

Smart Blood Query: A Novel Mobile Phone Based Privacy-aware Blood Donor Recruitment and Management System for Developing Regions

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Abstract—The growth in numbers and capacity of mobile devices such as mobile phones coupled with widespread availability of inexpensive range of services presents an unprecedented opportunity for mobile health care applications. Blood donation and transfusion service is one of the most complex management systems in health sector. Quality management of a Blood Transfusion Services (BTS) starts with safe blood donor recruitment (BDR) and donor care. In the South-East Asia Region (SEAR) almost all countries except Thailand depend heavily on replacement of blood from relatives and friends. In this paper, we present location-aware mobile phone based blood donor recruitment, information retrieval and management system that aims at ensuring the quality of the blood and increasing the efficiency of operation management. Here an attempt has been made to leverage the ubiquity and power of the standard mobile phone as a lifesaving mobile health care application, delivering more user convenience.

Keywords- blood transfusion service; blood donor; mobile phone; ubiquitous; data confidentiality.

I. INTRODUCTION

The need for blood is great. There is no substitute for human blood. Every two seconds someone needs blood. Every day blood is required in hospitals and emergency treatment facilities for patients with cancer, thalassaemia and other diseases, for organ transplant recipients, and to help save the lives of accident/trauma victims. And with an aging population and advances in medical treatments and procedures requiring blood transfusions, the demand for blood continue to increase. All these statistics clearly show the importance of blood query and raise the burning question of blood donation.

In developing countries, lack of resources, lack of professional management, myths and misconceptions arising from cultural and social differences form a barrier to blood donation. The Blood Transfusion Services (BTS) in the South-East Asia Region (SEAR) of World Health Organization (WHO) are mainly in the public sector in six countries. Regulation of BTS is well defined in three countries but weak in the remaining countries. A total of 2373 blood banks exist in the region which collect 7.347 million units of blood annually. Of these, 10-100 % donors

are voluntary non-remunerated donors [1]. Besides donor recruitment, donor screening and donor management are also not well addressed. The donors are mainly males of 20-35 years who come from the middle class of the society. Only 3-6 % of females donate blood. Most of the donors donate once in a lifetime as there is no emphasis on retention programs. Only 5-10 % is repeat donors [2]. So the need for a complete blood donor recruitment process is undoubtedly high. In this paper, we have demonstrated a mobile phone based blood donor recruitment and management process which fulfills the recruitment indicators identified by WHO: defined standard operating procedures, maintenance of confidentiality, development of donor motivational program and donor counseling [3]. Here we propose an intelligent blood donation system using SMS, based on strong and efficient database of donors and some major human characteristics, which may vary region to region. Our proposed system uses simple SMS messaging which is accessible to a wider range of people and does not require any mobile software installation.

The rest of this paper is organized as follows. In Section II, we present related work of existing blood donor recruiting systems. In Section III, the location-aware mobile phone based Smart Blood Query (SBQ) is proposed and explained in details. Test results and future works are discussed in Section IV. Finally, Section V concludes the work of this paper.

II. RELATED WORKS

All countries have now realized a need for regulation and implementation of a quality system as well as increased their efforts towards donor recruitment and retention. To meet the growing blood demand, some SEAR countries like Bangladesh, India, and Pakistan have launched web based donor management systems. Donors register themselves on the sites, specifying their blood types and contact information; requesters do the same, specifying when they need what blood type. Sometimes requesters must specify months in advance of elective treatments because of donation shortages. Two main shortcomings of web based approaches are: unable to handle emergency situations and lack of internet access for majority of people in SEAR

countries. In India, a smart phone based Virtual Blood Bank [4] has been proposed. This system uses GPRS and a centralized server to store blood donors and blood banks information. People who seek blood also communicate with the server through their mobile devices, specifying their blood type and current location in a subscriber application. The server matches the blood type and location with the profiles of registered donors or blood banks, retrieves the information and sends it to the seeker via GPRS. In this model, anonymity of donor information is not maintained which is a vital issue in donor recruitment system urged by (World Health Organization) WHO. Besides this, mass people cannot afford to use smart phones. The Indian Medical Association (IMA) has launched an SMS-based blood bank service [5]. Still this system lacks in maintenance of confidentiality and development of donor motivational program and donor counseling which is vital for collecting voluntary non-remunerated blood donation.

From above works, blood donation recruitment process is vital for the foundation of a safe and adequate blood supply. The existing systems give limited attention to accessibility, user friendliness and anonymity of information. In this paper, we propose a system which is not only accessible to all users and keeps anonymity of donor's information but also maintains the checklists provided by WHO for safe blood management.

