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*Review Article*

# The advantages and disadvantages of Radio Frequency Identification (RFID) in Health-care Centers; approach in Emergency Room (ER)

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**ABSTRACT**

The major problem at emergency room (ER) is access to specialist when they are elsewhere in the hospital. The nurse pages the doctor about the emergency. The specialists do not respond because they are busy with other patients in other place or something else. Radio Frequency Identification [RFID] can help us to track doctors, nurses or patients to render better health services to cure patients. The aim of this project was first, to identify and discuss the most advantages and disadvantages of the RFID in hospitals, second, to identify and discuss some experience in the entire world. This study reviewed the literature on the RFID applications in healthcare. The literature search was conducted with the help of library, data bank, and also searches engines available at Google, and conference proceedings. For our searches, we employed the following keywords and their combinations: RFID, healthcare, hospital, Medical Errors, Emergency Room, and Emergency Medicine in the searching areas of title, keyword or abstract. Technical reports were excluded since we focused on research papers. More than 53 articles were collected and assessed 26 of them were selected based on their relevancy. It can be used to guide future research in this field. Care providers can monitor their patient, products, and medical staff. To increase quality of care and decrease waiting time, care providers should use RFID technology to track and control patients, professional, and medical products.

**KEY WORDS:** Emergency, Patient, Track, Physician, Hospital, Radio Frequency identification.

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## INTRODUCTION

A nation's ability to adopt new technologies is paramount, affecting everything from the cost of producing capital goods to per capita income.[1] Hospital technology decision-makers now confront a growing pipeline of technology and major medical equipment that challenges traditional capital allocation processes.[2]

Radio-frequency identification (RFID) is a technology that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency (RF) portion of the electromagnetic spectrum to uniquely identify an object, animal, or person.[3]

Butt in 2010 stated, "The recent report self reported medical errors in seven countries Implications for Canada showed that in 2007, 17% or 4.2 million adult Canadians believed that a medical error occurred when they received healthcare services in the previous two years."[4]

Neuenschwander in October 2007 about pros and cons of the RFID tracking told, "RFID systems could also be utilized to track their own going in and coming out (e.g., where they are on campus,

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how long they have been in given patients' rooms, whether or not they washed their hands upon arrival, how long they were on break, and where they spent it.".[5]

***A project that entitled "RFID in Hospitals:*** issues and solutions" discussed about hospital problems in last decade and mentioned, "There is always a crowd of things and people going around in a hospital that need to be tracked. There are doctors, nurses, patients, and visitors who need to be kept track of in times of emergencies. There is an emergency and all the doctors are elsewhere in the hospital. The nurse pages the doctor about the emergency. The doctor responds in some time, but it is too late by then! This is exactly the scenario that needs to be avoided. If the position of the doctors can be tracked on a real time basis, a better arrangement and distribution solution can be had to ensure the availability of at least one doctor in every area of the hospital to take care of such emergencies.".[6]

According to Ajami, " general practitioners, interns, residents and specialists have multiple tasks in several places at the Ayatolahkashani Hospital such as in operation room, different wards, and clinics that obviously decrease quality of care in the Emergency Department.".[7] Information is such a valuable tool to mange and delivers better services.[8,9] Therefore, we need to access information to track medical staff. "Doctors can wear bracelets or badges containing the RFID tags. Usually there are far more nurses in a hospital than doctors, hence even distribution is seldom a problem in their case. However, it is still equally important to keep track of the nurses. For example, keeping track of close contact with patients having infectious diseases is of utmost importance for the health of the hospital staff.".[6]

***Literature Review:*** In some cases the physician on duty at the emergency department is not specialized for the patient's condition and must wait for the qualified specialist, such as an eye-related problem shall wait for an ophthalmologist, and an ear, throat, or nose (collectively referred as ENT) issue should be determined by an otolaryngologist.[10] Clearly, there is an urgent need to conduct a systematic review of literature toward the RFID applications, benefits, limitations and barriers in hospitals, with focus on the ER. Our review aims not only to provide a state-of-art assessment for other researchers but also to offer a useful guidance for implementing RFID-enabled systems for healthcare administrators. The aim of this project is first, to identify and discuss the most advantages and disadvantages of the RFID in hospitals, second, to identify and discuss some experience in the entire world. Specifically the following questions will be answered in this study:

1. What are advantage and disadvantage of applying the RFID in healthcare?
2. What was the experience of usage the RFID in hospitals in different countries?

The stakeholders include patients of the ER, doctors and nurses working in the ER, the staff of the department to which the patient is admitted, and the hospital itself.

