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INTRODUCTION

REVIEW OF LITERATURE

NEED/IMPORTANCE OF THE STUDY

STATEMENT OF THE PROBLEM

OBJECTIVES

HYPOTHESES

RESEARCH METHODOLOGY

RESULTS & DISCUSSION

FINDINGS

RECOMMENDATIONS/SUGGESTIONS

CONCLUSIONS

SCOPE FOR FURTHER RESEARCH

ACKNOWLEDGMENTS

REFERENCES

APPENDIX/ANNEXURE

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BOOKS

- Bowersox, Donald J., Closs, David J., (1996), "Logistical Management." Tata McGraw, Hill, New Delhi.
- Hunker, H.L. and A.J. Wright (1963), "Factors of Industrial Location in Ohio," Ohio State University.

CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

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- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

CONFERENCE PAPERS

- Garg Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–22 June.

UNPUBLISHED DISSERTATIONS AND THESES

- Kumar S. (2011): "Customer Value: A Comparative Study of Rural and Urban Customers," Thesis, Kurukshetra University, Kurukshetra.

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- Garg, Bhavet (2011): Towards a New Natural Gas Policy, Political Weekly, Viewed on December 17, 2011 http://epw.in/user/viewabstract.jsp

ROLE OF RFID TECHNOLOGY IN HOSPITALS

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ABSTRACT

The role of technology in hospitals has been increasing day by day due to the developments in technology and the advantages of using the same. RFID has a critical part to play in access control, tracking patients and various equipments in a hospital. Implementation of Radio Frequency Identification in hospitals will offer many benefits to the patients as well as to the hospital management. This paper briefly describes the role of RFID in hospitals. It also discusses the types of RFID, its applications in hospitals and cost of implementation of it. The study provides the recommendations for implementing RFID Technologies in hospitals in order to obtain its real benefits.

KEYWORDS
RFID, Hospital, equipments, technology

INTRODUCTION

RFID has a critical part to play in tracking various equipments in a hospital. A hospital even a medium sized has several thousand assets such as IV Pumps, pulse oximeters, ventilators Wheel Chairs, different type of stretchers, etc. These assets keep moving between different floors and wards of the hospital. Finding and retrieving these assets is often dose manually. Often doctors and nurses send out the hospital boys in search of them. This process is highly unorganized and it reduces productivity of the staff. Moreover it consumes precious time and in a rare case may also affect the patient's treatment process. Moreover the staff engaged in this search and retrieve process is often unhappy to do such tasks. Also the equipment itself is used with poor efficiency. Frustrated medical staff and unsatisfied patients naturally bring down the revenues and hurt the reputation of the hospital.

RFID can provide an effective solution to the above problem. The equipments, which are usually always searched for can be tagged with a unique identification number embedded in a RFID tag microchip. Such a tagged equipment can now be tracked anywhere in the hospital. The tracking system would display on a desktop or handheld the current location of the equipment. It can also display the history of locations where the equipment was kept and also identify the staff, which handled it. The RFID system can also be used to generate various MIS reports whereby the senior staff can understand the usage patterns of particular equipment. Reports showing the maintenance record of any equipment can also be generated. Senior staff can detect any mishandling of the equipment. Tagged equipment is also difficult to steal from the premises. RFID readers can operate on frequencies different than those used by other medical telemetry systems. Hence any possibility of interference is ruled out. Since, RFID is a wireless technology; it's easy to re-configure it as per the new layouts.

Doctors, when they visit each patient's for regular examination, have to manually note down the patient conditions. This diagnosis information has to be then again re-entered in the system. This consumes considerable time and also often leads to errors. RFID can provide an effective solution to this. RFID enabled wrist bands can be tried to patient's wristband. The band holds a unique identification number for each patient. The staff can be given a handheld band reader. Whenever the reader is waved over the band, the reader would instantly display key patient information such as patient's ailment detail, treatment history, and also insurance policy information. The staff can enter more updated information instantly after diagnosing the patients. RFID works through bedcovers or clothing, hence a patient doesn't have to physically move his/her hand or leg to get the tag read. The same wristband can also be used to track patients. Some treatments require patients to go through a series of sections in hospital. For example, a patient would be required to visit the laboratory for blood check up, then to the X-ray room and MRI scanner room and so on. In this case RFID system would capture patient's movement and update the system. If a patient is erroneously taken to a wrong section, then it can also alert the medical staff accompanying the patient. If a patient or staff tries to tamper with the band, then an alert can be sent to the respective authorities.

