFID technology see improvements such as efficient inventory management, better asset tracking, reduction of thefts, more accurate point of sale, fewer errors, and increased real time communication. For security reasons, the food and Drug Administration (FDA) has recommended that the Pharmaceutical industry implement RFID tagging on all drugs to track and to prevent counterfeiting and terrorist distribution (Wicks, 2006).

There are many options when it comes to tracking that can be very confusing for potential customers. Dash (2009) distinguishes between two main systems, RFID and Real-Time Location Services (RTLS). RFID is defined as the identification of a tagged object or person through a wireless communications network. It can be used to identify a tagged patient, manage and locate assets, prevent theft, and locate or manage staff. RTLS provides the ability to track and locate an object or person carrying an RFID tag through a series of Wi-Fi network access points in real time. Real-time systems can express the exact location of an object, depending on a few variables, such as the expected current and/or next location; prior locations; and, with the right technology, an object can be viewed moving down a corridor or across a city.

Similarly, Barlow (2011) discusses how supply chain managers can use technology to enhance and solve their tracking and work flow problems. There is no single technology that can handle all of the work flow and tracking problems within health care facilities. The situations need to be evaluated to ensure the best form of technology is used. In most cases, the ideal solution is a combination of RFID, RTLS, and bar coding. For instance, RTLS is too expensive to use on medications, but is perfect for real time use in patient location and safety.

Other studies address the implementation barriers that hospitals face when launching an RFID system. Some of the implementation problems with RFID in hospitals are similar to issues seen in other environments. The largest obstacles are cost related considerations such as the cost of tags, application of tags, tag readers, software development, and system maintenance (Ngai, 2010; Barlow, 2010). Another major issue is the significant amount of "dirty data" that is generated during use. Finally, according to Wicks (2006), hospitals are faced with confidentiality issues. For example, there are fears that third parties could access private patient information such as drug use, therapy, diagnoses, and types of injury.

Another common topic in existing studies are the savings and cost implications of RFID in hospital environments. Depending on the type of system and the actual uses, initial installation and ongoing operation costs can be prohibitive. Prices are certainly a barrier to successful RFID implementation, but as technology improves these systems have become more affordable. New efficiencies can pay for a typical system in one to two years, according to vendors (Page, 2007). Savings include staff time spent searching for equipment, inventory and equipment tracking, and speedier patient flow through RFID tracking. Page (2007) also points out the savings associated with malpractice prevention. For example, there is technology available that provides small RFID tags for such things as surgical sponges to prevent leaving them behind during surgery. Swedberg (2009) agrees that there are large cost efficiencies that can be realized with RFID. The wasted time spent searching for missing equipment and the expense of buying replacement equipment is a major cost to hospitals. He also points out that when patients arrive in the emergency room, personnel can immediately locate open beds and efficiently admit patients for needed treatment.

These claims of cost efficiency are further supported by GE Healthcare (2012). GE's groundbreaking AgileTrac system started off as purely an asset management system, but quickly morphed into a system that can track patients the same way as equipment. The efficiencies

gained allow hospitals to recoup costs within the first year. This system meets a real and immediate need for some of the largest health care centers in the world and is being continuously upgraded, at a near constant rate.

Empirical evidence suggests that those who are implementing or will implement RFID systems consider RFID barriers to be lower and RFID benefits to be higher than those not implementing the systems. Reyes (2012) found that managers believe the implementation of RFID in health care could lead to many benefits including improved patient care, improved patient security and safety, and improved organizational performance. The results also show that RFID deployment in health care is driven by internal factors, not external pressure. This result is expected, since health care organizations are not under a mandate to implement RFID. Decisions to adopt RFID must be driven by internal factors, such as visibility, efficiency, asset management, security, patient service, collaboration and cost reduction.

## RESEARCH METHODOLOGY

The majority of research data was gathered via personal interviews. Interviews were conducted in hospitals, medical centers, by email, and face to face with potential patients. The levels of employees in the hospitals and medical centers ranged from biomedical engineers, to operating room (OR) nurses, to operating room administrators. Questions varied based upon the level of usage that the employees experienced with the RFID systems. In some facilities, questions were only posed to the biomedical engineers, because they were the only employees with access to the RFID system. One interview was conducted with an employee of a hospital that did not currently have an RFID system in the facility.

