Journal of Management & Entrepreneurship
ISSN 2229-5348

UGC Care Group I Journal
Vol-13 Issue-01 April 2024

Advanced Strategies for Smart Blood Donation Management

[1]Komal Vijay, [2]Karn Kaushik , [3]Raj Nandani, [4]Pratibha Kumari

Assistant Professor, Arya College of Engineering, Jaipur, Rajasthan, India

Department Computer Science & Engineering, Arya College of Engineering, Jaipur, Rajasthan, India

rajnandani24200204@gmail.com,dudipratibha1234@gmail.com, komalvijaycse@gmail.com,

karan88ck@gmail.com

Abstract: Blood transfusion is vital in emergency medical care and various surgical procedures, highlighting the need for efficient management of the blood supply chain from donors to medical facilities. This study conducts a comparative review of existing strategies in blood donation and assignment management systems, focusing on ensuring a continuous supply of blood products to transfusion centers and hospitals. The emphasis is on optimizing blood donation processes and forecasting future donation trends. The optimization framework aims to minimize the wastage of blood units due to expiration while reducing reliance on external sources through effective management of critical blood shortage levels and expiration monitoring. Additionally, this study provides insights into the main findings, limitations, and unexplored challenges of current blood donation management systems. Finally, it offers recommendations to address these limitations and identifies potential avenues for future research and improvement in blood donation management.

Keywords: Blood donation, health administration, blood bank, donor intelligence, machine learning, data mining, categorization techniques, optimization.

1. Introduction

Blood transfusion is a crucial component of healthcare, vital for various medical procedures and emergency care. Given that blood is a limited resource, ensuring its consistent availability in hospitals and medical centers is essential for patient care. However, challenges in the blood donation process highlight the need for effective supply chain management to meet the demand for blood products.

This paper offers a comprehensive literature review of studies that focus on information management systems and optimization strategies to improve the blood donation process. Additionally, it explores the use of machine learning and data mining algorithms in managing blood donations. The research aims to identify and address the key limitations of current blood donation management systems.

2. Smart Blood Donation System

Blood donation plays a crucial role in ensuring an adequate supply of blood products for hospitals and medical centers, ultimately saving lives. Blood centers collect whole blood from volunteers, which undergoes strict screening and testing to ensure it is free from infectious diseases. This blood is then processed into various components such as red blood cells, platelets, plasma, and cryoprecipitate. There are two primary methods of blood donation: whole blood donation and apheresis, which allows donors to specifically donate certain blood components. Hospitals and blood banks maintain inventories of blood products under specific storage conditions, often requiring freezing or refrigeration. These products have limited shelf lives, with

plasma lasting up to a year, red blood cells for 42 days, and platelets for only 5 days. Consequently, maintaining a stable and sufficient supply of blood products is critical to prevent disruptions in medical procedures and patient care. The blood donation process incurs costs for collection, testing, and processing, with expired blood products resulting in significant waste and financial losses. Inaccurate estimations of blood demand can lead to additional expenses, compromised service quality, blood shortages, or overproduction. Managing the complex process of blood collection, supply, transfusion, and storage presents numerous challenges, particularly in matching hospital demands with available blood types. Before surgeries, extra blood products are commonly reserved for patients to prepare for potential emergencies or increased demand. However, the yearly decline in donated blood emphasizes the need for efforts to promote regular donation. Accurately forecasting donor numbers can help medical facilities anticipate future blood supplies and plan donation initiatives accordingly. To address these challenges, efficient blood donation management systems must guarantee sufficient blood storage, precise predictions of future supplies based on donor estimates, reduction of wasted blood due to expiration, and decreased dependence on external blood sources.