OBJECTIVE OF THE STUDY

The broad objective of this study was to study the role of RFID in hospitals and explore the possible applications of RFID in the hospital. Since not many hospitals have ever deployed an RFID system and the technology itself being comparatively, the study would provide some valuable insight into the actual working and implications of RFID in the hospital.

METHODS

The nature of study was descriptive and based on the secondary sources such as articles in journals and published books and internet material from the valid sources.

ROLE OF RFID TECHNOLOGY IN HOSPITALS

Equally important as the tags are to the successful deployment of an RFID system is the reader, which energizes the passive tag and receive the information from it on demand. The reader, first and foremost activates the tags that are within its theatre of control, causing them to transmit their information to the reader. Second, it serves as the interface between the theatre of operations (where the tags live) and the system that collects, analyzes, and distributes the massive volumes of data generated by energized tags (Shepard, 2005).

The RFID reader sends a pulse of radio energy to the tag and listens for the tag's response. The tag detects this energy and sends back a response that contains the tag's serial number and possible other information as well (Simson Garfinkel, 2006). RFID readers are capable of automatically recognizing and distinguishing all the RF tags within their reading field (SATO Solutions, 2004). Since is a reader able to identify a particular tag, the system can claim to have identified the object to which the tag is attached (Bhatt, 2005). This capability allows the RFID reader to simultaneously process all the data and provide for efficient material handling, packaging, and sorting of inventory. Not only will these RFID readers be able to track tagged items and equipment, but they can also be used to track

patients (i.e. in hospitals) (SATO Solutions, 2004). The reader is often connected to some kind of a processor that collect the data before passing it on to the databases and applications that live behind it. There the applications analyze the data, process it, and generates the stuff of management reports and dashboard displays (Shepard, 2005). In simple RFID systems, the reader's pulse of energy functioned as an on-off switch, in more sophisticated systems, the reader's RF single can contain commands to the tag, instructions to read or write memory that the tag contains, and even passwords.

RFID readers are usually on, continuously transmitting radio energy and awaiting any tags that enter their field of operations. However for some operations, this is necessary and could be undesirable in battery – powered devices that need to conserve energy. Thus, it is possible to configure an RFID reader so that it sends the radio pulse only in response to an external event. Like the tags themselves, RFID readers come in many sizes. The largest reader might consist of a desk top personal computer with a special card and multiple antennas connected to the card through shielded cable. Such a reader would typically have a network connection as well so that it could report tags that it reads to other computers. The smallest readers are the size of a postage stamp and are designed to be embedded in mobile telephones (Simson Garfinkel, 2006).

TYPES OF RFID

INDUCTIVE COUPLING

A very common type of RFID implementation is the "inductive coupling system". This works in the HF (high - frequency) range at close distances. The system consists of a powered reader and a passive tag. The passive tag receives power from the reader by means of a scientific principle called inducting coupling. Basically, the principles states that power can be transmitted from one inductive circuit (the reader) to another inductive circuit (the un powered tag) if there is a shared magnetic field (coupling) between them. Once power is fed to the tag through this coupling, the integrated circuit in the tag can send data to the reader using the same waves of electromagnetic energy sent by the reader. Typical applications for inductive coupling RFID tags include: RFEAS (electronic article surveillance), smart cards, access control, apparel, baggage control, biometrics, item level tagging, libraries, and transport.

TABLE-1

Frequency area	HF 13.56 MHz
Distance	Within 120 cm vicinity
Data Carrier	Communication passive, Energy supply passive
Serial Number:	64 bit
Data capacity:	<1 kbit EEPROM

BACKSCATTER TECHNOLOGY

RFID tags that use back scatter technology reflect back to the reader a portion of the radio waves that reach them. Data can ride along the reflected signal through a process called modulation. Compared to the HF that is present in inductive coupling systems, the UHF (Ultra – High frequency) frequencies used here are capable of operating at a greater range. Both the communication and energy supply data carriers are passive and work similarly to two- way remote control units. The RF reader writer is transmitting the signal in which the transponder generates the necessary energy to bounce back a mirror signal which is modulated back to the RF reader- writer. Typical applications include: handling, and supply chain pallet and case tagging.

