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A Knowledge-Based System to Identify the Potential Blood Donors

Atheer M. Alsulu, Ghaida R. Alduhaim, Reema A. Alluhidan, Wedad M. Alawad* and Meshaiel M. Alsheail
Department of Information Technology, College of Computer, Qassim University, Buraydah, Saudi Arabia.

ABSTRACT

Blood donations help save millions of lives every year. According to the World Health Organization, almost 120 million blood units are collected each year to help people with various health conditions. But this still doesn't meet demands. Blood cannot be stored indefinitely, making blood unit collection a challenge. Furthermore, even though blood banks run blood donation campaigns regularly, some patients are suffering from the lack of suitable blood types in blood banks. Additionally, finding appropriate donors is another common challenge facing blood banks. In this paper, we have proposed a scheme to improve the performance of blood banks and increase the chance to find suitable blood donors promptly. Besides, our system helps to select an effective target group for blood donation campaigns. The proposed blood bank system is artificial intel-ligence-based; it depends on machine learning algorithms to enhance the efficiency of the process of finding potential blood donors. Additionally, the blood donor database is not limited to people who have provided their information to blood banks as anticipated blood donors. It also includes some people who have never visited blood banks. In the suggested system, a machine learning algorithm classifies people in the database into two groups: people who are more likely to donate their blood and those who are less likely to donate blood. The classification relies on the factors that affect a person's be-havior, such as the education level, work environment, culture, and personality. One added benefit of the system would be encouraging blood donation among previously reluctant blood donors.

KEY WORDS: MACHINE LEARNING, BLOOD BANK, CLASSIFICATION, BLOOD DONATION.

INTRODUCTION

Blood donation is the "act of giving blood" which can be used to save lives Harmon& Angela (2019). Ac-cording to the American Red Cross, someone will need a blood

transfusion every two seconds. Because the blood does not have a substitute, volunteer blood donations are important. Blood donation does not harm a healthy person; it typically is a short process that can help someone in need. One blood unit (450 - 500 ml) can help four people. Donated blood units have various uses some of them will be mentioned. Blood donation helps patients with cancer, thalassemia, sickle cell disease, and other diseases. It also helps a person who has lost blood due to accidents, surgeries such as organ transplants, heart, and women with complica-tions during child-birth Rahman et al. (2011), Arif et al. (2012), Nabil et al. (2020), and Das et al. (2020). As figure 1 shows, most cases need to donate, they are cancer patients, accident victims, sur-gery, medical uses for extract Plasma to treat some diseases,

and heart patients to supply pa-tients of Coronary artery disease Wateen (2019) and Nabil et al. (2020).

Figure 1: Cases Need a Blood Donation
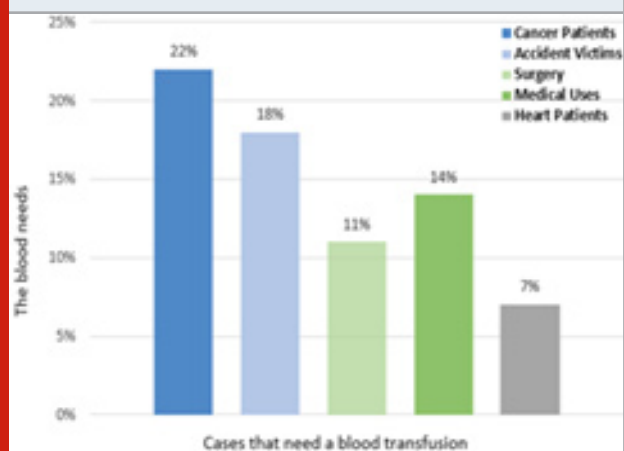
During the donation process, the person will give between 450 to 500 milliliter of blood from about 4,500 to 5,700 milliliter in his/her body Blood donation (2013). How much blood is in the human body (2017) and Naresh & Nagesh (2020). According to the Ministry of Health in Saudi Arabia, 90 million units of blood are donated each year globally Hematology - Blood Donation (2018). Regardless of that, the demand for blood transfusion is on the increase. In Saudi Arabia, only 42%of the blood banks' need is covered by voluntary donation and the remaining 58% is covered by a compensatory donation by donation from patients' relatives and friends while the goal is to reach self-sufficiency with 100% voluntary donations, see figure 2.