3. Related Work

In the realm of healthcare management, numerous studies focus on enhancing the supply chain management of blood donation through the development of systems utilizing optimization and classification methodologies (e.g., [1]–[2], [4]–[6]). Sundaram and Santhanam [3] categorized blood donation supply chain systems by delineating the key stages of a blood plastic bag's lifecycle, including donor registration, blood collection, screening and testing, inventory storage, blood unit delivery, and utilization. Conversely, Pierskalla [15] expanded this classification to encompass additional factors such as the locations of blood centers, blood product production, allocation to hospitals and medical centers, inventory control, and product delivery. This study examines recent research employing information systems and optimization techniques in healthcare to manage blood product supply chains. These methods aim to streamline blood donation processes, reduce waste, and lessen reliance on external sources when demand is high. Some also utilize predictive analytics to forecast future donation trends.

The study then discusses the main findings and limitations of current blood donation management systems. It suggests ways to address these limitations and discusses how these systems can be improved in the future. Figure 1 illustrates the main stages of a blood unit's life cycle, providing a visual guide to managing blood donations and supply chains.

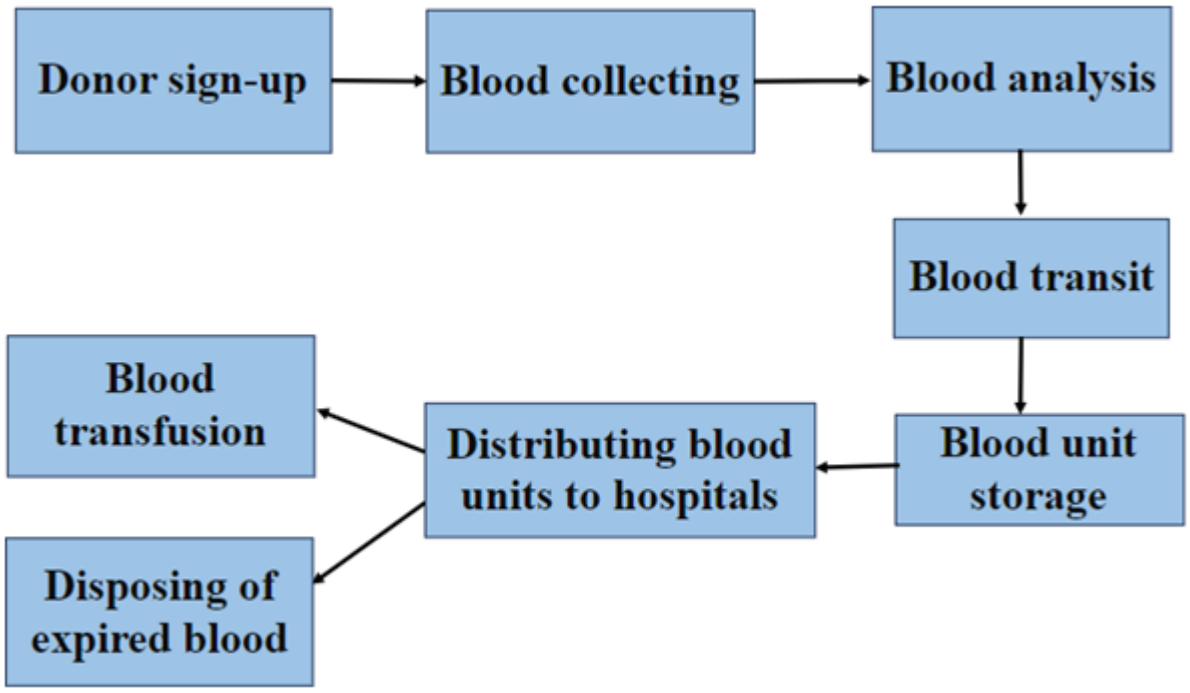

Fig1.The Key Steps in the Life Cycle of a Blood Unit.

