Blood Bag: A Web Application to Manage All Blood Donation and Transfusion Processes

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Abstract—**Many lives could be lost due to the difficulty in obtaining a proper blood bag, Therefore, this work aims to help citizens fulfill their needs for a safe and reliable blood group by searching for and locating a specific blood group. In this paper, we illustrate the problem of the blood bags shortage which is represented in the uncontrolled blood banks and parallel markets, lack of awareness and confidence, disappearance of the rare blood groups, and the difficulty in finding a specific blood group. Hence, we proposed the Blood Bag web-based application that is connected to a centralized database to gather and organize the data from all blood banks and blood donation campaigns. The proposed application organizes and controls the whole critical processes related to blood donation, testing and storage of blood bags, and delivering it to the patient.**

Index Terms—**Web applications for blood donation management, managing blood donations, controlling blood transfusion processes.**

I. INTRODUCTION

One blood bag can save a life during surgeries or road accidents, etc. Usually patients or their families look for a specific blood group they indeed need in the blood banks but they normally can not find it due to the shortage of blood bags. This is because of the fear of donating blood and the misconception that donating blood is harmful and transmits diseases. This is one of the obstacles to provide the blood bags. The availability of the blood bags is critical because of the high proportion of patients with renal failure, some cases of birth, surgeries processes and incidents that need to get the blood as soon as possible to save these cases' lives [1].

According to some Egyptian statistics, Lack of blood bags in hospitals threatens the lives of around 15% of the patients. Up to 300 thousand bags deficit every year. This confirms the fact that the lack of awareness is the main reason for the disappearance of the rare blood groups [2].

Some important facts should be explained first before explaining the proposed system. These are:

A. *Blood knowledge*:

The normal grown-up has around 5 l of blood inside their body, conveying fundamental components, expelling hurtful squanders, and coursing through their vessels. Without blood, the human body will quit working. This is because it is the liquid of life as it transports wastes to the kidneys and sickness battling materials to the tissue.

B. *Blood banks*:

The blood bank is the pool of different blood groups where keeping a stockpile of blood to be distributed in case of
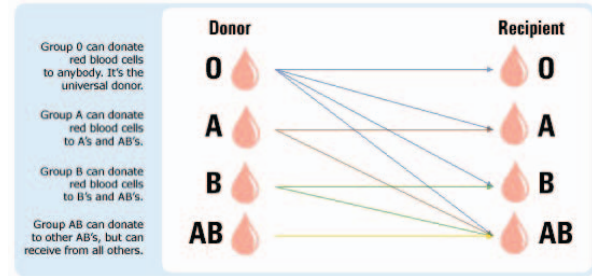

Fig. 1. The matched blood groups for a safe transfusion [3].

accidents (or any medical emergency and compensation of blood missing from the body), and keeping the blood in the freezer temperature.

The blood bank aims to:

- Provision of a large amount of blood of various categories.
- Storage of different quantities as required sanitary conditions and keep it useable anytime it is needed.
- Contribution to the society and illustrate the importance of blood to save lives.
- Separation of blood components such as red blood cells, and platelets, etc.

C. *Blood groups*:

There are many restrictions on the donation process as one cannot donate to anyone and cannot receive blood from anyone. Different blood groups need to be matched correctly. This is illustrated in Fig. 1.