III. SMART BLOOD QUERY PROJECT

Our proposed system has been developed using RapidSMS [6] platform which is an open source SMS-based tool. There are several reasons behind this choice of technology:

1. RapidSMS enables mass-scale mobile data collection and messaging.
2. Both qualitative and quantitative data can be collected easily and efficiently.
3. With the RapidSMS web interface, multiple users from around the world (with proper log-in credentials) can simultaneously access the system to view incoming data as it arrives, export new data-sets, and send text messages to users.
4. Being "open-source" software RapidSMS is free to download, use, modify and runs well even on low powered and older computers, needing only a GSM modem and SIM card to get started.

In Fig. 1, the network part of our system has been depicted. It consists of two device types:

1. Any mobile phone with messaging capabilities.
2. A Server (usually a PC) to deploy the database.

Blood donors register for this service through SMS, specifying their blood groups and other necessary information in specific format. These are stored in the central database.

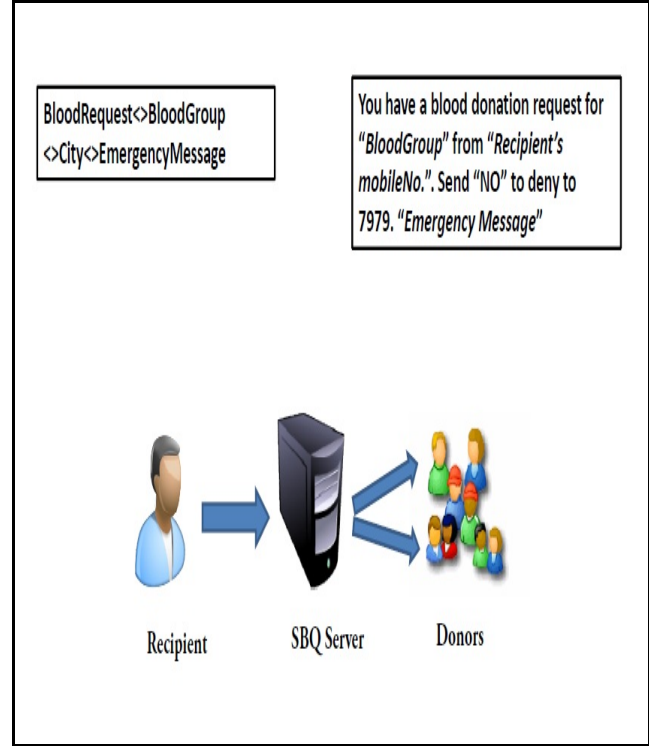


Figure 1: Smart Blood Query Project Network

Donors are also given the option to edit their profile and update details such as change in location or availability. When a query for blood come to SBQ server, it makes a quick query and sends a bulk SMS to top 5 search result donors, stating the situation. The donors have the option to either accept the request by replying 'YES' or deny it by replying 'NO'. If a donor agrees to the request, he/she is sent a brief questionnaire in order to check if he/she fulfills the requirements of blood donation. If everything is all right, the donor then contacts with the recipient. When a donor updates the date of last donation by SMS, his name is disabled from the donor list for 89 days after donation. Similarly, if the donor is unwell, he can edit his profile and mark as "unavailable."

A. Blood Donor Recruitment Process

There are concerns about the sustainability of centralized voluntary donor systems and their compatibility with the levels of health care that exist in many developing countries yet burdening patients' families with the responsibility of finding replacement blood donors will exacerbate poverty and reduce the safety of the blood supply. We have identified some major concerns regarding blood donation through a rigorous survey and discussion with blood donors, recipients and voluntary blood donation organizations. They are as follows:

1. Where to go, whom to contact: In emergency situations like accident or trauma, most people

- don't know where to go, whom to contact to get correct blood group.
2. Lacking in donor's motivation: Most of the time donors are not self-motivated as they are not informed about the urgency of blood. If donors know the urgency or critical condition of the recipient, then they will be able to realize the scenario and will be motivated to donate blood eagerly.
 3. Some unwanted human characteristics like superstitions of donating or receiving blood from people of same religion, class.
 4. Security issues like privacy of donor's information is a major challenge in blood donor management system.

In our proposed system, we address these problems and provide a solution quite uniquely. As described by the WHO, voluntary non-remunerated donation is far and away the safest form of blood donation and strenuous efforts must be developed for a strong program using a core with a high percentage of regular donors in order to maintain the highest possible quality of blood supply. In our system, a sincere effort has been made to assure this. When a donor first make a registration, he is given a unique pin code and a registered doctor's address for a physical check up whether he is able to donate blood. The donor's registration will not be completed until he visits the doctor. After the check up, if the doctor finds the donor physically fit, the doctor then sends a SMS specifying donor's pin code and his status, thus completing the donor's registration process. In current blood donation procedure, a major portion of time is consumed in registering at the facility, answering questions about donor's health and getting a physical examination. This lengthy process discourages a lot of potential future blood donors. Our proposed system eradicates this problem quite uniquely by providing each donor a registration ID through his mobile phone, which in turn becomes a virtual donor card. This virtual donor card system provides an effective solution to automate the part of information related to donor screening. Unlike Electronic Donor Cards specified in [7], our virtual donor card does not require any kind of extra device except mobile phone which is wide spread nowadays. It can be here noted that at the Macau Blood Transfusion Centre they have adopted the SIBAS [8] as its solution of computerized blood bank information management. SIBAS complies with the client/server infrastructure, as does its client end, and provides an integrated environment for those isolated but interdependent operations in the blood centre. In our system, one can access blood related information through mobile device which is easy to access and available technology.