4. Purpose and Methodology

In recent decades, the integration of machine learning, data mining, and optimization algorithms has revolutionized various domains, including healthcare management [01]–[04], [05], [07]. Within healthcare, these methodologies have been particularly impactful in optimizing blood donation processes and streamlining blood supply to transfusion centers and hospitals. For instance, Olusanya and colleagues introduced a method using a computer-based optimization technique called particle swarm optimization (PSO) to improve the distribution of blood in blood banks. Their method helps to evenly distribute blood supplies across different types and units, reducing waste and decreasing reliance on obtaining blood from external sources. They also combined various methods to enhance the optimization further. In the realm of mobile applications, Priya et al. [10] developed a web-based system for blood donation management. This system maintains donor, patient, and blood information, with geographic information system (GIS) integration enabling efficient donor localization during emergencies. Furthermore, numerous studies have leveraged machine learning and data mining algorithms to predict blood donation behavior and anticipate demand, crucial for addressing the increasing demand due to accidents, surgeries, and diseases. For example, Zabihi and colleagues used a special technique called fuzzy sequential pattern mining to estimate how many people might donate blood in the future. This helps blood banks manage their supplies better and ensure they have enough blood when it's needed. Sundaram and Santhanam employed a CART decision tree to identify potential blood donors based on their past donation habits. This approach aids in finding new donors more effectively and planning donation campaigns more efficiently.

Alajrami and his team developed a method to predict who might donate blood in the

future using a computer program called an artificial neural network. They found that their method was more accurate than other approaches people have tried. Similarly, Ashoori and his team utilized another type of computer program, a decision tree, to predict potential blood donors. They discovered that a specific decision tree program, called C5.0, was particularly effective at making accurate predictions. Ramachandran and his team used a decision tree program to determine which blood types were available, making it easier to identify people who regularly donate blood. Lastly, Mostafa examined various factors like age and interests that might influence blood donation and used the same type of computer program that Alajrami used, the artificial neural network, finding it more effective than another program called linear discriminant analysis.

In summary, these innovative approaches play a crucial role in optimizing blood donation management, ensuring efficient supply chain operations, and meeting the increasing demand for blood products.

5. Result and Discussion

The analysis presented in the previous sections underscores the multifaceted nature of developing effective blood donation management systems. Various factors must be considered to ensure the success and efficiency of these systems, ultimately guaranteeing a continuous supply of high-quality blood products to transfusion centers and hospitals. A primary consideration is the imperative to increase the number of blood donations, which directly impacts the performance of blood donation systems. By augmenting donation rates, these systems can optimize daily blood unit production to meet hospital demand. However, it is equally crucial to accurately ascertain the precise amount of blood products required by hospitals and transfusion centers to prevent wastage. Efficient blood donation management systems must therefore strike a balance between increasing donations and minimizing unnecessary blood unit disposal. Additionally, these systems need to predict the future demand for blood. By identifying potential donors and ensuring the correct blood matches with the right patients, these systems can operate more effectively. They should also keep track of available blood types, expiration dates of blood units, and donor locations using location services. Planning blood donation events, ensuring blood reaches its intended destination, and monitoring the remaining blood supply are also essential. However, upon reviewing existing systems, it becomes apparent that no single system integrates all these important features. Therefore, a significant challenge for future research is to develop new systems that effectively combine these elements. These new systems should focus on improving the donation process, predicting future blood demand accurately, and making informed decisions. They should leverage advanced computer programs capable of prediction and decision-making. There is a need for advanced systems that can manage blood donations intelligently to meet the demands of modern healthcare. By harnessing smart technology, we can enhance the blood donation process, ensure an adequate supply of blood when needed, and ultimately save more lives.

6. Conclusion

The demand for blood transfusions continues to rise steadily due to various medical procedures, emergencies, accidents, and illnesses. Therefore, effective management and coordination of

the blood transfusion process within the broader blood supply chain are essential. This study has provided an overview of diverse approaches and systems designed to optimize blood donation processes, highlighting their key features and applications. Some of these approaches focused on predicting blood demand, minimizing blood product wastage, and reducing the need for additional blood unit imports. Others aimed to forecast the future behavior of blood donors. Our discussion, informed by the review of existing blood donation management systems, has identified key limitations and proposed solutions to address them. We concluded that an effective blood donation management system should integrate multiple successful factors into a unified framework. This integration would enhance supply chain performance by delving deeper into blood donation processes and optimizing blood bag production to match demand, thereby reducing the incidence of outdated blood products and blood shortages.

