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Using RFID Technology for Efficiently Managing Blood Donation and Distribution Process in Blood Bank

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Abstract: Radio Frequency Identification (RFID) technology can be used in blood bank for managing blood donation process, for storing and identifying blood bag after donation and also for distributing blood product to the patients. Standard 13.56 MHz RFID tag has been accepted by International Society for Blood Transfusion (ISBT) for using in Blood Bank.13.56 MHz RFID tag can carry ISBT 128 data structure. Different types of RFID tag can be used in Blood bank for blood donation process. This research article presents the way for using RFID technology to make easier the blood donation process, blood bag storing process and also blood distribution process. RFID wristband tag can be used to recognize the blood donor properly and RFID passive label is useful for identifying, storing and issuing the blood bag for transfusion. Use of RFID technology in blood bank will reduce many issues and make easier the process of blood donation. This research will also demonstrate the benefits of using RFID tag instead of Barcode Labels on the Blood Bag. This research was done for presenting the efficient way of using RFID technology in Blood banks in Saudi Arabia.

Keywords: Blood Bank, Blood Donation ,Blood Transfusion, ISBT, RFID Technology, RFID tag, RFID Scanner.

INTRODUCTION

Nothing is better than saving a life and blood can save any patients life when it required. So, Blood bank is the place which is directly connected for patient life because it is involved in collecting bloods for patients. Delaying in blood donation process, wrong labeling, wrong blood sample collection, blood bag identification error, barcode identification error, delay in blood issuing process and wrong blood transfusion can cause major problem in blood bank activities.

Sometime those issues are directly or indirectly involve in patient death. It is very important to make the blood activity such as blood collection, processing, storing, issuing and transfusion to make more efficient and smooth. So, the necessity of using advance technology is very important for Blood Bank.

Currently many blood banks in Saudi Arabia is using barcode system for identifying blood bags and tubes. There is some limitation of using barcode system.

Fig-1: Blood Identification using Barcode

Fig-1 showing the process of identifying blood bag using barcode. Barcode should be “line of sight” with the scanner and should be read from very close distance.

RFID technology can be used to replace the existing bar-coding systems in Modern Blood banks for making easier the blood donation process, identifying blood bags and tubes more efficiently, issuing blood

more efficiently, blood cross checking can be more easier during blood transfusion and tracking blood bags etc. This article will mainly focus on the process and benefits of implementing RFID technology in blood banks in Saudi Arabia.

LIMITATIONS OF USING BARCODE IN BLOOD BANK

Many blood banks are using barcode system for labeling the blood bag and tube. There is some limitation of using barcode such as it can't store any related data inside it so if the barcode is unrecognized by the barcode reader it is very difficult to identify the blood bag and tube, also there is possibility to wrong blood labeling, barcode damaging while storing blood bag inside the fridge, blood bag identification taking long time, difficult to identify misplaced blood bag, cross checking error with patient existing blood group and more. There are many limitation of using bar-coding system such as,

- Barcodes are easily destroyable,
- Multiple barcode identification is not possible,
- Inside fridge barcode can be destroyed more quickly.
- After long time storing inside the fridge barcode label can become un-readable.
- Difficult to identify blood bag or tube from fridge or storage.
- Collecting/distributing bulk number of blood bag/tube is time consuming.
- Blood bag/tube automated tracking is not possible.

BLOOD DONATION SYSTEM AND DISTRIBUTRION PROCESS IN BLOOD BANK

Blood bank is the place of collecting blood from donors and distributing the blood for patient after collecting and processing. Two major activities are involved in blood bank.

1. Blood Donation 2.Blood Distribution

Blood Donation system has some other sub activities.