Figure 2: Blood Donation Types
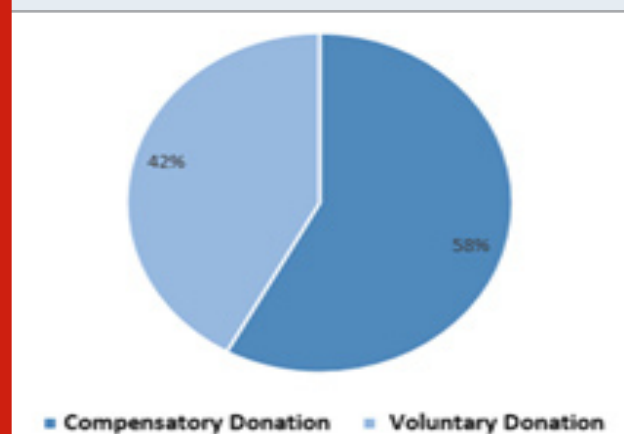
Furthermore, according to the results of the survey that we have collected which is shown to us that 84.1% of the people who answer the survey never donated and only 15.9% have do-nated before. That means there is a lack of blood donation. The de-tails of this survey have been explained in section 5. Many organizations in Saudi Arabia that works with the ministry of health to increase voluntary blood donation percentage" such as Wateen

"Wateen is a na-tional blood donation platform Harthy (2018) and World blood donor day (2016) and Das et al. (2020). However, the problem with most existing blood bank systems that it does not cover the blood banks' need by 100% of voluntary donations. These systems rely on patients who need blood to provide donors if the blood bank does not have enough blood units which can take a lot of time and effort. As figure 3 shows, a model of the existing blood bank system Harthy (2018).

Figure 3: Existing Blood Bank System
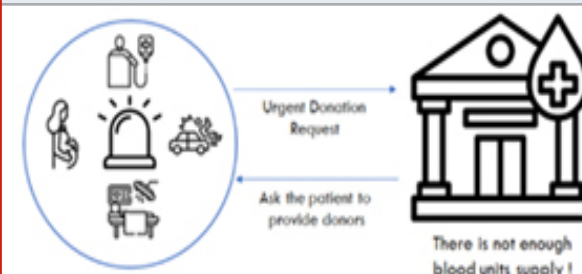
MATERIAL AND METHODS

The main goal of this proposal is to improve the blood bank system by reaching out to people more likely to donate through study some factors that affect their behavior by taking ad-vantage of the ML algorithms then contact them. That will help increase voluntary donation. This section is an overview of the concepts and definitions related to the proposed work. A brief description of the blood bank and machine learning is provided. Blood Bank is the cen-ter responsible for all blood-related operations where blood is collected from donors, blood tests and blood components donated, stored, treated and transported to patients in need of blood transfusion. Donated blood (whole blood) is sometimes separated, each component separately, and transferred to a different person as needed. The blood center may be inde-pendent or part of a hospital Obeagu et al (2016) and William (2018).

The history of blood bank starts at 1492 with the first blood transfusion attempt, then in 1901 was discovered blood groups A, B, and O. In 1907 was the first successful blood transfusion, and in 1932 has been created first blood store and transfusion center in the Middle East Wa-teen (2019), and now blood banks are everywhere. Saudi Arabia has over 260 World blood donor day (2016). Machine learning (ML) is "Field of study that gives computers the capabil-ity to learn without being explicitly programmed" ML what is machine learning? (2019). Ma-chine learning is done when machine learning algorithms are learned from the information directly, they did not dependent on predefined equation. Also, the improvement of algorithm performance depends on increasing the amount of sample available to learn What is machine learning (2019). The basic learn-ing models in ML are: Supervised Learning (SL), Un-supervised Learning, Semi-supervised Learning, and Reinforcement Learning Luo et al. (2020).