Questions asked during the interviews included: 1) How are you using RFID at your facility at this time?, 2) How long has the system been in place, and were you here both before and after the implementation?, 3) What are the key benefits of the system?, 4) What are significant drawbacks of the system?, and 5) Does the system work better or worse than you had anticipated? Table 1 breaks down the sample size for each hospital in our data and shows the different types and the number of people that were interviewed at each hospital. Each interview lasted approximately 20-25 minutes depending on follow up questions as well as secondary information.

| | Hospital A | Hospital B | Hospital C | Hospital D | Hospital E |
|---|---|---|---|---|---|
| OR Admin. | 1 | 0 | 1 | 1 | 1 |
| OR Nurses | 2 | 1 | 3 | 1 | 0 |
| Biomed Tech | 1 | 1 | 1 | 1 | 0 |
| Nurse | 3 | 2 | 0 | 1 | 0 |

Table 1 Sample Size

## DATA ANALYSIS

***Hospital A***

Hospital A is a 400+ bed hospital located in the Midwestern United States. It currently has an active RFID program that can be accessed by all employees from any computer in the facility. The facility purchased this system for $800,000 approximately 5 years ago. This system was implemented in an existing hospital. The materials and man hours needed to install this system imply that the system would be more ideal for implementation in newly constructed facilities. In addition to the upfront fee, there is an additional fee of $150 for each RFID tag used. There is also a monthly monitoring fee.

There are apparently two major drawbacks to the RFID tags. One employee stated that the RFID tags tend to fall off of the equipment to which they are attached. Employees often pick them up and put them in a pile instead of notifying the proper personnel. Thus, when someone tries to track an item, they are sometimes led to a pile of RFID tags, instead of the sought after equipment. Another employee said that the biggest complaint they have is that the tags periodically die. Each tag has a built in battery, but the entire tag must be replaced when the battery fails. This is done at the same charge of $150 per tag.

A hospital employee shared his thoughts on the RFID system that is in place. As a biomedical engineer, he is responsible for making sure that all equipment receives annual preventative maintenance in the month it is due. From his perspective, the biggest benefit of the program is “the ability to track any missing equipment to ensure that it is properly maintained and documented.” He also stated that the system would “allow nurses to find needed equipment

immediately rather than spending valuable time wandering the floor." The biggest issue with the RFID system is that the "tags either die, or simply fall off of the equipment they are tracking." At $150 per tag it is frustrating when they fall off or simply stop working. The frustration of lost tags escalates when "the staff just put them in a pile instead of informing the proper people that the tag fell off." The list of cons continues with the fact that staff turnover causes training issues with new personnel. Without proper training, new hires are hesitant to use the system. Oftentimes, training focuses on other important areas of the medical environment instead of teaching new personnel how to properly utilize the RFID System.

When utilized properly, Hospital A's RFID system is very impressive. Employees can search the entire hospital for a certain piece of equipment by description or by serial number. Furthermore, a nurse can specifically search a given floor for a certain item, identify its location by room, and even discover whether or not it is currently in use.

***Hospital B***

Hospital B is a 600+ bed hospital in the Midwestern United States. It currently has an active RFID program, but the technology is only used to monitor hospital beds for maintenance purposes. While this idea is useful, the RFID system falls very short of its potential. Because the beds are already being tracked for maintenance, Hospital B could very easily expand the RFID system and use it to identify the number and location of available beds. This is especially beneficial in an emergency room environment. This would not only make the hospital more efficient, but would provide better and timelier patient care.

Furthermore, one staff member said, "the layout of the antennas in the hospital does not provide a very thorough coverage area. Even when beds are in a certain area, they do not always show up; they are hidden." He went on to say that, "we tend to have a lot of missing beds that show up as being on the wrong floor of the hospital." Additional transmitters may be needed to ensure adequate coverage. However, it is a very old hospital and the addition of the needed transmitters would prove very costly.

***Hospital C***

Hospital C is a 600+ bed hospital in the Midwestern United States. It also has a current RFID system in place, but it is used in an entirely different way: Hospital C uses its system to track employees. RFID helps ensure that patients are getting the proper attention and service they

deserve from hospital staff. This usage of RFID also improves billing efficiency, leading to increased revenues. Hospital C experienced significant resistance by employees when its RFID system was first implemented.

It remains to be seen whether or not Hospital C will expand usage of its current system. However, common thinking at the facility indicates that there likely will be an increase of the RFID usage. As employees become more familiar and comfortable with the technology, their ability to apply it in meaningful ways will continue to have an impact on organizational efficiency.

***Hospital D***

Hospital D is a 200+ bed hospital in the Midwestern United States. It does not currently have an RFID system. One employee stated that he wished the hospital would look into a system to help with his monthly maintenance work. As a biomed engineer, his responsibilities include performing preventative maintenance on all equipment. This is important, because his work is monitored by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). JCAHO currently requires that a facility be 95% compliant on preventative maintenance. This becomes a challenge when the equipment cannot be located. RFID would facilitate this task.