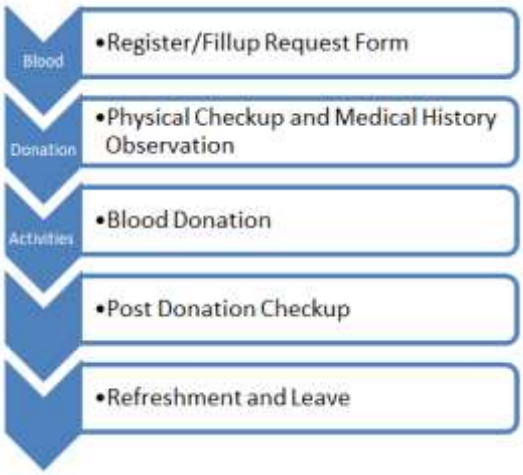


Fig-2: Blood Donation Activities

Fig-2 depicts the steps of blood donation in a Blood Bank. In Blood donation system firstly the donor needs to register in computer system/paper based registration form. The physician checks the donor physical ability and vital signs and also observe his medical history to identify that he is not infected in any critical disease such as hepatitis B, HIV etc. If the donor is eligible for safe blood donation then the donation process begins. After finishing the donation process, donors post donation reaction is observed to check that the donor is safe. After finishing all the process the donor is provided a refreshment pack (Juices and light snacks) and allowed to depart.

After blood donation finished there are some activities for processing and issuing blood to the patients.

Fig-3 depicts the steps of blood processing and issuing for patients. After blood donation process is completed the next phase is begin for storing the blood and distributing to the patient. Blood components are separated by centrifuge. All blood components are going through some verification process (such as blood group identification, laboratory testing etc.) to identify proper blood group, blood quality and blood safety before distributing for patient. Blood products are storing in fridge when it is ready for distribution. Once the blood request come for any patient from the doctor, the cross-match process is done to ensure that the blood product is suitable for the requested patient. After completing all the process the blood product is issuing for the requested patient. Before and after the blood is transfused to the patient the vital signs and other required information is recorded to identify any post reaction due to blood transfusion. If the blood product is not required for the requested patient then the blood product again returned to the blood bank so that it can be used for any other patient.

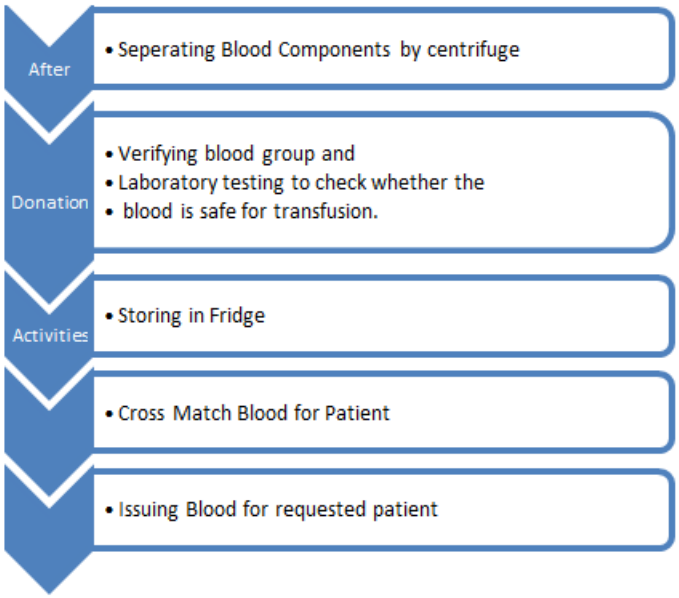


Fig-3: After Donation Activities

FUNDAMENTALS OF RFID TECHNOLOGY

Electromagnetic signal is used by Radio Frequency Identification (RFID) technology for identifying or reading data from a RFID Tag [1]. RFID system can have three components for identifying objects. (a) RFID tag (b) RFID Scanner/reader (c) Host Computer System.

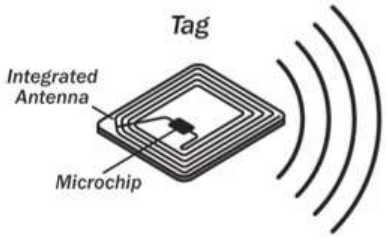


Fig-4: RFID Tag [2]

RFID Tag

RFID tag contains a memory chip which can store an identification code to identify any object. RFID tag contains an antenna which is used to identify the RFID tag from nearest distance based on the frequency of the tag. Using a passive RFID tag it is possible to identify the object from 10cm to few meters distance. Passive RFID tag cost is very less and applicable to identify any items or objects from nearest distance.