Several studies discuss blood bank systems and ways to improve their work. Most of them focus on providing non-knowledge-based blood bank systems that connect donors with recip-ients and blood banks. On the other hand, some focus on providing an effective blood bank system by using machine learning algorithm and classification techniques. The problem that we face in these studies was a few of them that use predictive in the blood donation sector. which made our reading and research limited in specific studies Naresh & Nagesh (2020).

Different ML algorithm have been used in researches that study ML algorithms and classifi-cation techniques in the blood bank sector. Some studies applied decision tree algorithms such as the CART algorithm was used in Santhanam & Sundaram (2010) to classify and identify blood donation behavior. The authors Ramachandran et al. (2011) used a decision tree (J48) algorithm to develop

a system to analyze large datasets of donor blood groups. Also, the au-thors Zulfikar et al. (2018) used decision tree and Naive Bayes classifier to determine the eli-gibility of the donor by proposing a classification model that reduces time in the selection process and then compares their accuracy and performance which is naive bayes was better Luo et al. (2020).

Besides, some of them add deep learning algorithms to their studies such as, author Bahel et al. (2017) used artificial neural networks, decision tree (C5.0) and support vector machines to solve the problems on the performance of ML algorithms in existing studies that predict the appropriate donor by proposing a new prediction model. Also, authors Boonyanusith & Jit-tamai (2012) used artificial neural networks and decision tree (J48) to develop a classification model from different factors that influencing behaviors in blood donation and compare the results between algorithms.

Table 1. Review of Knowledge-Based Blood Bank Systems of Previous Studies.

Paper	Goal	Dataset	Algorithm Used	Accuracy
2010	Create a model that identifies blood donation behavior using classification algorithms.	Blood transfu-sion service center	Decision Tree (CART)	99%
2011	Identify an appropriate blood donor in a short time and high efficiency. By analyzing large datasets of donor blood groups	Database of (IRCS) Blood Bank Hospital.	Decision Tree (J48)	59%
2018	Reduce time in the selection process which defines the eligibility of the donor.	Not mentioned	- Decision Tree - Naive Bayes	66.65% 79.95%
2017	Solve the problems on the performance of ML algorithms that predict the appropriate donor.	From the Blood Transfusion Service Center in Hsin-Chu City in Taiwan.	- C5.0 -Artificial Neural Net-works - Support Vector Machines	88.37% 83.72% 76.74%
2012	Compare results in blood donor classification between ANN and DT.	An online ques-tionnaire at 4 universities in Thailand.	-Artificia Neural Net-works -Decision Tree (J48)	76.25% 75.75%
2009	Study what factors influence on blood donation behavior in Egypt and compare the classification performance of NNs against LDA.	Self-completion questionnaire to citizens in Port Said, Egypt.	- Multilayer Perceptrons - Probabilistic neural network - latent Drichlet allocation	98% 100%

The author Mostafa (2009) presented a detailed study of profiling or classifying blood dona-tion in Egypt. Where he lists four factors that influence blood donation. Which they are: altru-istic values, perceived risks, knowledge, and attitudes. Then he develops hypotheses to tease these factors on data that were collected in Port Said, Egypt using the drop-off, pick-up meth-od and compare two types of artificial neural networks models.

This method is used in studies conducted in the Arab world due to the difficulty of reaching the respondents using mail questionnaires. In this study, the author listed only four factors that affect blood donation, but several factors are most influential in a person's actual coming to donate blood. In our proposed system, we will examine the factors mentioned by the author in his study Mostafa (2009) as well as other factors that are not

already mentioned and might have a greater impact on Saudi society such as Religious factors. Table 1 shows a summary of these studies.

The issues related to some of the previous studies was the predicted of the regulari-ty of donors based on the number of donation without considering the factors that may affect people in their coming to donate. However, some of them did not cover some important factors such as occupation and study major.

RESULTS AND DISCUSSION

The big challenges facing blood donation in Saudi Arabia and globally are finding blood do-nors and encouraging non-donors to donate. This study presents a potential solution to some of those issues. Establishing an effective system of predicting who is more likely to donate blood would improve the probability of increasing blood donors. The proposed system will be done by developing a classifier using an ML algorithm that clas-sifies people into more likely to donate blood and less likely to donate based on some factors that affect people in responding to blood donation requests such as social, psychological, and religious. After developing the classifier, it will be able to predict the classification of new people through their data that have been collected from different sources such as universities, hospitals or other work environments. The proposed system model is shown in figure 4.