The Emergency Room operation process and possible procedural problems have been discussed in detail and shown by Huang Y-C et all in their study which could be of immense help.[10]

Finding a research in healthcare in July 2005 revealed, "According to a study in 1999, health care spending in the United States totaled $1.2 trillion and accounted for 13.3% of the gross domestic product. On the other hand, cost containment in the hospital sector is a key issue in stabilizing health cost at a sustainable level. Despite efforts at controlling hospital costs, empirical evidence shows that constant dollar per capita spending on hospital inpatient care rose by 53% between 1980 and 1993. Further, during the same period, real per capita spending rose by 65% for all types of hospital care and more than 87% for all health services.".[11]

IBM announced, "RFID is the use of radio frequencies to read data electronically that is stored in small devices called tags.".[12,13] Table-I shows some examples of on-going the RFID pilots and applications by country.[14]

To emphasize pros of the RFID Chowdhury and Rajiv reported that " doctors and nurses in their daily activities can save a lot of time searching for medical devices and can focus on their professional duties."[15]

## METHODOLOGY

This study was non-systematic review which the literature on the RFID applications in healthcare was based on a formal research framework. Researchers used a sub-systematic method, which was divided into three phases: literature collection, assessing, and selection. Researchers identified studies which denoted advantages and disadvantages of applying the RFID in healthcare centers. The literature search was conducted with the help of library, data bank, and also searches engines available at Google, and conference proceedings. Since the use of the RFID in healthcare industry is quite recently, Researchers did not limit their search to any published date. For

Table-I: The RFID trials, pilots and applications by country.14

| *Healthcare application* | *Country* |
|---|---|
| Patients safety/ Quality of care/Pharmaceutical/ Management of Assets | US |
| Patients safety/ Management of Assets | Germany |
| Patients safety/ Personnel Support | Taiwan |
| Patients safety/ Quality of care/Pharmaceutical | Switzerland |
| Patients safety/ Quality of care/Pharmaceutical | Canada |
| Patients safety/ Quality of care/Pharmaceutical | Czech Republic |
| Quality of Care | India |
| Patient safety | Italy |
| Patient safety / Management of Supplies | Netherlands |
| Patient safety / Management of Supplies | UK |

our searches, we employed the following keywords and their combinations: RFID, healthcare, hospital, Medical errors, Emergency Room, and Emergency medicine in the searching areas of title, keywords or abstract. Technical reports were excluded since we focused on research papers. More than 53 articles were collected and assessed 26 of them were selected based on their relevancy. The RFID has been applied in a variety of healthcare practices. The last phase followed our proposed research framework and conducted detail analysis with regard to the literature. Researchers proposed some useful suggestions and implications [e.g., the most popular application, the perceived benefits, critical barriers and limitations] for researchers in this area. We first identified the existing problems and challenges faced by healthcare. Then we studied how the RFID was applied in healthcare area to solve or partially solve these barriers. By organizing findings in our collected literature, we identified the benefits and barriers of the RFID adoption in healthcare. These implications can be used to guide future research in this field.

## RESULTS

"The main components of an RFID system include the hardware [tags, readers and antennas] and the software systems. The RFID tags can be passive or active, depending on powering techniques. Passive tags can only communicate with the reader when they are sitting in an electromagnetic field of the reader since they do not have battery power; while active the RFID tags can power the integrated circuits and broadcast the response signal to the reader. An RFID reader scans the tag and sends the tag information to the back-end database system that filters, analyzes, and stores the data and then passes on useful information to other enterprise application systems for further processing. The database system can have multiple readers located in different places sending data through wired or wireless networks.

In addition, enterprise application systems, such as hospital information systems [HIS] and supply chain management systems, can connect to the middleware to retrieve tags information via security protocols. In healthcare, the RFID systems are usually combined with other technologies such as Bluetooth, mobile devices, and sensors for different purposes. Passive the RFID tags are primary used for patient identification and drug authentication while active the RFID tags are mainly used for the tracking purpose.".[16]

The benefits of using RFID in healthcare sector include improved patient safety, prevention and reduction in medical errors, saving in cost, increased efficiency and productivity, elimination of paper based documentation besides reduction in patient waiting time.[15]

Advantages, pros, and Critical success factors towards the RFID adoption are:

1. Top management support and the commitment of leadership, Integrating the data collected, Coordinating among department and starting with the small RFID project.[17]
2. Improving patients' safety(identification and verification pts, patient tracking system, tagging of surgical instrument, security of newborn, specimen management system, Speeding up medical treatment.[18]
3. Improving operational efficiency (better management of medical instrument, analyzing operational inefficiency and Rapidly decreasing cost of the RFID.[19]
4. Eliminating or reducing clinical errors, Improving the work-flow of doctors, nurses and other caregivers, Locating medical staff in real-time which are especially worthy, Helping avoiding thefts and Enabling assets and people tracking in hospital.[20]

Table-II: List of the most relevant areas for RFID applications in healthcare.14

| *Years* | *Up to 2004* | *2005-2010* | *2011 Onwards* |
|---|---|---|---|
| Main uses | Error prevention of products [drug dose, correct blood and treatment, mother/ baby mismatch etc]<br>Patient tagging for error prevention,<br>Locating staff/ staff alarms,<br>Locating assets | Error prevention of products now including auto luer connections and parts,<br>Patient tagging for error prevention,<br>Locating staff/ staff alarms/tags that record incidents, Locating assets/speedy, accurate stocktaking ,<br>Theft prevention,<br>Cost control,<br>Recording procedures[eg for defense of lawsuits]<br>Drug trials compliance monitoring/ prompting, Behavioral studies to optimise operations, Pharmaceutical anti-counterfeiting | Error prevention of products Patient tagging for error prevention,<br>Locating staff/staff alarms,<br>Locating visitors/ visitor alarms/ virtual queuing ,<br>Locating assets/ speedy, accurate stocktaking,<br>Theft prevention , Cost control,<br>Recording procedures[ eg for defense of lawsuits]<br>Drug trails compliance monitoring/ prompting[ taking drugs]<br>Drug trials compliance monitoring/ prompting<br>Patient compliance monitoring/prompting [taking drugs]<br>Behavioral studied to optimise operations, Pharmaceutical ant-counterfeiting Track and trace of most medicines, consumables and assets |

5. Bringing down health care costs but also facilitating automation and streamlining patient identification processes in hospitals[15];
6. Decreasing costs by tracking of goods and retail supply chains[21];
7. Reducing cost and improving efficiency by tracking asset and people, Reducing medical errors to improve patient safety and save lives, Turning reduces medical costs, as much as $1 million annually for a small-scale hospital, Improving operations by actively monitoring asset and patient flow through the hospital, Analyzing the recorded data to improve hospital efficiency and Enhancing patient satisfaction.[16]

Some of the benefits by the actual users are denoted below:

"• Virginia Hospitals in US has deployed the RFID network to track mobile medical equipment at three Virginia hospitals operated by Bon Secours Richmond Health System. The three facilities are St. Mary's Hospital, Richmond Community Hospital and the Memorial Regional Medical Center.
• Birmingham hospital NHS trust in U.K. has tagged patients with the RFID chips to improve safety and ensure that correct operations are carried out on the right patients.
• Blood bank supplies at Saarbruecken Clinic are equipped with the RFID chips so to prevent any confusion or mix ups in regard to blood transfusion and blood treatments. In the first phase, almost thousand bags of bloods are being labeled. The solution makes sure that correct blood is given to each patient." [22]

"Some of the major hospitals in Singapore like, Alexandra Hospital, and The National University Hospital, Singapore General Hospitals had implemented the RFID technologies to track patients, staff and assets. The solution was a huge success during SARS outbreak. Similarly it is seen that there are lots of implementations in countries like China, Philippines, South Korea, Japan, U.A.E. and other technology leading countries. In one of the major surveys in the U.S. on benefits of the RFID technology in healthcare, 70% cited the patient safety as the major factor to implement the RFID. Using the RFID active the RFID wristband tags like the ones provided by Orizin, a patient can be easily tracked across hospital and their movement can be controlled to un-wanted places. We are very much upbeat with the potential of the RFID in healthcare segments. As per some of the major reports, healthcare vertical's consumption of the RFID tags and services will rise from US$ 90 million this year to US$ 2.1 billion in 2016. We feel what we see today is just the tip of the iceberg; the best is yet to come."[22]

***Disadvantages:*** It includes:

1. Iinsufficient budget available, complexity of technology and systems.[17]
2. Cost still very high for providers[19];
3. Prohibitive costs, Technological limitations and Privacy concerns.[16]
4. Information below shows quantitative analysis about implement the RFID in the ER.[23]