TABLE-2

Frequency area	UHF 860-950 MHz
Distance	Long range around 3 to 4m
Data Carrier	Communication passive, Energy supply passive
Serial Number:	96 bit
Data capacity:	<0 to 2K bytes information WORM

PASSIVE SYSTEM

The battery-assisted passive system relies on a battery located inside the tag as its energy supply. The communication data carrier is passive and the transponder functions similarly to a smaller "smart label" tag, but the energy supplied to the IC inside the tag is provided by the battery. Typical applications using back scatter semi-active RFID tags include: electronic toll collection.

TABLE-3

Frequency area	UHF 860-950 MHz, UHF 2.45 GHz
Distance	Long range around 4 to 8m
Data Carrier	Communication passive, Energy supply Active
Serial Number:	10 digit number ID

OPERATING FREQUNCIES

Similar to your radio tuning into different frequency channels to listen to different stations, RFID tags and readers must both be tuned to the same frequency in order to communicate (SATO Solution, 2004). The RFID tags and readers operate within several distinct frequency ranges, each of which is intended for specific application characteristics (Shepard, 2005). The most regularly used frequencies among RFID systems are low-(around 125 KHz), high-(13.56 MHz) and ultra-high frequency (860-950 MHz) Radio waves behave in a different way at different frequencies, so you must choose the best frequency for the correct application (SATO Solution, 2004). Low frequency devices (30 to 300 KHz) are typically found in passive tags and used in short range applications such as livestock identification and for antitheft systems in automobiles.

A typical device would operate between 125 and 134 KHz. High frequency devices (3-30 MHz) are used most commonly in smart card and smart label applications such as baggage tracking or small product labeling; typically systems operate in the range of 13.56 MHz. Very high frequency devices (300 MHz to 3GHz) are primarily used in highway toll – collection applications. In the United States, systems typically operate at 900MHz or 2.5GHz; in Europe, similar systems operate in the 5.8 GHz range (Shepard, 2005)

TABLE-4

	Low Frequency	**High Frequency**	**Ultra High Frequency**
Operating Range	125KHz	13.56MHz	860 – 950MHz
Read Range	10cm	1m	Up to 3 m
Power Consumption	Low	Moderate	High
Data Transfer Rate	Slow	Moderate	Fast
Application	• Point-of-Sale • Small scale Retail application	• Library systems • Patient identification	• Airline baggage tag • Tracking of controlled drugs • Pallets • Cases

NETWORK

Most RFID tags transmit a number or more, so what does a typical reader do with a typical 96-bit number in most cases, the reader sends it to a computer. What the computer does with the RFID code depends on the application. With an access- control system, the computer might look to see if the RFID number is present on a list of numbers that's allowed access to a particular door or location. If the number is present, the computer might energize a solenoid that would unlock the door. (Simson Garfinkel, 2006). An RFID network generates a continuous stream of data. Because of its sheer volume, this data needs to be handled very carefully. In the world of connected objects, the goal is to have efficient RFID networks that provide the right information to the right application at the right time (the "3 Rs") and make enterprise – management systems event- driven (Bhargava, 2007).

NATURE OF RFID DATA

RFID data has some similarities with other streaming data, such as stock trades, but it is still very different.

HIGH VOLUME

RFID interrogator read any tag within the read range, generating a huge amount of RFID events.

NON – CONTEXTUAL

An RFID tag is read as it events the vicinity of an RFID interrogator, and an RFID event is generated and routed over the network. At the lowest level, the event is just a tag ID, a reader ID and the time last seen. The broadcasting of each RFID event to all parties creates too much noise, however, and not every application needs a particular event. The result is more traffic on the network, and applications get bulkier and slower because they have to process every event.

SPURIOUS READER

Because of the wireless nature of RFID technology, RFID tags are read any time they come within the read range on an interrogator. If the receiving and shipping portals are close and a tag passes through the receiving portal, a spurious EPC read may occur at the shipping portal as well. Spurious reads can also happen due to human error. A forklift carrying RFID – tagged inventory may take a wrong path, for instance, resulting in spurious reads. From an application standpoint, such reads need to be discarded by putting business rules or appropriate checks and balances in place.

NON TRANSACTIONAL READS

If a forklift carrying tagged material passes through a reader's vicinity three times, three different events are generated for the same tag, even through only one is relevant to the application; this might happen if an operator were to overlook something and back up the forklift to correct the mistake. Two of the three resultant reads would be spurious and would need to discarded, either by the network or by the applications consuming the data. The later choice would increase traffic on the RFID network. Applications need logic to sieve out such spurious events, making them bulky.

