

# Radio Frequency Identification (RFID) technology and patient safety

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**Background:** Radio frequency identification (RFID) systems have been successfully applied in areas of manufacturing, supply chain, agriculture, transportation, healthcare, and services to name a few. However, the different advantages and disadvantages expressed in various studies of the challenges facing the technology of the use of the RFID technology have been met with skepticism by managers of healthcare organizations. The aim of this study was to express and display the role of RFID technology in improving patient safety and increasing the impact of it in healthcare. **Materials and Methods:** This study was non-systematical review, which the literature search was conducted with the help of libraries, books, conference proceedings, PubMed databases and also search engines available at Google, Google scholar in which published between 2004 and 2013 during February 2013. We employed the following keywords and their combinations; RFID, healthcare, patient safety, medical errors, and medication errors in the searching areas of title, keywords, abstract, and full text. **Results:** The preliminary search resulted in 68 articles. After a careful analysis of the content of each paper, a total of 33 papers was selected based on their relevancy. **Conclusion:** We should integrate RFID with hospital information systems (HIS) and electronic health records (EHRs) and support it by clinical decision support systems (CDSS), it facilitates processes and reduce medical, medication and diagnosis errors.

**Key words:** Identification, medical errors, patients, radio, safety, technology

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## INTRODUCTION

At least 44,000 people, and perhaps as many as 98,000 people, die in hospitals each year as a result of medical errors that could have been prevented.<sup>[1]</sup>

Radio frequency identification (RFID) is a wireless technology capable of automatic and unambiguous identification without line of sight by extracting a unique identifier from microelectronic tags attached to objects.<sup>[2]</sup>

The RFID is a technology that uses radio waves to transfer data from an electronic tag, called RFID tag attached to an object, through a reader for the purpose of identifying and tracking the object. The RFID is already used to track and trace the victims in a disaster situation. Data can be collected in real time and be immediately available to emergency personnel and saves time by the RFID. Crisis management teams, hospitals and emergency personnel, have access to data through a computer database.<sup>[3]</sup>

The RFID was the first explored in the 1940s as a method to identify allied airplanes.<sup>[4]</sup> Today, the

RFID system have been successfully applied to the areas of manufacturing, supply chain, agriculture, transportation, healthcare, and services to name a few.<sup>[5]</sup>

Medical errors could be prevented by building a safer healthcare system. Recently, the RFID has been applied in hospital management. The RFID is valuable for quickly retrieving patient information and monitoring patient locations in the hospital.<sup>[6]</sup>

In the past decade, the risk of harm caused by medical care has received increasing scrutiny. The growing sophistication of computers and software should allow information technology to play a vital part in reducing that risk — by streamlining care, catching and correcting errors, assisting with decisions, and providing feedback on performance.<sup>[7]</sup> To our knowledge, there have been few previous reports based on on-site experiments showing that the RFID is suited for usage in a hospital, specifically for medication delivery and mapping nurse practice workflow.<sup>[8]</sup> Organizational resources and technical structures such as hardware and software are very essential requirements in the redesign of electronic projects.<sup>[9]</sup>

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Chao *et al*, in a study titled improving patient safety with RFID and mobile technology announced “These medical errors can be classified into five categories: poor decision making, poor communication, inadequate patient monitoring, patient misidentification, inability to respond rapidly and poor patient tracking. Employing innovative information technologies in correcting these deficiencies and meeting the Joint Commission on Accreditation of Healthcare Organization (JCAHO) patient safety goals is the current trend in enhancing patient safety”.<sup>[10]</sup>

The result showed that the RFID adoption though assigned with low level of awareness; adoption capital recompense and infrastructural challenges in the Nigeria health sector in particular also has high and great tendencies to thrive. The result of the second research question revealed that the Nigerian health care service delivery can harness the benefits of the information technology (IT) solution system to function in its clientele servicing in forms like authentication and identification of personnel, patients’ data and blood verification; drug dispensary among others.<sup>[11]</sup>

One study shows, “An alarming statistic from an American healthcare organization shows that an average of 195’000 people in the USA died in hospitals in each of the years 2000, 2001 and 2002 as a result of potentially preventable, in-hospital medical errors asserts that “the problem is not bad people in health care — it is that good people are working in bad systems that need to be made safer”.<sup>[12]</sup>