## DISCUSSION

According to a study on the RFID in healthcare it was suggested, "The most widely accepted

and adopted application is asset and equipment tracking since it is badly needed by hospitals and does not involve privacy and social issues. Asset tracking applications can reduce theft, improve resource utilization and save costs. A number of pilot tests and small-scale projects in hospitals have proved that. In contrast, people related applications such as patient tracking are more complicated since there are major concerns about privacy issues. One popular research topic is the patient drug compliance since it can largely reduce medical errors associated with the medicine taking process. Although drug administration systems can help improve patient safety, most of them are still in prototype stage and not yet accepted in hospitals. Once social and privacy issues are solved by improved technology and consolidated legislations, hospitals will soon adopt patient related applications to reduce medical errors and improve patient safety. Several studies envision the future of an RFID-enabled smart hospital that uses the RFID and wireless technology to provide a variety of applications. This will benefit vulnerable people such as the elderly. The most benefit is recognized as improved patient safety and reduced medical errors. Besides, healthcare professionals in their daily activities can save a lot of time searching for medical devices. Also, they have real-time access to patient related data, so they can focus on their professional duties. Other benefits include cost saving, improved medical process, and enhanced patient satisfaction. As the healthcare industry is investing more money and efforts, the RFID is expected to be able to help achieve the two goals of reducing costs and improving patient safety. To sum up, the RFID technology offers healthcare practitioners' advantages to improve patient safety, save time, and reduce costs but also causes critical issues for successful implementation. To increase the acceptance and wide use of the RFID in healthcare, more customized the RFID systems, more institutional support, seamless integration with existing HIS, satisfactory security/privacy measures, and mature regulations to protect privacy are needed.".[16]

It is often difficult to make a differential diagnosis in patients admitted to the emergency department with the complaint of shortness of breath. Echocardiography is still the gold standard diagnostic method of heart failure, although its use in emergency departments is limited in terms of both cost and accessibility. Therefore, B-type natriuretic peptide (BNP) and N-terminal pro-brain natriuretic peptide [(NT)-proBNP] have become routine tests in emergency departments in recent years because they are reliable, easy to use and low-cost laboratory tests. American College of Emergency Physicians and European Society of Cardiology recommended the clinical use of natriuretic peptide measurements as an aid in the diagnosis or exclusion of acute heart failure.[24]

Shaker et al. findings showed that comparing three shift works, the highest patient doctor relationship questionnaire (PDRQ) score was for morning (27.1 ± 5.5) and the lowest value was for afternoon shift (23.8 ± 5.3). PDRQ score for night shift was 25.1 ± 6.9 ($p = 0.002$). The results of this study encouraged that patients' satisfaction of relationship with doctors was the lowest in the afternoon and it may be better to implement some strategies to reduce residents' workloads and increase quality of works in the afternoon shifts.[25]

Findings of Yarmohammadian et al showed that their study were categorized into three general categories including requirements (organizational and sub-organizational), barriers (internal and external) of Hospital Emergency Incident Command System (HEICS) establishment, and providing short, mid and long term strategies. These categories are explained in details in the main text.

Regarding the existing barriers in establishment of HEICS, it is recommended that responsible authorities in different levels of health care system prepare necessary conditions for implementing such system as soon as possible via encouraging and supporting systems. This paper may help health policy makers to get reasonable framework and have comprehensive view for establishing HEICS in hospitals. It is necessary to consider requirements and viewpoints of stakeholders before any health policy making or planning.[26]

## CONCLUSION

RFID can prevent mistakes, improve the patients' care, optimize the work flows, and reduce the operating costs in the ER. The advantages of implementation the RFID outweigh disadvantages and it makes the prevention of human error in medicine, ensure easy and fast access to medical staff, equipment, and medicine. It is cost effective. All these factors lead to improvement in quality of care in healthcare sector.