D. *Blood components*:

- **Whole blood**: includes white and red cells, and platelets (pending in plasma).
- **Red cells**: hold oxygen from the lungs to the body's tissues and take carbon dioxide back to the lungs to be breathed out.
- **Platelets**: tiny colorless cell fragments whose fundamental task is interfacing with coagulating proteins to stop or prevent bleeding.
- **Plasma**: a liquid made out of 7% imperative proteins, around 92% water, and 1% mineral salts, fats, sugars, vitamins, and hormones.
- **Cryoprecipitate AHF**: a part of plasma plentiful of clotting elements and is prepared by freezing and afterward gradually unfreezing the frozen plasma [5–8].
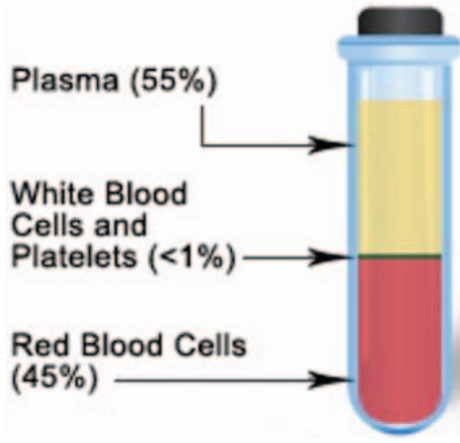
Fig. 2. The blood components [3].

TABLE I
BLOOD GROUPS RATIOS IN HUMANS. [3].

Blood group	Caucasians	African–American	Hispanic	Asian
O+	37%	47%	53%	39%
O−	8%	4%	4%	1%
A+	33%	24%	29%	27%
A−	7%	2%	2%	0.5%
B+	9%	18%	9%	25%
B−	2%	1%	1%	0.4%
AB+	3%	4%	2%	7%
AB−	1%	0.3%	0.2%	0.1%

These blood components are shown in Fig. 2.

E. *Problems of blood bags shortage*:
- The uncontrolled blood banks and parallel markets. Blood bag cost is so costly particularly for the delivery of rare factions and hotlines to communicate with donors. Blood banks employees can make their profitable business by embezzlement of blood bags. This is because of the lack of:
  - Controlling empty and filled bags.
  - Recording donation data in the blood banks.
  - Controlling blood donation campaigns [9].
- The lack of awareness and confidence.
  Examples of the lack of awareness are the misconception that donating blood can transmit diseases, and the false beliefs that donating blood is harmful.
  The lack of confidence that the donated blood will reach to the individuals who merit it and that it won't be sold in the parallel markets.
- Disappearance of the rare blood groups.
  Table I demonstrates the ratios of blood groups in humans.
- The difficulty in reaching a specific blood group.
  At the point when there is no central database between the blood banks (showing the ebb and flow stock of the blood and its segments), then the patients must search for donors and it may be hard to get donors in emergencies.

F. *Donation eligibility requirements*:
- Age: 18–60.
- Weight: More than 50 kg.
- Donation rate (female: every 4 months, male: every 3 months).
- Ideally nibble-two hours before donating for the first time.
- Hemoglobin: (female: more than 11.5, males: more than 12.5).
- Hematocrit ratio: (female: more than 38, male:- more than 41).

- The likelihood of the separation of the blood elements that are utilized in the treatment of blood thinners and kidney disease, liver, etc.
- Blood Pressure: 90–180 to 50–100.
- Pulse: regularly 50–100/min.
- Temperature: 35–37 °C.
- The absence of any symptoms.
- The blood transfusion centers focus on the restorative examination of the donors to ensure the free of the sickness. They also test the blood to ensure the respectability and illnesses free of that blood [4], [7].

In this paper, we proposed "Blood Bag" web-based application in order to help get the needs for specific blood groups. Furthermore, the donors can register their data to be notified on their mobile phones by SMS when a new donation campaign is registered in the system and before arriving to their area. This is to control the donation processes outside of the blood banks. After the analysis processes, the blood bank's employee uploads the complete report to the system and the donor can login to explore this report. Therefore, the "Blood Bag" application controls the whole processes related to the blood donation. This all guarantees the delivery of a safe and reliable blood bag to the patients.

The rest of this paper is organized as follows. Section II explains the previous work. Section III details the proposed system. Section IV concludes this paper. The future work in this area is presented in the last section.