In the future, we need to devise intelligent solutions to address all the challenges involved in managing blood donations. By utilizing advanced computer programs like optimization, machine learning, and data mining, we can make better decisions, reduce costs, predict donor behavior, and estimate the required amount of blood more accurately. The goal is to solve problems that could cause difficulties for donors, patients, blood centers, blood banks, and hospitals, ensuring that blood donation processes are more efficient and effective in the long run.

7. References

[1]. M. Ashoori, S. Alizade, H. S. Hosseiny Eivary, S. Rastad, and S. S. Hossieny Eivary, “A model to predict the sequential behavior of healthy blood donors using data mining,” Journal of Research and Health, volume 5, number 2, pages 141–148, 2015.

[2]. M. M. Mostafa authored a study in 2009 titled "Analyzing Blood Donors in Egypt: An Examination Using Neural Networks" published in Expert Systems with Applications, volume 36, issue 3, pages 5031–5038.

[3]. S. Sundaram and colleagues conducted a study titled “A comparison of blood donor classification data mining models.,” published in the Journal of Theoretical & Applied Information Technology in 2011, volume 30, issue 2.

[4]. W.BoonyanusithandP.Jittamaipresentedapapertitled“Blooddonorclassificationusing neural network and decision tree techniques,” at the World Congress on Engineering and Computer Science in 2012, published in volume 1, pages 499–503.

[5]. M. O. Olusanya, M. A. Arasomwan, and A. O. Adewumi authored a paper in 2015 titled “Particle swarm optimization algorithm for optimizing assignment of blood in blood banking system,” published in Computational and Mathematical Methods in Medicine, volume 2015.

[6]. M. Darwiche, M. Feuilloy, G. Bousaleh, and D. Schang presented a study on “Prediction of blood transfusion donation,” at the 2010 Fourth International Conference on Research Challenges in Information Science (RCIS), published by IEEE, pages 51–56.

[7]. Kumari S and Raina TR conducted a study on "Understanding Knowledge, Attitude, and Practices (KAP) Concerning Voluntary Nonremunerated Blood Donation (VNRBD) Among College Students in Jammu, India" published in the International Journal of Community Medicine and Public Health in 2015, pages 45–50.

[8]. YadavK,NamdeoA,andBhargavaM.A.Presentedalecturein2013titled"Retrospective and prospective investigation of maternal mortality in a rural tertiary care hospital of Central India." published in the Indian Journal of Community Health, issue 25(1), pages 16-21.

[9]. F. Zabihi, M. Ramezan, M. M. Pedram, and A. Memariani Delivered a presentation in 2011,“Ruleextractionforblooddonatorswithfuzzysequentialpatternmining,” inThe Journal of Mathematics and Computer Science, volume 2, number 1.

[10]. P.Priya,V.Saranya,S.Shabana,andK.Subramani Deliveredapresentationin2014 titled, “The optimization of blood donor information and management system by technopedia,” in the International Journal of

Innovative Research in Science and Engineering, and Technology, volume 3, issue 1.

[11]. "A Study on Blood Bank Management System" authored by A. Clemen Teena, K. Sankar,andS.KannanKannanfromtheDepartmentofMasterofComputerApplications (MCA), Bharath University, Selaiyur, Chennai-73, Tamil Nadu, India.

[12]. GuptaN,GawandeR,andThengadiN.publishedanarticletitled"MBB:AnApplication for Saving Lives" in the International Journal for Research in Emerging Science and Technology in March 2015, volume 2, issue 1, pages 326-330.

[13]. Chandra T, Gupta A. Occurrence Rates of ABO and Rhesus Blood Groups in Northern India.JBloodDiscordTransfer2012;3:132.16. DesaiKN,SataparaV.Astudyonblood donation among health professional students in Anand: Gujarat. J Appl Hematol 2014;5:51-3.

[14]. Manikandan S, Srikumar R, Ruvanthika PN. An Investigation into Blood Donation KnowledgeandPracticesAmongHealthProfessionalStudentsinChennai,TamilNadu, Southern India. 2013;3:1-4.