SHORT READS

RFID data becomes obsolete quickly as a tag moves to the next stage in a business process. If the finished product is shipped out of a factory, the complete history of that tag be moved to an archival database, or even discarded (as opposed to keeping it in the active database and increasing the cost). RFID technology leads us to a world of connected objects, enabling inventory to speak for its presence and drive processes, as opposed to processes driving inventory (Bhargava, 2007).

CONVERTING RFID DATA INTO INFORMATION

The volume of RFID data makes it imperative to handle that data very carefully, at the proper time and the right place in the RFID network. The main difference between data and information is that information has a context associated with it and is valuable to certain processes or applications with minimum interpretation.

Consider the example of receiving RFID – tagged goods at a receiving dock door. As an RFID interrogator receives inventory, many RFID read events are generated. Raw RFID data consists of individual RFID reads, stored as separate events in the repository. If all these EPS reads were collected and compared with an advance shipping notice (ASN), that would translate to more meaningful information. These multiple RFID reads could be stored as a single business event, called "receiving," would be transmitted to a receiving application, to send out notifications to the sender of those tagged goods. In a supply chain dealing with perishables, a business event called "state" would be very helpful, compared with just a raw RFID read. As an EPC was read in the supply chain, the RFID network could evaluate the freshness of the product using master data. If the EPC were read past the expiration data, then a business event called "state" would be stored in the RFID network. Anytime this EPC was read again in the supply chain, the RFID network would look for a state event and stop the product from going further without any additional evaluation. A single physical read may lead to multiple business events. To turn RFID data into meaningful information, one needs to convert and authenticate it into events using business rules, store business events (such as "receiving" or "state") and route them to the right application.(Bhargava, 2007)

EVENT ROUTING

An RFID network may generate high volumes of streaming RFID reads, while subscriber applications may receive RFID reads in two ways

- Every EPS (or auto – ID) read is sent to all subscribers of an RFID network.
- Subscribers receive only processed events they have requested

Comparing this with Internet Protocol (IP) networks, the first strategy is similar to a hub, where all IP packets are broadcast to every device connected to that hub. In an RFID network, this strategy creates unnecessary traffic and puts the burden on the application to sieve out the "interesting" events. In a smart RFID network, raw events are pre-processed and converted to business events before being passed to the subscriber applications. As information flows in a company's RFID network, it may change it's from and content. (Bhargava, 2007)

APPLICATION – DRIVEN SMART RFID NETWORKS

Data becomes valuable information if it is relevant to a recipient. In an application-driven RFID network, applications define the rules for processing RFID reads. The network layer executes those rules for organizing RFID data and then delivers quality information to its subscribers. The most common example would be an RFID network providing a location service. Anytime an application needed to know the last location of an EPC, it could query the RFID network to obtain it. The topology of RFID interrogator networks depends upon the tracking and tracing capabilities needed to achieve enhanced process efficiency, better inventory control and improved business intelligence. The middle step of converting RFID data information is vital for successful RFID network implementations, because of the sheer volume. (Bhargava, 2007)

PRIVACY AND SECURITY CONCERNS

In global context "privacy" is understood in different ways by different individuals, across many cultures and sectors. Privacy has traditionally been discussed along two vectors:

- As a fundamentals human right, including the right to be free from unreasonable search and seizure or intrusion.
- As protection of personal information (Simson Garfinkel, 2006).

A part from the technical concerns of RFID, there is a deeper concern brewing about the unauthorized security and invasion of privacy made possible by the widespread deployment of RFID tags (Shepard, 2005). Privacy activist have raised alarms over RFID technology. Indeed, given the fact that 915MHz tags can be read from a distance of 10 feet or more, these is serious public concern over the ability of an electronic intruder to activate the tag on an unsuspecting citizen and download the information contained in it = or worse, track the person's movements throughout the day (Shepard, 2005). Unlike most, other privacy – invasive technologies, it allows observes to learn where the subject is physically. Indeed, not only does the profile that RFID technology helps construct, contain information about where the subject is and has been, but RFID signifies travel with the subject in the physical world, conveying information to devices that otherwise wouldn't recognize her, and that can take actions based on that information.

How much should one worry about RFID privacy threats? One might say that RFID privacy problems are inconsequential because passive tags have a short read range, yet this doesn't seem reassuring. Theoretically, passive tag systems can be read a maximum distance of up to 20 meters. Moreover, readers can

effectively invade privacy even with much shorter reading ranges. One can embed an RFID reader, invisibly, in floor tiles, carpeting, or doorways. A read range of only a few feet is entirely adequate to track people coming through a door (Weinberg, 2006).