Figure 4: The Proposed System Framework
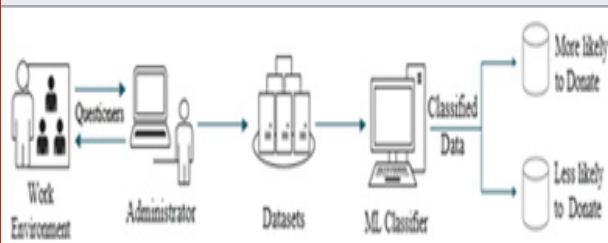
The process of developing the classifier requires providing previous data to the ML algorithm in the training phase. However, due to the lack of blood donor data sets that have the factors that affect the blood donors, we carried out a questionnaire to collect data the details of this survey will be explained in section 5. A closer look at the system's work and how it will help in real-life scenarios. First, the blood bank has to collect data from employees in different environments or students in universities via questionnaire. Then the system administrator will add that data to the system. After that, when the blood bank has a request for blood donation, the system will display the potential donors from the database, which contains in-formation of the people who are more likely to donate. Then, it will drop the records that do not match the request such as, people who have blood group does not match who in need to donate. Also, the system will automatically block the donor if it does not pass two months after the last donation. Figure 5 shows the utilization of the proposed system in real-life scenarios.

Figure 5: The Utilization of the Proposed System in Real-Life Scenarios
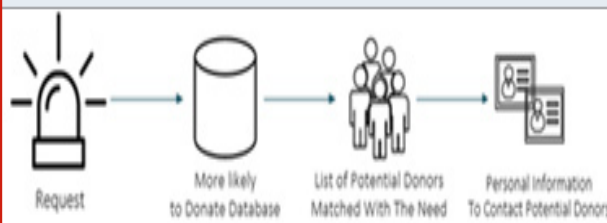
This system would be useful in different ways such as, devise strategies that target non-donors for example, through awareness campaigns on the importance of blood donation. Also, targeting donors through contacting them at urgent blood requests, and blood donation cam-paigns. The outcome of the proposed system will improve the efficiency of the blood bank system by finding blood donors more accurately, and reduce costs by contacting the potential donors rather than contacting someone how is not willing to donate. To implement the proposed system, we collected and analyzed data to train and test our mod-el.

Table 2. The First Section of the Second Questionnaire.

Question	Description of question
Age Gender Blood type	The age of the respondent. The gender of respondents. When a Respondent knows the type of blood group, he or she is often aware of the importance of donating, especially when it is a rare species
Education level	the level of education of respondent.
Work or study in a medical field	Because they work or study in a place where there is a need for urgent blood donation, and they may see patients in a serious condition in need of blood with the lack of suitable blood for them in the blood bank, so they are aware of the importance of donation.

Data Collection: There was not a data set which suits our system. Because of that, data col-lection is carried out using a Self-Administered Questionnaire (SAQ) which is a type of communication method. That is one of the approaches to collecting data through different channels. First Questionnaire: The first questionnaire

was conducted online to gain insight into the reality of blood donation in Saudi society. The survey contains general questions about the respondents such as, gender, blood unit, and if she/he has donated blood before. If the answer to the last question was affirmative, she/he will proceed to the second section of the survey, which includes several questions about the details of the respondent's experience in blood donation such as the reasons for blood donation. We collected 1,704 responses in this ques-tionnaire, of which only 271 (15.9%) had previously donated blood.

Second Questionnaire: The second questionnaire which is the one we will use to implement our model. This one had spread using both paper and online surveys to make sure that is reaching out to the largest possible segment of the community. The main objective of the sur-vey is to know the essential reasons that impulse people donate their blood. The survey con-tains two sections of questions. The first section contains personal questions

about the re-spondents like age, gender, education level, and blood unit which is part of the factors that affect people's willingness to donate blood. The second section contains several questions about other factors that affect people's desire to donate, including psychological, health and other factors.