Fig-5 showing RFID tags, which are suitable for using in blood bank donation system.

Fig-5: Suitable RFID Tag for using in Blood Bank [3]

RFID Scanner/Reader

RFID scanner used to identify the RFID tag. RFID scanner uses a radio frequency to get response from the RFID tag. Different types of RFID scanner/reader are available. Some of them are hand scanner which are portable and some of them are flat bed scanner which can be used from user workstation.

Fig-6: RFID Hand tag Scanner

Fig-7: RFID staff workstation tag Scanner

Fig-6 and Fig-7 depicting different type of RFID tag scanner/reader suitable for using in blood bank.

Scanner first broadcast a radio frequency signal to identify the RFID tag. When the RFID tag get the signal then it sends back a respond signal to the RFID scanner [4].

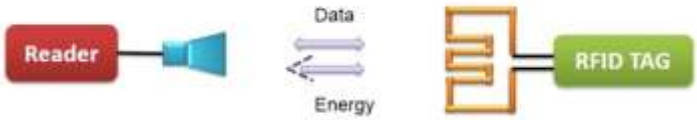


Fig-8: Showing the process of data reading from RFID using RFID scanner [5].

Host Computer System

A host computer system can be connected with RFID reader to verify the Tag data [6]. Fig-9 showing the process of reading a RFID tag and verifying using computer system.

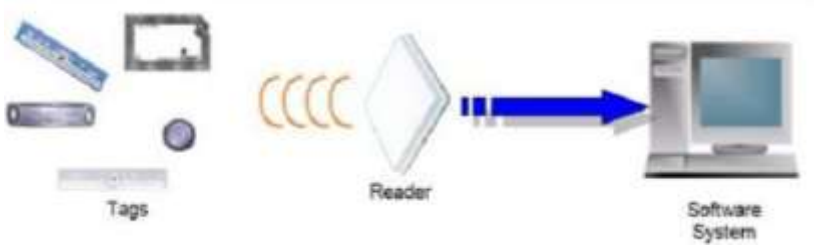


Fig-9: RFID tag data verifying using host computer [7]

Process of reading RFID tag

RFID tag reading needs to do several tasks. First of all every tag should be initialized with proper identification data. When the reader spread electro-magnetic wave through the antenna to the nearest distance according to its frequency range, then if the nearest tag match with the signal then it respond back to the antenna. RFID reader return the data received from matched tag to the connected system for processing. The application system installed in the host computer start to process the tag data based on requirement. Fig-10 displaying the function of processing data using a host computer system.

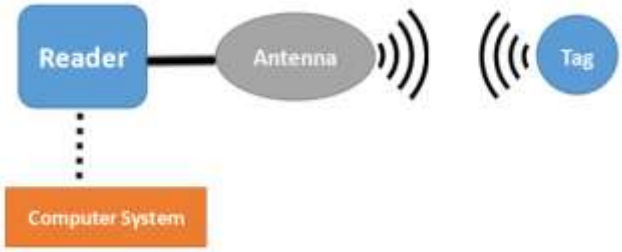


Fig-10: RFID tag data processing with host computer [8]

PREVIOUS STUDY OF USING RFID

Joseph Dalton, PhD *et al.*, [9] shows a method of using RFID technology to reduce blood transfusion error. He shows Intel was introduced a pilot program at San Raffaele Hospital in Milan, Italy, which greatly reduces errors in blood transfusion. The program uses radio frequency identification (RFID) technology to automate the tracking of blood bag.

Mohammad Mizanur Rahman *et al*., [10] shows a method of Using RFID Technology for Managing Patient Medical File. He shows that RFID technology can quickly identify a patient medical record file from a shelf, It reduces the labor to identify a medical record file if it is misplaced, It is easily identifiable if the file is issued to a wrong person or to wrong medical department.

Syed Md. Shahid *et al*., [11] proposed a Library Management System using RFID technology. He showed a new approach to circulation, tracking, inventorying and security of Library Materials. He clearly show how to make a comprehensive system which can address both security and materials tracking of a Library System.