[15]. G. K. Soni, H. Arora, B. Jain, "A Novel Image Encryption Technique Using Arnold Transform and Asymmetric RSA Algorithm", International Conference on Artificial Intelligence: Advances and Applications 2019. Algorithms for Intelligent Systems, Springer, pp. 83-90, 2020.

[16]. Jha, P., Dembla, D. & Dubey, W. Deep learning models for enhancing potato leaf disease prediction: Implementation of transfer learning based stacking ensemble model. Multimed Tools Appl 83, pp. 37839–37858, 2024.

[17]. G. K. Soni, A. Rawat, S. Jain and S. K. Sharma, "A Pixel-Based Digital Medical Images Protection Using Genetic Algorithm with LSB Watermark Technique", Springer Smart Systems and IoT: Innovations in Computing, pp. 483-492, 2020.

[18]. G. Shankar, V. Gupta, G. K. Soni, B. B. Jain, & P. K. Jangid, "OTA for WLAN WiFi Application Using CMOS 90nm Technology", International Journal of Intelligent Systems and Applications in Engineering, 10(1s), pp. 230-233, 2022.

[19]. Babita Jain, Gaurav Soni, Shruti Thapar, M Rao, "A Review on Routing Protocol of MANET with its Characteristics, Applications and Issues", International Journal of Early Childhood Special Education, Vol. 14, Issue. 5, 2022.

[20]. P. Jha, D. Dembla and W. Dubey, "Comparative Analysis of Crop Diseases Detection Using Machine Learning Algorithm," 2023 Third International Conference on Artificial Intelligence and Smart Energy (ICAIS), pp. 569-574, 2023.

[21]. G. K. Soni, A. Rawat, D. Yadav and A. Kumar, "2.4 GHz Antenna Design for Tumor Detection on Flexible Substrate for On-body Biomedical Application," 2021 IEEE Indian Conference on Antennas and Propagation (InCAP), pp. 136-139, 2021.

[22]. P. Gaur, S. Vashistha and P. Jha, "Twitter Sentiment Analysis Using Naive Bayes-Based Machine Learning Technique", Sentiment Analysis and Deep Learning. Advances in Intelligent Systems and Computing, pp. 367-376, 2023.

[23]. Jha, P., Dembla, D., Dubey, W. (2023). Crop Disease Detection and Classification Using Deep Learning-Based Classifier Algorithm. In: Rathore, V.S., Piuri, V., Babo, R., Ferreira, M.C. (eds) Emerging Trends in Expert Applications and Security. ICETEAS 2023. Lecture Notes in Networks and Systems, vol 682. Springer, Singapore.

[24]. G. K. Soni, D. Yadav, A. Kumar and L. Sharma, "Flexible Antenna Design for Wearable IoT Devices," 2023 3rd International Conference on Technological Advancements in Computational Sciences (ICTACS), pp. 863-867, 2023.

[25]. P. Jha, T. Biswas, U. Sagar and K. Ahuja, "Prediction with ML paradigm in Healthcare System," 2021 Second International Conference on Electronics and Sustainable Communication Systems (ICESC), pp. 1334-1342, 2021.

[26]. P. Upadhyay, K. K. Sharma, R. Dwivedi and P. Jha, "A Statistical Machine Learning Approach to Optimize Workload in Cloud Data Centre," 2023 7th International Conference on Computing Methodologies and Communication (ICCMC), pp. 276-280, 2023.

[27]. H. Arora, M. Kumar, T. Rasool and P. Panchal, "Facial and Emotional Identification using Artificial Intelligence", IEEE 6th International Conference on Trends in Electronics and Informatics (ICOEI), pp. 1025-1030, 2022.

[28]. Himanshu Aora, Kiran Ahuja, Himanshu Sharma, Kartik Goyal and Gyanendra Kumar, "Artificial Intelligence and Machine Learning in Game Development", Turkish Online Journal of Qualitative Inquiry (TOJQI), vol. 12, no. 8, pp. 1153-1158, 2021.