II. PREVIOUS WORK

Several web applications and social networks pages expatiate the issue of blood shortage over the world especially Middle East, Africa, and Asia. These try to deal with blood shortage by collecting the contact data of the donors and patients and helping the patients search for donors without taking care of the nature of blood bags and blood donation (such as blood analysis, blood bag stock control, etc.). The following table explores samples of these works (see Table II).

III. THE PROPOSED SYSTEM

We proposed the "Blood Bag" as a web-based application connected to a centralized database which gathers and organizes the data from all blood banks and the blood donation campaigns. This system sorts out and controls the entire basic procedures identified with blood donation, testing and storing blood bags, and delivering it to the patient.

TABLE II
BLOOD BANK WEB APPLICATIONS.

	Web application	Location
a.	http://www.bankeldm.com/index.php Last visited on 18/12/2016—09:00 AM	Egypt
b.	http://www.law3andakdam.com/ Last visited on 18/12/2016—09:12 AM	Egypt
c.	http://sangdz.com/adduser.php Last visited on 18/12/2016—09:30 AM	Algeria
d.	http://www.bloodbank.sd/ Last visited on 18/12/2016—10:00 AM	Sudan
e.	http://indianbloodbank.com/ Last visited on 18/12/2016—10:15 AM	India
f.	http://www.hyderabadblooddonors.org Last visited on 18/12/2016—10:30 AM	India

A. The phases of developing the proposed application

- **Scope definition**: Control pure blood bag and combating the parallel market. This will be done by controlling the whole donation process from empty blood bag till filled one whose used by anyone really need it. Passing through donation process, donor, follow him up, the application registration and campaigns.
- **Requirement analysis**:
  ○ Observation the work environment during actual donation and all processes related to the donation.
  ○ Interviews to collect information about donation, campaigns, and blood analysis.
- **Problem analysis**:
  ○ Where blood groups are available.
  ○ The difficulty in obtaining the required blood group.
  ○ Blood donation is invalid.
  ○ Parallel markets.
  ○ Repeated blood analysis.
  ○ Fear of blood donation.
  ○ Lack of knowledge of the benefits of donating blood.
- **System design and implementation**
  ○ This system was built using Microsoft Visual Studio 2015 (ASP.net-C#), Dev Express 15.2.7, and Microsoft SQL Server 2012.
  ○ System Requirements: "Blood Bag" supports the following web browsers(Chrome v. 50.0 or later, Firefox v. 48.0 or later, and Internet Explorer v. 11.0 or later).
  ○ The system runs on Microsoft Windows (versions 7, 8, 8.1, and 10).

B. System components

The main components of the proposed system are illustrated in Fig. 3.

The previous figure shows the following modules:

- **Admin session**: it manages the main data. After the admin login, he can manage the system data using the following main parts:
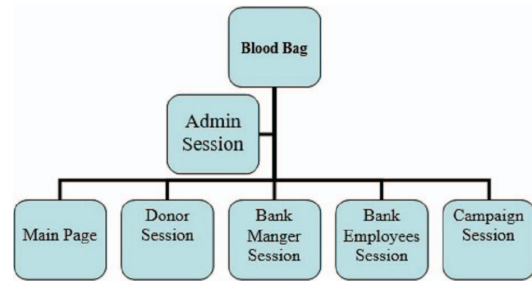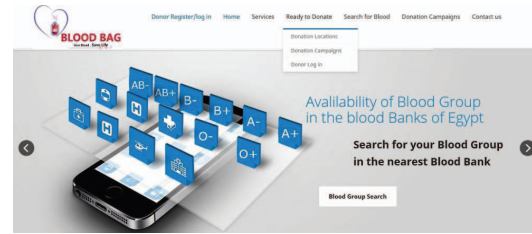

Fig. 3. Blood bag system components.
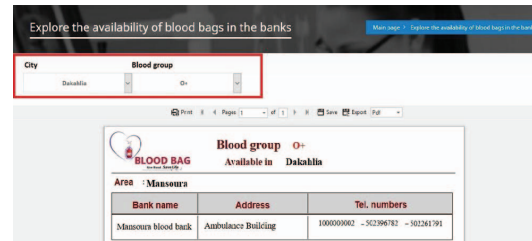

Fig. 4. The main page.