BENIFITS AND DRAWBACK OF USING RFID TECHNOLOGY

There are many benefits of using RFID technology.

- RFID tag can read from nearest distance and not required to be positioned properly.
- Unique identification no can be stored in RFID tag chip.
- RFID scanner can read multiple tag simultaneously.
- Various types of scanner available to read RFID tag.

Besides more benefits of RFID there are some disadvantages also. RFID tag, scanner and other required devices are more expensive. Multiple RFID tag reading can have signal collision and lack of accuracy if the quality of RFID tag is not good enough. Sometime Electromagnetic interference can make problem for reading RFID properly and hinder the accuracy.

METHODOLOGY OF USING RFID TECHNOLOGY IN BLOOD BANK SYSTEM

Blood banks are using Barcode System in different region in Saudi Arabia as well as in other countries also. Barcode giving some benefits when it is used with computer based system but due to many problems related with barcode (mentioned in section II) there is more scope to improve it using RFID technology. Since the blood is very important for any patient life so, there is no chances for doing any kind of mistake related to blood bag labeling or any distortion happened in blood bag label when it is storing in the fridge, also can't delay for searching blood bag from the fridge when the patient situation is critical.

RFID technology can be used to solve all the issues in blood bank donation system.

RFID technology using Methodology is discussed in-detail in the following section.

Step 1(Donor Registration)

Donor should be registered using blood bank management System (BBMS) software for recording donor demographic data and arrival information. Each donor should wear a wrest band RFID tag to identify them during the blood donation process.

Fig-11: RFID wrist band tag for donor [12]

Step 2(Donor Eligibility Check)

Donor physical check up should be done by a physician to check his vital signs and previous medical history to identify that the donor is eligible for blood donation. Donor previous donation history also should be observed form the BBMS. Using RFID wristband tag physician can get donor information from BBMS.

Fig-12: Identifying donor information using RFID technology

Step 3(Blood Processing and Storing): Blood bag used for collecting blood should have RFID tag. Blood bag should follow the ISBT 128 labeling standard [13]

Fig-13: Blood bag with RFID tag

Fig-14: ISBT 128 Standard Blood bag label

Whole blood or separated blood product should be properly labeled with ISBT 128 standard tag. Each bag should have RFID tag for identifying them. After blood product processing completed, all blood bags should be stored in the fridge before distributing to the patient.

Step 4(Blood Product Issuing)

Blood product is issued to the patient based on doctor's request. Once the request is received from the doctor to the blood bank, the blood product is issued to the patient after crosshatching the blood based on patient blood group. Several task involved before issuing blood product.

a. Searching blood product from the fridge based on requirement
b. Record issue details in BBMS
c. Verifying pre and post transfusion reaction information
d. Returning blood product to the storage which is not transfused.
e. Multiple blood products issuing to other hospital or to hajj camp (Saudi Arabia only).

RFID hand scanner can be used to search the blood products from the fridge, It helps to identify blood bag quickly and easily.

Fig-14: Blood bag identifying using RFID scanner

Single Blood product can be issued to any Patient based on the request. From stuff workstation RFID Hand scanner can be used to identify and issue individual blood product.

Fig-15: Single Blood bag issuing

RFID gate/tunnel reader can be used when it required to send many blood product bag to other hospital or in hajj camp (Saudi Arabia) or any specific place. RFID gate/tunnel reader can read more than 50 blood bag at the same time.

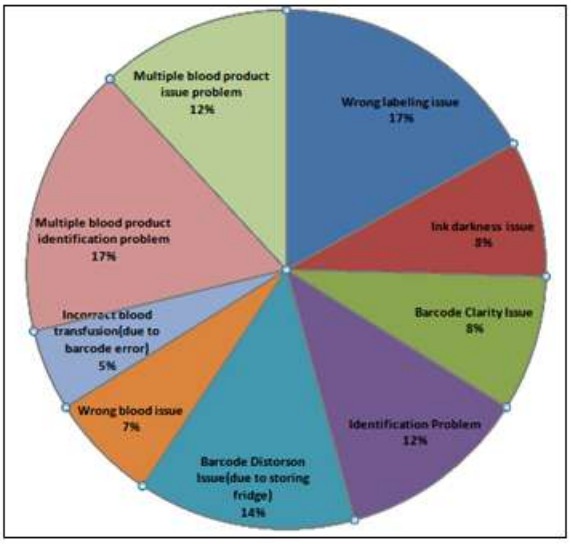
Fig-16: Multiple Blood bag issuing

If not used blood product bag returned to the blood bank then RFID hand scanner can be used to identify each blood bag and return them to the storage fridge.