Hospitals would also benefit from RFID technology in "patient satisfaction." Most hospitals receive grades based on patient satisfaction. Using RFID would make the stay much more patient friendly and more efficient. Possibly the most important benefit to RFID is increased patient safety. As one employee from Hospital D stated, "RFID would allow us to track instruments, equipment, and other products used in surgery and guarantee that human errors are minimized."

Hospitals considering RFID implementation face this negative argument, explained by one staff member. In existing facilities, without RFID technology, "the startup cost can be tremendous and the software and the implementation of the transmitters could overwhelm." This employee acknowledged that the time saved looking for equipment would cut down on costs across the board. "If a nurse makes $40/hour and she spends 15 minutes of every hour looking for lost equipment, that could save $80 per day. Now imagine that the same situation is happening to 10-12 nurses in the hospital. The savings could be significant."

Not only would the RFID system cut down on the time spent searching for equipment, it would also reduce some of the excess equipment that is not necessarily needed. To support what this employee had stated, further research at a similarly sized hospital shows that 58% of IV pumps are not even being used; they are being repaired or are in storage, etc. In addition, such pumps were only found 36% of the time, often accounting for up to 30 minutes of nurses' time searching for such items. Bon Secours Richmond implemented an RTLS system and saved more than $5 million dollars in equipment costs, wasted time on the clock, and staff efficiency. St. Mary's Hospital raised their utilization of IV pumps to 92% and can prepare a room for surgery 25 minutes quicker than they used to (Dirksmeier, 2011).

***Hospital E***

Hospital E is a 25+ bed hospital located in the Midwestern United States. It does not currently have an RFID system in place. The operating room manager of this facility believes that RFID is a great idea in large urban hospitals, but that in much smaller hospitals, RFID programs are not practical. Because of the small size of these hospitals, it is not even worth exploring at this point. Even though the hospital staffs fewer people, the restricted size and budget make it so that there is not really any unneeded equipment and everything is easily found. According to this manager, the initial startup cost for a full RFID system is more than some of these hospitals' 2-3 year operating budgets.

***Patient/Potential Patient Interviews***

For this paper, the authors interviewed 10 individuals (potential patients), and asked the following questions:

- Would you appreciate being tracked by RFID during a hospital stay?
- Would your answer change if the RFID transmitter was an implanted chip versus a wristband?

All of the patients initially were either in favor of tracking or ambivalent. One patient said, "That seems like the least personal thing they're going to see while I'm in the hospital." However, when asked the follow-up question on type of RFID transmitter it became clear that patients are only interested in this technology if their RFID tag is removed when they leave the hospital. At the core of opposition to "skin tags" is the implicit invasion of privacy that one could be

subjected to. It is one thing to allow hospitals to use personal information while a patient, but beyond that it takes most people out of their comfort zone.

## DISCUSSION

RFID presents significant upside potential for medical facilities, with one major drawback: initial cost, particularly of installation in existing structures. Notably, after investing in these expensive systems, many hospitals are not using their RFID systems to their full potential. Although the costs may seem extravagant or even prohibitive, research studies show that savings associated with RFID can cover the implementation cost in as little as one year of operations when systems are used to their full capacities. Even so, hospitals that are considering implementation should proceed carefully. Care should be taken to fully research technology and software needs. Potential uses should be identified and evaluated for feasibility. In addition, implementation should include proper training and, more importantly, business process redesign. By redesigning the workflow, RFID can result in incredible benefits.

In analyzing three of the 49 hospitals that currently have an RFID system in place; it is obvious that hospitals are not using RFID to its greatest capabilities or benefits. Only 1% of hospitals have the system in place, and those that do are often only utilizing one or two of the system's benefits. We propose that if all medical facilities and hospitals were informed of the potential benefits of RFID, the system would be more widely used. If such a system were implemented and utilized for all of its possible benefits, a medical business could recoup their initial costs in implementing the system within one year, or possibly within as little as a few months.

A direct example of how the RFID system can both improve business process as well as save money can be found in the South Carolina health system. The South Carolina health system implemented an active and passive RFID tracking system in 2011 for portable devices and equipment. For the active tags it costs them between $60 and $100 per tag. They no longer lose equipment because they can also look up a tagged item on the computer and find within 10 feet of where it's located at all times and an alarm sounds if the piece of equipment tries to leave the operating room (Barlow, 2009). Surely they have already saved thousands of dollars on equipment. If they used the system for tracking patients and staff as well as equipment, the savings would be tremendous.