B. User Interaction with the System

User friendly and system responsiveness are one of the key features of our system. A blood recipient can query for a specific blood group specifying location and the type of

urgency. The server matches the blood type and location with the profiles of registered donors, retrieves the information and sends it to top 5 matched donors in the vicinity of the recipient. Here we have provided a time out scenario. If no response (YES/NO) comes from the donors within 5 minutes, a new search will be initiated for finding blood banks nearby to the recipient and a SMS will be sent to the recipient, providing the information. SBQ is a 24/7 service and anyone, simply having a mobile phone can make a query for blood any time, any place. With just one SMS, one has access to hundreds of participating blood donors, centers and hospitals nationwide. Besides the recipients, the donor has flexibility to review his profile either through mobile phone or through dedicated website of SBQ, simply by using the pin code. He can update his location or update his status as 'AVAILABLE' or 'UNAVAILABLE'. Donor retention is very important for getting regular and repeated voluntary blood donors for safe blood transfusions. Donors should be retained by giving them special care, a feeling of being an important person and reducing waiting period. Through our system, we intend to provide the donors regular health tips, free check up/medical counseling news and updates and a timely reminder to donate blood. Our system has urges on the importance of Post-donation Confirmation, Notification and Counseling as it is an important aspect of blood safety.

C. Disaster Response

Unless otherwise stated, a "disaster" includes any domestic disaster or act of terrorism that:

- Suddenly requires a much larger amount of blood than usual OR
- Creates a sudden influx of donors requiring accelerated drawing of blood to meet an emergent need elsewhere. [9]

Examples of disasters are fires, floods, storms, road accidents, explosion etc. In SBQ, disaster response is addressed quite uniquely. Whenever a disaster situation arises in a location, a nearby hospital or blood bank can make an alert message describing the situation and broadcasts it to nearby donors and blood banks. The system is also capable of making automated alert messages to blood banks/hospitals if amount of blood stock is lower than a threshold value. Thus the system makes blood inventory management easier and flexible.

D. Confidentiality in Information Processing

Successful BTSs require handling a lot of donor information which are mostly personal information. Handling personal data imposes the necessity of security and confidentiality of data. At the same time, it requires easy access to data for serving blood donor information. So to meet the challenge of easy accessible data and make data