RESULTS AND ANALYSIS

A data sheet given below to show the approximate number of problem can be happened due to use of barcode label.

Blood Donation related problems for using barcode label.	**No of problem(Per Month)**
Wrong labeling issue	10
Ink darkness issue	5
Barcode Clarity Issue	5
Identification Problem	7
Barcode Distortion Issue(due to storing fridge)	8
Wrong blood issue	4
Incorrect blood transfusion(due to barcode error)	3
Multiple blood product identification problem	10
Multiple blood product issue problem	7

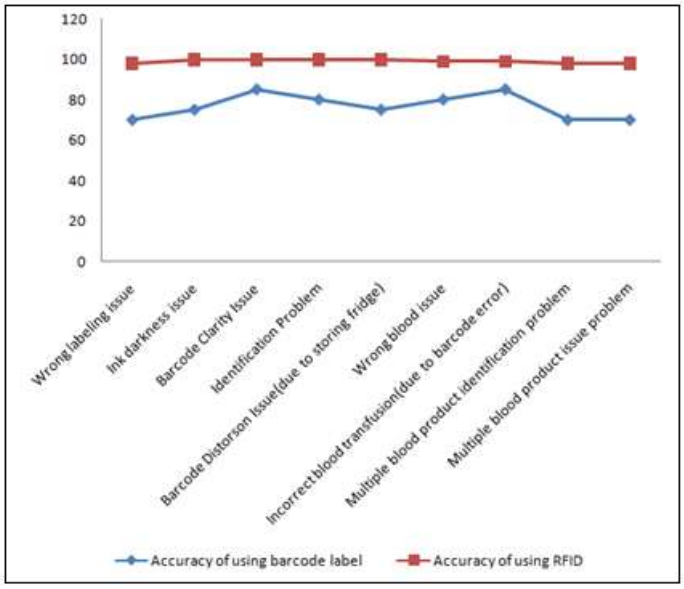


Graph-1: Graph representing the problems related to using barcode label.

Graph-1 represents the above data sheet to display the percentage of different type of problem related for using barcode label.

Another data sheet showing the Accuracy of using RFID technology.

Blood Donation and Issue Problems	Accuracy of using barcode label	Accuracy of using RFID
Wrong labeling issue	70%	98%
Ink darkness issue	75%	100%
Barcode Clarity Issue	85%	100%
Identification Problem	80%	100%
Barcode Distorson Issue(due to storing fridge)	75%	100%
Wrong blood issue	80%	99%
Incorrect blood transfusion(due to barcode error)	85%	99%
Multiple blood product identification problem	65%	98%
Multiple blood product issue problem	70%	98%



Graph-2: Graph representing the accuracy of using RFID technology

Blood is a very important for a patient life It required more accuracy, as much as possible. There is no chance for any tolerance or making mistake because it can be directly connected with patient life. Wrong blood transfusion can cause patients death also.

ACKNOWLEDGEMENT

The aim of this research was to find out an efficient solution for improving the blood donation and issue process using RFID technology. RFID technology helps to make more accurate system for blood donation and distribution. The study demonstrates that RFID technology can bring a clear improvement of accuracy. An observation is carried out in the Central Blood bank of Riyadh to find out an effective solution for the problem caused for using barcode label.

CONCLUSION

RFID technology can be the best solution for blood bank to establish a more accurate and error free blood donation and issue process. It makes easier the blood donation process. It can quickly identify any blood product from storage fridge. Multiple blood product bag searching and issuing problem can be solved easily by using RFID technology. So, using RFID technology could be a very essential step for blood bank for establishing more accurate and error free blood collection and distribution process.

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