First questionnaire, first section contains general questions about the respondent
- Age: The age of the respondent.
- Gender: The gender of respondents.
- The type of blood: The blood type of respondent. This question helps us find out the most common blood type in Saudi Arabia, and the percentage of each type.
- Have you ever donated blood: When the respondent answers this question in the af-firmative, he will proceed to the second part of this questionnaire, which contains questions about the details of his blood donation experience.

Table 3. The Second Section of the Second Questionnaire.		
Factor	**Question**	**Description of question**
personal	Are you regular in donating?	Donate approximately every three months if there is not a health issue prevents you. A regular respondent donation indicates an understanding of the importance of donation.
	Did you go through a health issue that made you need blood donation?	If the respondent has ever needed a blood donation, he/she will know the importance of donation.
	In most cases of blood donation was the reason for the donation?	The respondent will identify one of these options: volunteer, kinship or never before.
Social	Have you ever donated blood?	In the past, a respondent donation indicates an understanding of the importance of donation.
	Have you lost a relative or acquaintance because he/she needs blood?	If the respondent a harsh experience and lost some of his/her relative or acquaintance because of the lack of blood. This makes him/her aware of the importance of donation.
	Have you ever suffered in the search for a blood donor?	If the respondent had a harsh experience in the search for urgently suitable donors to save a human life makes him/her realize the importance of donation.

Cultural	Do frequent donations and social media engagement encourage you to donate?	We will examine the effect of this factor in encouraging people to donate blood.
	Did you know that people with chronic non-communicable diseases, except heart disease, are able to donate blood?	Knowing the respondent about the blood banks' need for donors make him/her aware of the seriousness of the matter and the importance of a donation.
	Did you know that blood expires after a period in the blood bank?	
	Did you know that the need for blood is not limited to injuries caused by car accidents?	
	Do you think that blood needs in Saudi Arabia are adequately covered and the blood banks does not need more donors?	
Health	Do you think that blood donation is similar to some health practices like cupping?	Because cupping is a solution to stimulate blood circulation and get rid of some blood, is the respondent think that donation is similar to cupping because it also activates the blood circulation.
Religious	Do you suffer from an infectious disease, take medicines or any other health excuse that prevents you from donating?	The respondent will not be able to donate blood if his/her suffer from some health excuse.
	Do you think the main motivation for your blood donation initiative is to save the lives of others?	Because it helps save the lives of others.
Misconcep-tions	Do you think that blood donation is a danger to the health of the donor like the transfer of infection or diseases?	As a result of the unawareness of some people on how to donate, so they refrain from donating for fear of transmission of diseases or infection.
	Do you think blood donation is a risk to women's health?	Due to the exposure to several health symptoms lose a quantity of blood during her life such as menstrual cycle and birth. Some people think that women should not donate.

Second section of first questionnaire, contains questions about donor's blood donation expe-rience.

- Reasons for your blood donation: This question determines why respondents previous-ly donated for personal or voluntary reasons or both of them.
- How many times did you donate blood: find out how many donations have been done by respondents.

Second questionnaire, the first section of the questionnaire contains some personal ques-tions, see table 2. After answering these questions, he/she will proceed to the second section of the question-naire, which contains several questions about some factors that affect people's desire to do-nate, including psychological, health, cultural, and other factors. These questions are divided

into several sections according to the factor that belongs to, see table 3.

CONCLUSION

In this study, we have discussed the need for more efficient blood bank systems that helps in-crease the numbers of blood donors. We have proposed a knowledge-based system for blood banks that increase the chance to find potential blood donors. The system will be classifying people into potential donors and people who may not donate their blood. The classification will be based on the factors that affect people's behaviors in responding to blood donation requests like people's values, and their culture. The system would not only improve the effi-ciency of the blood bank system, but it would also reduce costs by contacting potential donors rather than contacting someone how is not willing to donate. As future work, we will develop the proposed system using machine learning techniques.

REFERENCES

Arif, M., Sreevas, S., K. N. R. R. (2012). Automated online blood bank database.2012 Annual IEEE India Conference, INDICON2012, pages 12–17.

Bahel, D., Ghosh, P., Sarkar, A., Lanham, M. A., and Lafayette, W. (2017). Predicting blood donations using machine learning techniques.