One characteristic of RFID will to some extent ameliorate the privacy threat: while strangers can collect RFID data from tags on goods or documents in a person's possession that data isn't necessarily linked to the name or other personally identifying information. In some situations through, giving rise to information privacy concerns, sensitive information I born already attached to the data subject's name or other personally indentifying information. Think of credit-card purchase information .RFID tag information, by contrast, while attached to anyone's name or personally identifying information (Weinberg, 2006).

In order to understand RFID privacy threat, one need to distinguish situations in which some data collector has drawn a link between the name (and other personally identifying information) and data an RFID tag carry, from situations in which there is no such link (Bhargava,2007). Further, accelerating the move to control RFID privacy is the drug industry, which has serious concerns about the customer protection due to Health Insurance Portability and Accountability Act (HIPAA) requirements as well as drug counterfeiting, both of which can be mitigated through the judicious use of RFID. Wal-Mart, clearly one of the most active proponents of RFID deployment, recently announced that it would require all drug manufacturers that supply prescription painkillers and other drugs subject to abuse and theft to mark the drug containers with RFID chips by April 2004 (Shepard, 2005).

Perhaps no signal application of RFID technology has generated more controversy than the implantation of RFID chips into people. Implantable RFID tags, VeriChip the most popular of them are typically small glass cylinders approximately 2 or 3 mm wide and between 1 and 1.5cm long. Inside the glass cylinder are a microchip, a coiled antenna and a capacitor for energy storage. Microchip are typically implanted under the skin of the arm (in human beings) or the back of the neck (in laboratory animals) with a 12-guage needle. Implantable RFID chips are typically read through use of an intense magnetic field operating at radio frequency of 100 KHz to 15MHz. As it is promoted, the implanted chip is the ultimate security device: an unforgeable identification number that cannot be lost or stolen, each VeriChip has a unique serial number. The serial number is programmed into the computer that control access to a building or a set of confidential files, and if he person whose hands wave sin front of a reader has an approved serial number, the computer grants access. A second application that is promoted by the VeriChip is for tracking patients and medical records, the serial number on the implanted chip can be used as an index into medical records. In October 2004, the food and Drug Administration (FDA) ruled that the serial number inside the VeriChip could be linked to healthcare information (Simson Garfinkel, 2006). RFID technology, in sum can present substantial privacy threat. It would be desirable to design RFID system so that they don't generate these threats. If the system fails to protect privacy through good technical design, these threats could be addressed through restraints on information use and sharing (Weinberg, 2006).

Ironically, even though RFID solutions are sometimes offered as an enhancement to security, the technology itself presents certain vulnerabilities. As in any enterprise system, security considerations of an RFID systems – ensuring the authenticity of the information stored on the tags themselves, securing the transmission of information between the tags and readers, and ensuring overall application and infrastructure security (Bhatt, 2005). The principal purposes of data security are twofold : to safe guard the privacy of the data that is being transmitted between communicating devices and ensure that the information travels from the transmitter to the receiver unchanged, and to verify that the sender really is who they say they are. The first of these responsibilities is handled through encryption and authentication procedures. Encryption is a technique that effectively scrambles the content f a transmitted message in such a way that it can be decoded only by someone with the appropriate key. The second is through non-repudiation is a technique that makes it possible for a receiver to be satisfied that the message claiming to have been transmitted by a specific source really did come from that source (Shepard, 2005). Physical security measures involve efforts to prevent both corruption of tag data and interception of communication between tags and readers. For instance, a malicious tag reader that is not a part of an RFID system can attempt to read tags in its vicinity. Wireless security focuses on securing the communication pipe between the readers and tags since this communication can be intercepted using wireless sniffing and spoofing devices. Any security- sensitive application must carefully weigh the risk of both interception or alteration of tag-to-reader and reader-to tag communications (Bhatt, 2005).

RFID APPLICATIONS

RFID applications fall into two principal categories. The first includes short range applications, which as the name implies, are characterized by the need for the tag and the reader to be in close proximity to one another, as in access control or secure-ID applications. The second major group of applications is the medium-to-distance application set, which allows the distance between the two to be significantly greater, as in tollbooth and some inventory – control applications (Shepard, 2005).