According to Revere (2010), the patient supply chain consists of ancillary care, pharmaceutical services, direct patient care services, medical equipment and supply services, and workflow services. Outcome is directly related to the interaction, efficiency, and communication of the input processes. RFID can be used in each input process to promote efficiency. For example, in pharmaceutical services RFID results in fewer errors and enhances inventory management. In direct patient care services, RFID leads to less waiting and more efficient patient transport, along with equipment tracking. In all areas, efficiency and patient safety is enhanced.

In addition to initial cost barriers, another problem to implementation of the RFID system is patient and employee attitudes. From patient interviews, it appears that as long as patient privacy is not invaded after the patient has exited the facility, it would be fairly easy to convince patients of the RFID system's benefits and use the technology to improve their care. They may not volunteer themselves for an under the skin tag, but they would certainly be open to the idea of wearing a wristband. However, the staff is much more resistant to the idea of the tracking system. They do not want to have their every move tracked and every minute of their day documented. Doctors, nurses, and anesthesiologists may even face potential pay cuts as it becomes apparent that they are not using their time efficiently. Hospitals may discover that fewer staff members are needed to address the needs of patients and could eliminate some staff positions.

The age of the facility can also be seen as a barrier to entry. The older the facility, the more difficult and the more costly it will be to implement such technology. In order to have the system work at 100%, it is necessary to have monitors in every room. This is due to the fact that every inch of the facility needs to be "in range" for the system to fully operate at highest capacity. Such equipment is more difficult to install in older, outdated facilities.

Perhaps the biggest consideration when deciding to implement an RFID system is the size of the hospital. It is one thing to implement and maintain this system in a 400+ bed facility, but what if the hospital only has 15-20 beds? Many rural hospitals do not have the patient load to justify such an expense. RFID definitely is a benefit to most urban hospitals, but the relative size of the hospital must play a major part in the decision process.

Overall, we recommend that all medical facilities of a significant size look into the possibility of implementing an RFID system. During the decision phase, each facility should be educated on the full uses and benefits of these systems by a professional in the RFID industry.

Every facility should thoroughly chart potential costs and weigh such costs with the extensive benefits offered by the system. It is possible that some medical facilities would find that the initial cost is not worth it; however the authors believe that many would benefit from the implementation of such a system.

Once a decision to implement RFID has been made, facilities should carefully plan for the changes that will impact the organization. Business processes will certainly need to be modified. The four stages of Business Process Management (BPM) include creating a model process, defining system components (people, procedures, data, hardware, and software), implementing new processes, and assessing results (Kroenke, 2011). By thoroughly addressing all stages of BPM, hospitals should improve the acceptance of the new system and enjoy more benefits and rewards through maximization of the system capabilities. For example, user training should include information that conveys the importance of RFID tracking and its benefits to the organization. Managements' support and belief in the technology can produce a climate of acceptance, and may lead to employee innovation. The facility would be wise to adopt a philosophy of continual improvement of their RFID system in order to identify useful capabilities. Instead of being threatened by the tracking capabilities, employees could be involved in finding more efficient ways of utilizing the technology. Such innovations will lead to further cost and time efficiencies that will improve the overall operations of the facility, while making jobs less stressful and less time consuming.

## CONCLUSION

This paper presents how RFID is a state of the art technology that uses electromagnetic fields attached to tags to identify and track objects. According to McGrady (2010), growth of RFID in medical institutions is expected to continue to increase between 10-15% per year, driven by internal financial pressure to increase competitive edge. This technology can increase patient safety, speed treatments, and provide better follow up treatment. Additionally, RFID can lower direct and indirect labor costs, and can reduce medical errors.

The authors propose that every hospital should, at a minimum, explore the potential of implementing an RFID system in their facility. Each medical facility should begin by weighing the costs versus the benefits in implementing such a system. We believe managers will find that while the initial implementation of the system is very expensive, the benefits will outweigh the

initial cost quickly. In the long run the facility has the potential to save thousands, possibly millions, of dollars if the system is utilized to its entire potential. Managers will find that they are most likely able to cut a significant amount of staff and/or duty hours through more effective time allocation, maintain fewer pieces of equipment more effectively, and closely monitor staff interactions with patients. All of these issues will lead to significant cost savings and reduction in liability. Additionally, the authors believe that many facilities will mostly likely receive better ratings due to improved patient safety, patient satisfaction, and more accurate billing. Based on the findings, the authors highly recommend careful study of the implementation of an active or passive RFID tracking system in every major health care facility in the United States.

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