Blood donation. (2013) Accessed:27, Feb, 2020, https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/blood-donation .

Boonyanusith, W. and Jittamai, P. (2012). Blood donor classification using neural network and decision tree techniques. In Proceedings of the World Congress on Engineering and Computer Science, volume 1, pages 499–503.

Das, H. D., Ahmed, R., Smrity, N., & Islam, L. (2020, April). BDonor: A Geo-localised Blood Donor Management System Using Mobile Crowdsourcing. In 2020 IEEE 9th International Conference on Communication Systems and Network Technologies (CSNT) (pp. 313-317). IEEE.

Harmon, Angela (2019) blood donation. Accessed:27, Feb, 2020, http://sdl.edu.sa/middleware/Default.aspx?USESDL=true&PublisherID=AllPublishers&BookURL=https://sdl.idm.oclc.org/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ers&AN=121772951&site=eds-live.

Harthy, S. (2018). 60% blood need in Saudi Arabia and voluntary donation only 40%. Accessed:27, Feb, 2020, https://www.kau.edu.sa/PreesArch.aspx?Site_id=5710571&nid=57178&tlng=ar .

Hematology - Blood Donation. (2018) Accessed:27, Feb, 2020, https://www.moh.gov.sa/en/HealthAwareness/EducationalContent/Diseases/Hematology/Pages/007.aspx .

How much blood is in the human body.(2017) Accessed:27, Feb, 2020, https://www.healthline.com/health/how-much-blood-in-human-body.

Luo, Y., Tang, Z., Hu, X., Lu, S., Miao, B., Hong, S., & Na, N. (2020). Machine learning for the prediction of severe pneumonia during posttransplant hospitalization in recipients of a deceased-donor kidney transplant. Annals of Translational Medicine, 8(4).

Ml what is machine learning? (2019) Accessed:27, Feb, 2020, www.geeksforgeeks.org/ml-machine-learning/.

Mostafa, M. M. (2009). Profiling blood donors in Egypt: Aneural network analysis. Expert Systems with Applications, 36(3):5031–5038.

Nabil, M., Ihab, R., El Masry, H., Said, S., & Youssef, S. (2020, January). A Web-based blood donation and Medical Monitoring System Integrating Cloud services and Mobile Application. In Journal of Physics: Conference Series (Vol. 1447, No. 1, p. 012001). IOP Publishing.

Naresh S., & Nagesh, O. (2020). Secure Dynamic Interactive Blood Bank based on Cognitive Computing. International Journal of Industrial Engineering & Production Research, 31(2), 295-300.

Obeagu, E., Ochei, K., and Oshim, I. (October 2016). Current concept of blood bank organization and planning: A review.

Rahman, M. Akter K., S. H. A. B. S. A. (2011). Smartblood query: A novel mobile phone-based privacy-aware blood donor recruitment and management system for developing regions. Proceedings-25th IEEE International Conference on Advanced Information Networking and Applications Workshops, WAINA 2011, pages 544–548.

Ramachandran, P., Girija, N., and Bhu-vaneswari, T. (2011). Classifying blood donors using data mining techniques. International Journal of Computer Science Engineering &Technology, 1(1).

Santhanam, T. and Sundaram, S. (2010). Application of cart algorithm in blood donor's classification. Journal of computer Science, 6(5):548.

Wateen (2019) Accessed: 27, Feb, 2020, https://wateenapp.org/.

What is machine learning? how it works, techniques applications (2019) Accessed:27,Feb,2020, https://www.mathworks.com/discovery/machine-learning.html.

William C. Shiel (2018). Definition of blood bank. Accessed:27, Feb, 2020, https://www.medicinenet.com/script/main/art.asp?articlekey=13184.

World Blood Donor Day.(2016) Accessed:27, Feb, 2020, https://www.moh.gov.sa/en/HealthAwareness/HealthDay/2016/Pages/HealthDay-2016-06-14.aspx .

Zulfikar, W., Gerhana, Y., and Rahmania, A. (2018). An approach to classify eligibility blood donors using decision tree and naive bayes classifier. In2018 6th International Conference on Cyber and IT Service Management (CITSM), pages 1–5. IEEE.