SHORT RANGE APPLICATIONS

ACCESS CONTROL

This typically involves the use of a credit – card –link device which is inserted in a card reader. The card contains information about the card holder and is used

RFID FOR EQUIPMENT TRACKING

Hospitals for long are facing the challenge of managing and tracking equipments and assets ranging from IV pumps, bedside equipments, surgical and other life supporting equipments. Knowledge of where any equipment is located at a given time will be of help to both the care givers and patients. In spite of well defined material processes, emergencies and unexpected events cause equipment to be misplaced, which leads to time-intensive searches, high replacements costs, poor utilization of the equipment itself and many undefined problem. RFID is known to address these problems through greater visibility of assets all along the hospital facility. Much of the manual activities carried out in the hospital can be eased by an RFID system and thus resulting in increased operational efficiency.

In the current system much of the equipment tracking and managing is done manually, each department or floor has been given certain equipments like, nebulizers, pulse oximeters, defibrillators alpha beds etc and are responsible for their availability and usage. The inventory of these equipments is done daily; condition of each if these equipments. This process is repeated every time the nurses change their shifts which means it is done at least three times a day!! Again before the nurse hands over the shift if any equipment is transferred to other department, the same has to be informed to the nurse taking over the shift.

Apart from just tracking the presence of equipments, there are certain other valuable things like crash carts, oxygen cylinders and fire extinguishers etc which might not be moved everyday but the importance of their presence in the given location assigned cannot be over emphasized. Also the workable condition of these have to be checked time to time for example, a crash cart which have important life saving drugs have to be checked and updated regularly. RFID can thus offer workable solutions leading to enhanced visibility if each equipments within the hospitals setting. Each equipment is affixed with an RFID tag which can store information such as the product code, the department to which it is allocated, and even the date it is due for any kind of maintenance. These tags are in turn read by RFID readers which can be either located at fixed positions or movable (handheld reader). The readers pass on the information they collect from the tags to a database which process this huge volume of data and present it to the end user according to the request. Each floor, ICU, and department have can have a computer with asset tracking software and connectivity to the database; can assess the location and user status of any equipment affixed with a tag. The asset tracking software has floor plans of the hospital and the list of equipments and codes. Thus when a hospital personnel logs on to the system and enters the equipment whose location has to be determined, the system looks up to the database where the readers deposit the information about each tagged equipment with their location in the hospital facility and conveys the same on the system screen. Thus RFID ensures greater visibility of equipments and help to make them available at critical times in patient care.

Also the RFID system can be programmed to raise alarms when equipments is moved out or not found at its given location such a function will be of use specifically for crash carts, fire extinguishers and oxygen cylinders. Certain RFID tags come with sensors which can detect in the equipment is in use or not or if require repairs and maintenance work and convey the same to the computer system.

The choice of the tag depend upon the kind of the equipment and their usage and movement pattern, some which move all along the facility and are shared with multiple departments will require active tags which can be read from a distance and store data up to

RFID FOR PATIENT TRACKING

Hospital environment inherently involve mobility, be it of critical medical equipment support personnel, medical staff and patients. With patients being the prime responsibility of the hospital, all its activities directly or indirectly involve patient care and with complex medical treatment procedure it has become

imperative for the hospitals to develop a fool proof system of patients tracking and identification. The hospital personnel are faced with multiple challenges of maintaining and updating patient records, managing their various treatments and diagnostic procedures etc. knowledge of the patient's location within the hospitals is another challenge as he has to undergo various procedures requiring him to move through the hospital. This particularly becomes a problem when a patient is shifted from one department another, for example a patient may be admitted in a ward, and later he might be moved to the operation theatre or ICU, thus creating a problem for the nurses and doctors to track their exact location, transfer of the medical record of the patient record is another important concern. Much of this activity is handled manually by the nurses, as depicted in the following processes.

It can be inferred that the patients treatment and identification is complex process involving many time consuming and tiring activities. RFID for patient tracking is one of the most talked about application of RFID in hospitals. The functioning of the RFID system for patient tracking is pretty much the same as for asset tracking with some variation in the amount of data stored on the tag and the connectivity of the readers to the database. A wristband embedded with an RFID tag is given to the patients, which provide storage and wireless read/write capability of patient information for positive patient identification and streamlined operation. These tags can be now read through the readers located in the hospital, and it will be more appropriate if these readers are connected to the electronic patient records. The currently used bar coded wristband stores minimal information on it and it can be easily tampered or torn, the RFID wristband contains a tamper mechanism that will prevent from being removed, or emit a tamper signal if an attempt is made to remove it. This would be particularly help fool in case of neo natal care ward to ensure that babies go home with their rightful parents and to eliminate opportunities for baby abduction or kidnapping. For pediatrics, only staff or parents may be permitted to take infants or children from specific areas or boundaries of a ward.