Fig. 5. Search for blood.

  – Bank management.
  – Locations (City & Area) management.
  – Employees and position management.
  – Campaign's car management.
  – Diseases data.
- **Main page**: visitors can explore the blood banks addresses, blood donation instructions, and search for a particular blood group and the whereabouts of the blood donation campaigns. Furthermore, the donor can register his/her information to receive a notification SMS when a new donation campaign enrolled in the system and before arriving to his/her area.

The main page is illustrated in Fig. 4.

Fig. 5 illustrates how the visitor can search for specific blood type by selecting "search for blood" from the main page, and then selecting the city and the required blood group to explore its availability according to his/her search criteria.

- **Donor session**:
  This session contains the following functions:
  ○ Update personal data.
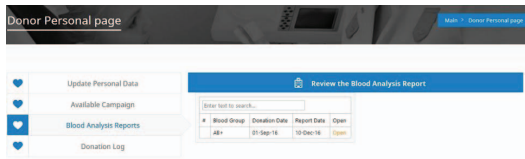 ○ Explore the available campaigns according to their addresses.

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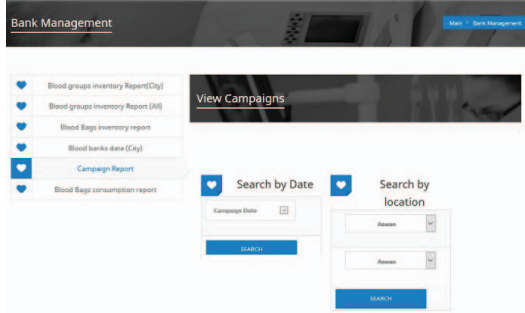Fig. 6.   Review the blood analysis reports page.

Fig. 7.   Review campaign report from bank manager session.

○ Review the blood analysis reports & donation log.

Fig. 6 illustrates how the donor can access and review his blood analysis reports after his/her login.

- **Bank manager session**:
  It contains the following functions:
  ○ Inventory reports blood groups and bags (tables & graphs).
  ○ Blood banks data.
  ○ Campaigns reports.
  ○ Blood bags consumption report grouped by blood group (Tables & Graphs).

Fig. 7 illustrates the different search criteria to review campaigns reports from the bank manager session.

- **Bank employee session**:
  ○ Donation registration & print donation cards.
  ○ Fill and print donation applications.
  ○ Register a new patient.
  ○ Modify donor's data.
  ○ Upload (PDF) donation reports after analysis for donor's access.
  ○ Add empty blood bags.
  ○ Register new campaigns.
  ○ Send SMS notifications to donors.
  ○ Add blood bags to a campaign.
  ○ Receive bags from campaign & after analysis.
  ○ Blood bags disposal (damaged).
  ○ Donors' rejection.
  ○ Release blood bags.

Fig. 8 illustrates how the bank employee register new donation by entering the donor national number to review the donor status (accepted or rejected) and whether the donor suffers from any diseases before filling the donation application.
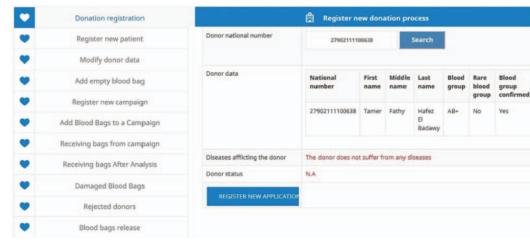