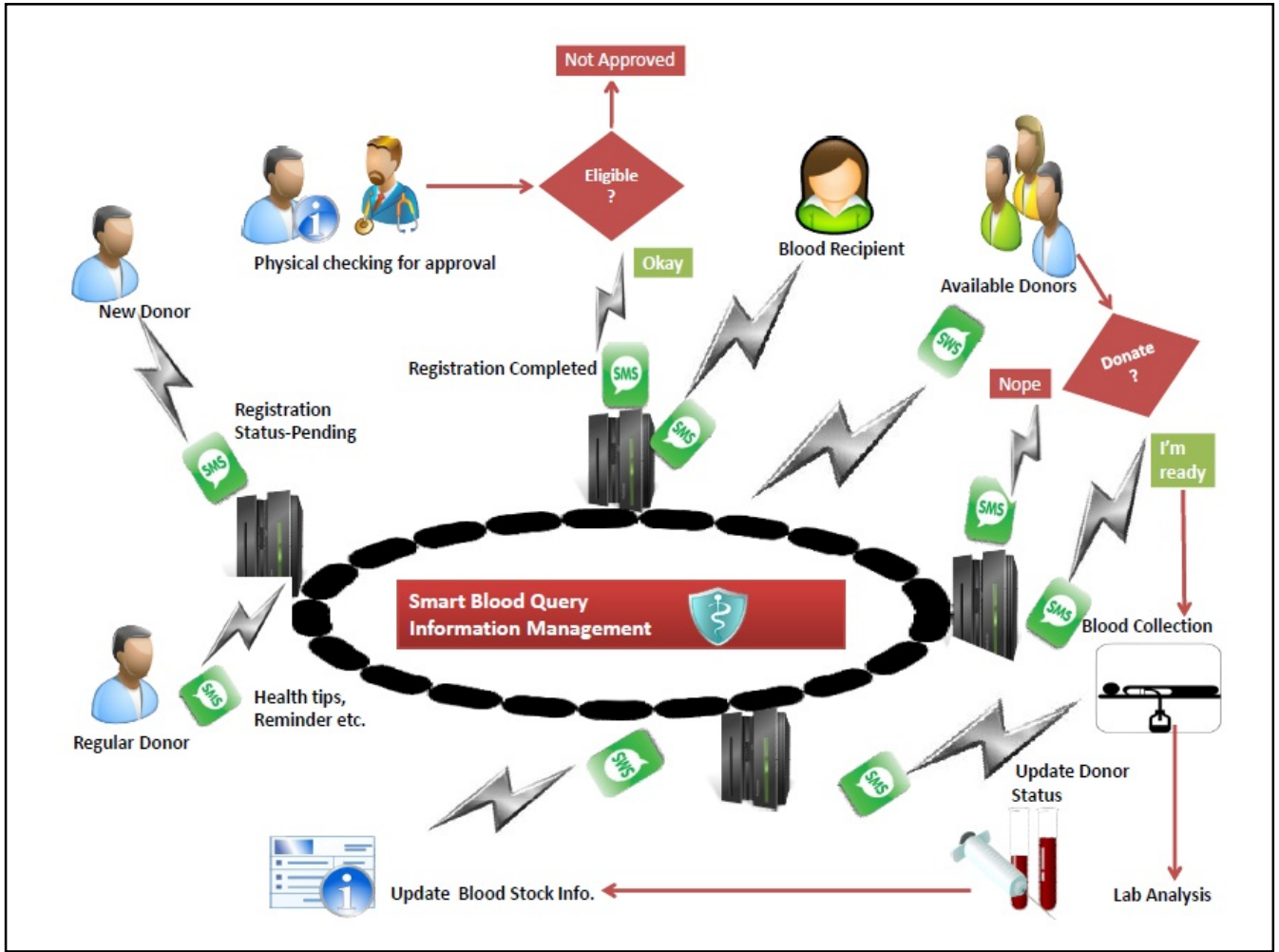


Figure 2: Smart Blood Query in Action

anonymized, we require anonymizing algorithm. In our system, we have adopted a new privacy model called LKC-privacy [10], together with an anonymization algorithm, to meet the privacy and information requirements in this BTS case. Experiments on the blood transfusion information-sharing system between the Hong Kong Red Cross Blood Transfusion Service (BTS) and public hospitals demonstrate that this anonymization algorithm can effectively retain the essential information in anonymous data for data analysis and is scalable for anonymizing large dataset. Besides anonymizing data in server side, our system also prevents donor information passing to recipients, which is common information breezing in current SMS-based and smart phone based donor management systems. Current systems provide complete donor information which may be abused. Our system enforces donors to contact with the recipient when a blood donation request arrives. As a donor is a trusted person in our system, it can be assured that the recipient's contact information will not be misused. Figure 2 depicts a complete scenario of our system.

I. TEST RESULTS AND FUTURE WORKS

Currently we are evaluating our project. We are working with a voluntary blood donor organization for testing our system. As far as the responses come till now are positive and optimistic. People who use it praise it highly as it is a real time, faster and easily accessible system than the conventional method of contacting blood banks or blood donor organizations for blood. Furthermore, when blood banks run short of a particular blood type, the application can find several donors to refresh the supply. We hope to launch the application through a network operator after the testing phase.

Besides these facilities, we are planning to integrate some data mining facilities in our system. We have been spearheading an effort to establish the first-ever national, public-private collaboration to track adverse reactions and incidents associated with blood collection and transfusion as well as tissue, organ, and cell therapy transplantation. The collaboration — known as the Biosurveillance Network

— involves gathering and analysis of data to help identify trends and recommend best practices and interventions intended to significantly improve patient care and safety while reducing overall costs to the health care system. We also wish to implement an intelligent donor classification algorithm, CART [11] to make donor profiling more robust. We hope we can make a better change in collecting voluntary non-remunerated blood donors through this effort.

II. CONCLUSION

In this paper, we propose a novel technique of blood donor recruitment and information management system. As far as we know, this is the first type of work in BTS domain that addresses all the key parameters of donor recruitment strategies like increasing public relations, effective communication methods, blood Donor Issues in disaster management, donor motivation, counseling as well as donor self-deferral opportunity. The Smart Blood Query Project facilitates its users both blood donors and recipients to access the service any time anywhere with no sophisticated hardware and software installation. Furthermore, we are working on extensive testing of our prototype in real world situation in conjunction with relevant health care professionals and domain experts in order to develop an understanding of complete blood management system for the monitoring of donors, patients and identifying what information is required from concerned group of people. We hope proper implementation of our project can bring a significant change in BTS situation of SEAR and developing countries.

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