Also the ability to track the patient's location will be of great advantage to the nurses who have to keep an account of many patients at a given time. A patient's location can be viewed on the computer screen with RFID patient tracking software. RFID enabled Patient Identification and Information System uniquely provides hospitals with improved services and increased efficiencies by replacing time consuming and error- prone manual processes with a seamless real-time wireless information system. Upon admission, patients are issued with RFID wristbands with patient's information and UHID number encoded on the RFID chip. RFID printer encodes the information on the RFID chip and hospital personnel can identify patients simply by waving their RFID readers which may be handheld pocket PCs over it and bring up detailed patient information – such as problems, past monitored information (E.G. Temperature, Blood pressure), lab results, medication list, allergy list...- from a central database over a wireless connection. Thus, it can change the way doctors and nurses interact with patients by empowering them to quickly identify a patient and, retrieve, review and update patients' medical information right from the bedside.

RFID ENABLED POCKET PC WITH READER

Medical staff do not have to return to nursing station to obtain patient data, which is of paramount importance in emergency treatment, because with the RFID enabled patient information system medical staff can gain access to patient records more instantly. Nurses, equipped with mobile RFID terminals, can visit and identify patients with their RFID wristbands which can be scanned when the lights are turned off or through clothing and bedcovers, thereby causing no patient disruption. Upon identifying the patients, detailed patient information as well as the specific tasks and medication information for the current patient visit is retrieved and displayed from the central database over a wireless connection. When the nurse finishes her task such as giving the correct medicines or recording temperature of the patient as specified in her mobile terminal, she simply updates the corresponding screen and saves the information to the central database. These will be particularly helpful in case of patients which have to be transferred from one department to another like a patient from the ward taken to the operation theatre for surgery, the nurse can feed in the patients brief history and also the reports of all the pre operative test and procedures, thus making the job of the OT personnel simple and error free. The amount of immediately available information at each stage of what happened in the previous step; provide opportunity as to what will be next step.

Traditionally, while visiting patients, nurses take notes on paper and re-enter them using a computer at nursing station. RFID and wireless enabled mobiles terminals replaces this error-prone and labor-intensive paper – bound system with a real-time, new generation wireless system, thus doctors and nurses can monitor conditions of patients and treatment activities in real-time, equipped with RFID enabled large tablet-PCs, they can quickly identify a patient, retrieve comprehensive medical records, review patient's recovery status, and check past medical logs which have been recorded by nurses via their RFID mobile terminals. It completely eliminates the chance of patient being given a drug to which he/she is allergic. The patient's medical histories stored in the database stored in the database will quickly, alert if the patient is given any wrong medication.

PATIENT'S DETAILS RETRIEVED FROM THE RFID ENABLED WRISTBAND

The benefits that are stemmed from RFID enabled patient identification and tracking:

- Real - time and accurate medical data platform
- Prevented patient identify mix-up and medication errors
- Increased patient satisfaction
- Fast patient data gathering in emergency cases
- Seamless identification and matching of specimens or transfusion to correct patient
- Reduced surgical site errors-right patient, Right surgical site, Right procedure
- Increased productivity and enhanced healthcare workflow

Apart from patient and asset tracking RFID can be used for an array of other of other function like inventory management, blood group verification etc. some of the many benefits of RFID are:

- Point of care: Patient identification, medication delivery etc.
- People tracking: Patient tracking, staff tracking-real time location, boundary checking
- Process-Centric: Operating Room/Intensive care Unit Management, cleaning/disinfection/ sterilization process
- Asset tracking: Medical equipment/Instruments, pharmaceutical inventory, blood product management
- Making newborns more secure
- Reducing drug and blood administration errors

COSTS OF IMPLEMENTING RFID

RFID undoubtedly offers huge benefits to hospitals, but like any other new technology it comes with a price. Through the potential ROI on RFID is becoming clearer in some applications, the cost of implementation nevertheless remains a major barrier to wider adoption of the technology. The cost of the tags (which would be required in large numbers) is one of the major causes of concern in implementation RFID; also the cost of reader and the middleware for the integration of the software has to be considered. There are tags available for about 28 cents, but a question should not be ignored is "do they serve our purpose?" yes, they might in some areas, but they are other areas which require active tags with greater reading range and read write capability and higher performance, the cost of which range from $20-$50. Passive tags are most popular where they serve the purpose of identification and security of the item it is affixed to, but here we talking about an RFID system which would help us locate a critical medical equipment in a hospital facility of about three floors, of 40,000sft, indicate if it is in use and store information about the product, naturally all this would make the price of the tag go up.