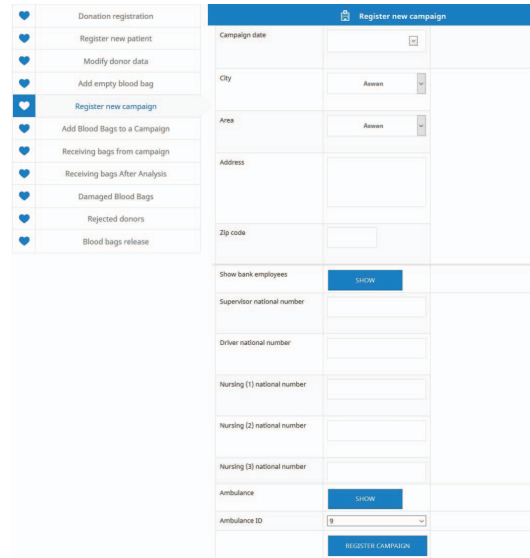Fig. 8.   The employee session (register new donation process).

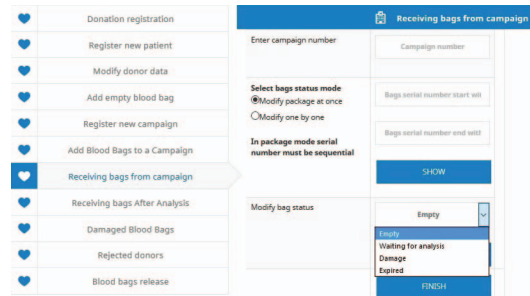Fig. 9.   The employee session (register new campaign).

Fig. 10.   The employee session (receiving bags from campaign).

Fig. 9 illustrates how the bank employees register new donation campaign by entering its data (address, team, ambulance, driver, and empty blood bags identified by a sequential serial number).

Fig. 10 illustrates how the bank employees search using the campaign number to register the returned blood bags which released to the campaign and assign each bag status (empty, waiting for analysis, damage and expired)

Fig. 11 illustrates how the employee modifies the donor status to be rejected upon receiving the blood analysis report.

Fig. 12 illustrates how the bank employee can release blood to patient for transfusion.

Fig. 11. The employee session (Rejected donors).

Fig. 12. The employee session (blood bag release).

Fig. 13. The campaign session (register new donation).

- **Campaign session: includes the following functions**:
  - Register new donation.
  - Check donor status before donation.
  - If accepted, register new application form.
  - Print barcode for blood samples and bags.
  - Print donation card with user name and password for donor access to his page to review the analysis report.
  - Update campaign address in case of emergency move from the previously assigned location.
  - Send SMS to the donors according to their addresses.
  - Review the total donation processes has been done by the campaign.

Fig. 13 illustrates how the campaign supervisor can register new donation using the donor national number.

Fig. 14. The campaign session—barcode structure.

Fig. 15. The campaign session (send SMS).

Fig. 14 illustrates the printed barcode identify the blood bag after donation using two segment concatenated (donor national number & donation date).

Fig. 15 illustrates how the campaign supervisor can send SMS notification to the donors whose addresses matches the campaign address.

IV. CONCLUSION

Blood Bag system helps blood banks and donors save lives of the patients through a controlled system which manages all blood donation and transfusion processes. These processes are stored in a central database. We aim to ensure that the transfusion blood is safe, and reliable. Moreover, we aim at defeat the uncontrolled blood banks and parallel markets, raise the awareness, and support confidence.

Following up the donors through sending an SMS with the next donation campaign date and location, we aim to encourage them to donate and give them the ability to review their analysis report on the proposed website.

All donors data registered in the system are available for all blood banks and campaigns to avoid uncontrolled donation processes from infected donors. The responsible physician must search for the donor data by the national distinguishing proof and audit the status (accepted, rejected) before the donation.

V. FUTURE WORK

As a direction for future work in this area, we plan to connect all of the blood banks labs to insert the detailed blood analysis reports to implement a quantitative analysis of the diseases that appeared and repeated in a specific area. This will help plan for the future campaigns and target locations for the next donation.

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