Barriers and critical success factors towards RFID technology adoption in South-East Asian healthcare industry showed that most respondents believed that barriers towards the RFID adoption are: (1) lack of information; (2) insufficient budget available; (3) complexity of technology and systems. Critical success factors are: (1) top management support and the commitment of leadership; (2) integrating the data collected; (3) coordinating among departments; and (4) starting with small the RFID project.<sup>[13]</sup>

Yao *et al*, revealed, “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 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.”<sup>[14]</sup>

### How the RFID system works

The most RFID systems consist of tags that are attached to the objects to be identified. Each tag has its own “read only” or “rewrite” internal memory depending on the type and application. A typical configuration of this memory is to store product information, such as an object’s unique ID manufactured date, etc. The RFID reader generates magnetic fields that enable the RFID system to locate objects (via the tags) that are within its range. The high-frequency electromagnetic energy and query signal generated by the reader triggers the tags to reply to the query; the query frequency could be up to 50 times per second. As a result communication between the main components of the system i.e. tags and reader are established. As a result large quantities of data are generated. Supply chain industries control this problem by using filters that are routed to the backend information systems. In other words, in order to control this problem, software such as Savant is used. This software acts as a buffer between the IT and the RFID reader.<sup>[15]</sup>

### Components of an RFID system

The RFID system consists of various components which are integrated in a manner defined in the above section. This allows the RFID system to deduct the objects (tag) and perform various operations on it. The integration of the RFID components enables the implementation of an RFID solution.<sup>[15]</sup> The RFID system consists of following five components:

- Tag (attached to an object, unique identification).
- Antenna (tag detector, creates magnetic field).
- Reader (receiver of tag information, manipulator).
- Communication infrastructure (enable reader/RFID to work through IT infrastructure).
- Application software (user database/application/interface).

In this study the role of the RFID technology in improving patient safety and increase the impact of this technology in the health care industry with was discussed.

## MATERIALS AND METHODS

This study was non-systematical review, which the literature search was conducted with the help of libraries, books, conference proceedings, PubMed databases and also search engines available at Google, Google scholar in which published between 2004 and 2013 during Febuary 2013. In our searches, we employed the following keywords and their combinations; RFID, healthcare, patient safety, medical errors, and medication errors in the searching areas of title, keywords, abstract, and full text.

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errors, and medication errors in the searching areas of titles, keywords, abstracts, and full texts. The preliminary search resulted in 68 articles. After a careful analysis of the content of each paper, a total of 33 papers was selected based on their relevancy.

## RESULTS

The RFID technology used for three purposes: tracking, inventory management, and validation. Each of these characteristics could provide benefits that could yield cost savings and improved productivity.

### Tracking

The RFID is used to follow a product through the supply chain and clinical workflow. It can be used to track a product to a particular patient and identify the clinician who used to say product to a patient. The RFID reduces the amount of time involved in locating or tracking, thereby making the process less cumbersome.<sup>[16]</sup>

### Inventory management

Inventory management is the most important aspect of managing an organization. It enables managers to monitor usage patterns throughout their organization. It is a complex process that asks what (what is in stock), how (how much is it), who (who has it), where (where is it), and when (when to reorder). The RFID helps manage patient inventories so that the right assets are available when and where they are needed.<sup>[17]</sup>

### Validation

Validation assures that an action has taken place or that the desired item is on hand. Like tracking, the ability to validate through the RFID technology can reduce medical errors, check productivity, and help construct necessary documentation for administrative and audit purposes. The validation is an effective method of ensuring quality in a healthcare setting. The most important validating function is to verify that the patient being treated is, in fact, the right patient and that the treatment that is about to occur is appropriate.<sup>[18]</sup>

Studies examining the relationship between the use of RFID and patient safety have been expressed as follows: Patient safety will be improved and costs as well as medication errors will be reduced considerably.<sup>[19]</sup>

The RFID can help nurses to quickly identify patients and their corresponding medicine.<sup>[20]</sup>

Using the RFID technology, such administration system provides automated medication verification for inpatient's medicine doses and generates corresponding

medication evidence, which may be audited later for medical dispute.<sup>[21]</sup>

The RFID had great potential for reducing medical errors and nurse workload with high efficiency.<sup>[22]</sup> The information technology has to support healthcare in developing practices and nursing patients without confronting any complications or errors. One critical and important part of healthcare is medication care, which is very vulnerable for different kind of errors, even on fatal errors. Thus, medication care needs new methods for avoiding errors in different situations during medication administration. This poster represents an RFID-based automated identification system for medication care in a hospital environment.<sup>[23]</sup> The RFID makes the prevention about human error of medicine, easy and fast access to medical staff, equipment, medicine. It is cost effectiveness. All of these factors cause to increase the quality and quantity of care in the healthcare sector.<sup>[24]</sup>