Also the tag of the price is negotiable depending on the number of tags purchased, for example Gillette inc who ordered about 500 million tags from Alein Technology Corp said it costs them less than 10 cents per tag due to the economies of scale; however it would cost 40 cents for smaller orders. However a hospital of 500 beds have equipments running into thousands and it is not a viable proposition to tag all of them with a high price tag of about $50, so we make a distinction in equipments which would require this and which can do away with it, Based on the observation in the hospital and discussions with manager from the biomedical department, a conclusion was made that at present it would suffice if the location of some critical equipments likes ventilators, ultrasounds, ECHO machines and potable x-ray machine can be tracked which will come to a total of about 50. These equipments move around the hospitals and hence it would be beneficial if the knowledge of their location and use status is available at all times.

Other equipments like alpha beds, pulse oximeters, nebulizers, and defibrillators which are distributed to respective departments, a lower price tag which come for an average of $1-$2 would serve the purpose of ensuring that presence of equipment at its assigned place. The study involved, learning of the various hospitals process and working of departments like bio medicals, maintenance, nursing, ICU's and wards and it has been noticed all though they are not too many obvious loop holes in the current system of working still a lot needs to be done in order to ensure a smooth, easy and error free system for working. Due to the dependence on manual work there is always a scope for error and unpleasant experience for both patients and staff. In order to live up to the mission of providing quality healthcare to patients, hospitals need to continuously upgrade and adapt to newer technologies offering effective solution over the traditional method of doing things. One such technology is RFID system which provides tangible and tangible benefits. Especially to hospitals, enabling them to quickly identify and locate equipments or personnel. Although the understanding of RFID is more among retailers, distributors and manufacturers, many hospitals are beginning to adopt RFID, in view of the enormous benefits it offers. The amount of paper based and manual work revolved around patient care, consume a lot of time of the nurses and other hospital personnel which could be better utilized in patient care. RFID provides not only tangible benefits to the hospital by helping it better manage its equipments, with increased an intelligent utilization and preventing it from any kind of theft and pilferage, but also intangible benefits of patient and employee satisfaction. It reduces the work load of nurses, by helping them in correct identification of patients and streamlines their treatment process, the RFID tag which store data will help in quick retrieval of vital information about the patient as compared to the current system, where each page of the patient's record have to be scanned.

CONCLUSION

No doubt RFID is a powerful innovative technology one should not get caught in the bills and whistles associated with it and rather look to tape its real potential. In order for RFID to deliver its real benefit the following recommendations are made:

- The hospital should clearly lay down what it seeks to benefit from the technology, the problem it wants to address; otherwise it will have a technology which is searching for problems to be solved. Here the main problem identified was to make available equipment at a given time without much delay and the patient care process involved a lot of running around by the nurses. Hence an RFID which will solve this has to be chosen.
- End user's (nurses, doctors, materials and bio medical management) operation is very important. As the level of awareness among hospital staff about RFID was found to be very low, it is extremely important to educate them about the working of the technology, how it can their day to day problems etc. their opinions and suggestion should not be overlooked in the implementation. It is advisable for the hospital to have a pilot test done to understand the practicality of the technology before full fledge tagging.
- Patients should also be involved. Their opinion a views should be kept in mind in choosing the shape and form of the tag cannot be ignored.
- The expected ROI from the investment should be calculated based on the cost annually in procuring equipments and maintenance of the existing ones, thefts, malfunctions etc. a clear ROI case can be established by comparing the cost associated with procuring additional biomedical devices versus saving money and time by knowing where critical assets are when they are needed most.
- An analysis into the existing IT structure should be done and consider the changes needed to support the RFID – items like cabling, cost of software its ability to merge with the current system should be carefully considered.
- Ultimately working with an unbiased and experienced vendor will make all the difference in the success of the technology. A vendor that has proficiency in the RF domain and offers professional services that can strengthen the hospital's resources with specialized RF expertise, while maximizing the value of the investment should be selected. It should understand the hospital's requirements, the frequency selected for the tags and readers should not interfere with the working of the devices in the hospitals. The technology selected should be dictated by the requirements and not the other way around.

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