## REFERENCES

1. Comin DA, Hoijn B. An Exploration of Technology Diffusion. American Economic Review. 2010;100(5):2031–2059.

2. Coye MJ, Kell J. How Hospitals Confront New Technology. Health Aff. 2006;1(25):163-173.
3. Rouse M. Definition; RFID (radio frequency identification). April2007;Availablefrom:http://searchmanufacturingerp.techtarget.com/definition/RFID)
4. Butt AR, Mba CHE. Medical Error in Canada: Issues Related to Reporting of Medical Error and Methods to Increase Reporting. MUMJ. 2010;7(1):15-18.
5. Neuenschwander M. Pros and Cons of RFID Tracking. october 2007; Available from: http://www.hospitalrx.com/pdf/IveBeenThinkingRFIDTracking.pdf.
6. Pappu M, Singhal R, Zoghi B. RFID in hospitals: issues and solutions. Consortium for the Accelerated Deployment of RFID in Distribution. 2004:1-12.
7. Ajami S, Ketabi S, Yarmohammadian MH, Bagherian H. Wait time in emergency department (ED) processes. Medicinski Archive. 2012;66(1):34-38.
8. Ajami S, Ketabi S, Saghaeiannejad-Isfahani S, Heidari A. Readiness Assessment of Electronic Health Records Implementation. Acta Informatica Medica. 2011;19(4):224-227.
9. Ajami S, Tavakoli Moghadam,O. A Comparative Study on Health Information Management System with Standards in Ayatolah Kashani Hospital in Isfahan, Iran. Health Information Management. 2006;1(3):63-71.
10. Huang Y-C, Chu C-P, Lin Y-S, Kuo C-H. RFID Applications in Hospitals – A Case Study for Emergency Department 2010.
11. Correa FA, Gil MJ, Redín LB. Benefits of Connecting RFID and Lean Principles in Health Care. Business Economics. July 2005;10.
12. Ajami S, Akbari B, editors. RFID in Earthquake Information Management System: work in progress. Proceeding of Second National Conference Health system, risk management And Disaster 2012; Isfahan, Iran: Health Management & Economics Research Center Isfahan University of Medical Sciences.
13. Ajami S, Akbari B, Yarmohammadian MH, Hejazi M. Evaluation Usage of "Radio Frequency Identification" in Earthquake›s victims tracking Information Management System through viewpoint of Relief Experts.M.Sciences Thesis,Isfahan: Isfahan University of Medical Sciences; 2012.
14. Vilamovska AM, Hatziandreu E, Schindler HR, Oranje-Nassau CV, Vries H, Krapels J. Study on the requirements and options for RFID application in healthcare Identifying areas for Radio Frequency Identification deployment in healthcare delivery: A review of relevant literature. Directorate General Information Society and Media, 2009 European Commission.
15. Chowdhury B, Khosla R. RFID-based Hospital Real-time Patient Management System. Melbourne, Qld 2007:363-368.
16. Yao W, Chu CH, Li Z. The use of RFID in healthcare: Benefits and Barriers. 2010:128-134.
17. Vanany I, Shaharoun ABM. Barriers and critical success factors towards RFID technology adoption in South-East Asian Healthcare Industry. December 3rd – 5th, 2008:148-155.
18. Awang NH. Providing Better Services Through the Use of RFID Technology in Healthcare. Public Sector ICT Management Review. 2008;2(2):22-25.
19. Kanyuk P, Young J. RFID in Healthcare: Novelty or Mass Market. Report BFTC1095. 2004.
20. Fuhrer P, Guinard D. Building a smart hospital using RFID technologies: use cases and implementation. Fribourg (Suisse): Department of Informatics - University of Fribourg; 2006.
21. IBM. IBM Wireless Solutions, RFID: Real solutions for health care. 2006; Available from: http://docs.google.com/viewer?a=v&q=cache:Ly_Fd1rGYREJ:www-304.ibm.com/easyaccess/fileserve%3Fcontentid%3D201283+IBM+Wireless+Solutions,+RFID:+Real+solutions+for+healthcare&hl=en&pid=bl&srcid=ADGEESgNs2UH8PejvbQ3 ZcV7SKRBEAJLK7p7SaGepSy2Z Pgx2aqeqiWJcA_efW0VDtyLn8g3dJ2QaidEXRsNaBGzp7ikuNlkfHdER7D5ca 97Ui WAFGzceigI0a_TNvHvTRxwH2b10VNi&sig=AHIEtbSsjL4ViUjzSh7jxaRsFGSxh5mLbw.
22. Agrawal P. RFID in Healthcare. Asian Hospital & Healthcare Management Issue 14 | 2007. Available from: www.asianhhm.com/information.../orizin_interview_rfid.htm.
23. Kuo F, Fu CJ, Liu L, Jin MH. The implement of RFID in Emergency Medicine. 2007:125-30.
24. Cimilli Ozturk T, Unluer EE, Denizbasi A, Guneysel O, Onur O. Can NT-proBNP be used as a criterion for heart failure hospitalization in emergency room?. J Res Med Sci. 2011;16(12):1564-1571.
25. Shaker H, Iraji S, Emami-Naini A, Motei-Jouibari MA, Vatankhah N, Ghavami Y. Effect of shift work on patient-doctor relationship in emergency department. J Res Med Sci. 2011;16(11):1495-1499.
26. Yarmohammadian MH, Atighechian G, Shams L, Haghshenas A. Are hospitals ready to response to disasters? Challenges, opportunities and strategies of Hospital Emergency Incident Command System (HEICS). J Res Med Sci. 2011;16(8):1070-1077.