In a study that its problem was mislabeling of tissue specimens in their gastrointestinal and colorectal surgery endoscopy units and most labeling errors have been due to either the wrong patient label or no label being affixed to a specimen bottle. As a result, an initiative was created to reduce the number of specimen-labeling errors. This initiative involved the application of radiofrequency identification (RFID) technology to specimen bottles, moving to a paperless pathology requisition system and confirmation of the correct site and correct patient by both the endoscopy nursing staff and the endoscopist for each specimen bottle. Their results confirmed that these data confirm that the initiation of a new specimen-labeling system that uses RFID technology, a paperless requisition process, and confirmation of the correct site and correct patient by two healthcare providers significantly decreased specimen-labeling errors at every level in a high-volume endoscopy center.<sup>[25]</sup> Implementation of a practical combined the RFID system that is fully integrated with the clinical system, which one day could be employed in large scale for improving clinical workflow and minimizing medical errors.<sup>[26]</sup>

Wisely Aware RFID Dosage (WARD) system, which based on an integration of barcodes and RFID tags, to demonstrate effective and safe patient care environment, for preventing the risk of medication error.<sup>[27]</sup> The application of RFID can bring hospitals towards the integration of technology benefits and improved medical safety.<sup>[28]</sup>

The RFID by removing the human factor and would improve patient safety by eliminating the current surgical sponge count protocol.<sup>[29]</sup>

Table 1 shows some examples of promising completed or ongoing the RFID trials, pilots and applications by country.<sup>[30]</sup>

**Table 1: The RFID trials, pilots and applications by country<sup>[30]</sup>**

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

Most RFID applications in health care organizations in the above table, ultimately, patient safety has expressed that safety by Reducing medical errors, and increase the quality of pharmaceutical and diagnostic services is achieved.

The mobile nursing care system using RFID technology strengthens the capabilities of staff to track patient's vital signs across various locations and in different medical facilities. The Mobile Intelligent Medical System (MIMS) includes vital sign monitoring and alarming services, mobile nursing applications, and rule-based clinical decision support in a mobile nursing environment. The system continuously monitors critically ill patients with the objective of reducing the risk of serious harm resulting from the slow provision of health care. Further, we also believe the system can be extended to most medical domains and integrated with other hospital information systems. With more medical centers linked into the system, the MIMS will bring better and safer medical services to the healthcare industry.<sup>[31-33]</sup>

The RFID technology has tangible benefits such as reduced cost, time, human resources, and prevention theft.<sup>[16]</sup>

## CONCLUSIONS

In the healthcare industry, there are other advantages for example; increase accuracy tasks, reduce human errors, improve safety, and patient satisfaction. No doubt, in coming years, using of the RFID will be a requirement in the healthcare industry.

Although, the sole usage of RFID will not be able meet expectation of health care organizations. If it is used alone, health care organizations will be faced with numerous challenges. But, if we integrate it with hospital information systems (HIS) and electronic health records (EHRs) and support it by clinical decision support systems (CDSS), it facilitates magically processes and reduce medical, medication and diagnosis errors.

## Summary points

What was already known on this topic?

- There are critical successes in improving health services for patients through tracking (staff, patients, and properties), inventory management, and validation (medication, documents, treatment, and specimen).
- There are barriers to adopt the RFID that can classify into; lack of information, insufficient budget available, and the complexity of technology and systems.

What this study added to our knowledge?

- This technology can facilitate to access individuals (Medical staff and patients) and shorten wait time of care processes.
- The RFID technology has tangible benefits such as reduced cost and time, reduced human resources, theft prevention, improve productivity.
- In addition, in the healthcare industry, there are also intangible benefits include increasing accuracy tasks, refining business processes and reduce human errors, which will ultimately improve safety and patient satisfaction.
- Use of the RFID in health care industry alone will be faced with numerous challenges.

## Highlights

- To minimize medical errors and improve clinical workflow, we can implement the RFID system with the clinical system.
- If the RFID integrate with hospital information systems (HIS) and Electronic Health Records (EHRs) and supported by clinical decision support systems (CDSS), it can facilitate processes, reduce medication and diagnosis errors, and increase patient safety.

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