

Bloodline: A Efficient Interface for Urgent Blood Availability

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Abstract

Blood donation and transfusion have long been critical issues, with blood shortages worldwide leading to many preventable deaths. One of the key challenges contributing to these shortages is the absence of a centralized system for managing blood donations. Traditional methods of blood collection are increasingly outdated in the digital age, highlighting the need for an automated system to streamline donation processes and provide information to those in need. To address this, we have developed a comprehensive website that simplifies and centralizes blood donation and reception. This new developed system utilizes an SQLite database to store historical donation data, facilitating efficient analysis and management. The platform allows users to register as blood donors, making their nearby shortest availability known in case their blood type is required. Additionally, a search function is incorporated to help individuals easily locate potential donors. The system also allows donors to update their health-related information, ensuring accurate and up-to-date records in the blood management database.

Keywords: Blood donation, transfusion, centralized system, conventional methods, automated system, analytical processing

INTRODUCTION

Our country urgently requires a well-organized, online healthcare system, particularly for blood donation and transfusion services. An integrated approach to blood management is essential for ensuring the safety of blood supplies, reducing the risk of transmitted infections, and providing adequate transfusion services to the population. Central to this strategy is the collection of blood from voluntary donors, along with rigorous screening for infectious diseases to ensure safe blood transfusions.

However, the current blood donation framework in the country is highly fragmented and faces significant challenges, including inadequate infrastructure, limited financial resources, and inconsistent management practices. The lack of a centralized system has led to disparities in standards across different states, cities, and even individual centers within the same city. Many large hospitals do not have their own blood banks, resulting in the proliferation of private blood banks. Additionally, there is a severe shortage of trained professionals in the field of transfusion medicine.

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To ensure blood transfusions are safe, reliable, and efficient, it is essential for blood centers to be equipped with advanced technology and staffed by highly trained professionals. Proper blood handling and processing demand skilled personnel, adherence to strict quality control protocols, and the implementation of good manufacturing practices. However, managing and organizing blood transfusion services effectively continues to pose challenges, particularly in adopting comprehensive quality management systems.

Blood transfusion is a medical procedure where blood donated by healthy, voluntary individuals is provided to patients in need due to illnesses, surgeries, accidents, or other medical conditions. The procedure generally takes between 60 and 180 minutes, depending on the required volume. Maintaining its efficiency and safety is crucial for the survival and recovery of patients during critical situations.

Globally, the demand for blood often exceeds its supply. In India, for example, the Ministry of Health and Family Welfare reported in 2016 that only 10.9 million units of blood were donated against a demand of 12 million units. This shortage is largely due to the absence of a robust voluntary blood donation system and inefficiencies in blood collection processes. The COVID-19 lockdowns exacerbated these shortages, and other contributing factors include limited public awareness and misconceptions about blood donation.

Addressing the growing blood shortage in India requires a comprehensive approach rather than small-scale efforts. Central and state governments could play a vital role by promoting social awareness about voluntary blood and apheresis donations. Initiatives such as organizing scientific workshops, rallies, and large-scale donation drives can help educate the public about the benefits of donating blood. Additionally, more blood donation camps in accessible locations could increase public participation and ease the donation process.

Coordination among blood banks, hospitals, and NGOs working in isolation is equally important. A lack of communication between blood banks means they often remain unaware of each other's inventory levels, which can further delay critical blood transfusions.

The World Health Organization (WHO) emphasizes the need for a centralized, well-coordinated blood management system to ensure quality and safety. This system should be governed by national policies and regulatory frameworks to maintain consistent standards. WHO recommends a comprehensive strategy for blood safety and availability that includes the following:

1. Establishing a national blood system with coordinated transfusion services, evidence-based policies, and effective legislation to ensure timely and sufficient supplies of safe blood.
2. Collecting blood and its components from low-risk, regular, voluntary, and unpaid donors while strengthening donor management systems that include care and counseling.
3. Ensuring all donated blood undergoes quality-assured screening for transfusion-transmissible infections (e.g., HIV, hepatitis B, hepatitis C, syphilis) along with confirmatory testing, blood typing, and compatibility assessments. Processing blood into components and plasma-derived products must also be optimized to meet healthcare demands.

Our project has been designed to address these challenges by developing an integrated website that tackles common issues in blood donation and transfusion. The platform prioritizes timely blood supplies, collects blood from regular unpaid donors, and evaluates both the quality of the blood and the donor's health conditions. Our aim is to build a system that aligns with these guidelines and improves the overall efficiency of blood donation and reception processes.

LITERATURE REVIEW

The existing blood bank storage system primarily relies on physical files. This approach involves storing data about blood, donors, and recipients in documents and archives, which makes processing and managing information cumbersome and time intensive. Records of blood donations and transfusions are also maintained on paper, making them prone to errors and human mistakes, which could endanger lives.

Another significant issue with this system is its inefficiency. Retrieving information about donors or recipients is a time-consuming and labor-intensive process, which can hinder hospitals' ability to respond swiftly in life-critical situations. Additionally, security and backup of information are compromised, as physical records are susceptible to theft, loss, or damage, making this method unreliable.

The primary objective of our project is to create a platform that consolidates all information about blood donations and registered donors, facilitating faster blood delivery during emergencies. Through extensive research on blood management systems and their practices, we have aimed to design a robust and efficient solution.

A functional blood donation management system must fulfill certain essential requirements. It should enable seamless information sharing among donors, recipients, and other relevant parties. Additionally, it must provide real-time updates on blood inventory levels across stakeholders such as blood banks and hospitals. Understanding the shortcomings of the current system was critical to identifying and implementing effective solutions in our project [1].

EXISTING SYSTEMS

Numerous studies have been conducted on blood bank management systems, with most emphasizing the role of automation as a tool to enhance efficiency and effectiveness in this field. However, these studies often overlook potential challenges that systems might face due to limitations or misuse of certain functionalities. In our review, we examined several systems that have been proposed in the literature [2].

For instance, in *“Benefits of Management Information System in Blood Bank”* [3], the authors highlight the advantages of using management information systems (MIS) in blood banks. The paper focuses on the implementation of MIS in blood bank operations, exploring the benefits it offers to blood bank management. Introduces a robust blood donor data management system based on GIS coordinates, accessible through an Android mobile application. The proposed system is designed to offer essential and valuable services for blood donation [4]. The authors provide an overview of the features, advantages, and limitations of existing web-based data systems for blood banks [5]. They also compare different systems, offering suggestions for improvements.

The *“Android Blood Bank”* [6] describes an Android application that updates donor information efficiently, allowing administrators to access complete donor data. The app also provides a list of nearby blood banks based on the user's location. Teena et al. [7], an information management system is proposed where authorized blood bank personnel can log in securely and manage donor and patient records effectively. The paper *“MBB: A Life-Saving Application”* [8] presents a system that connects donors and blood transfusion services, creating a centralized database that tracks blood stocks and donor information in various regions. The app also allows users to see which patients need blood and register as donors, thereby facilitating local blood donations in times of need.

Additionally, Pradhan et al. [9] proposed a management information system to streamline blood bank operations by managing donor, recipient, and blood data. Yuan et al. [10] developed a Blood Bank Management System that automates the aggregation of donor data into one platform.

While the current systems mostly cater to normal blood donation practices, allowing users to access information about registered donors—such as their name, contact details, and location—there are still gaps in the system. Blood donors are often only contacted by hospitals when there is an immediate need for blood. Despite the availability of potential blood donors, only about 10% of the general Indian population donates blood. Advances in medical science have increased the demand for blood, yet many potential donors do not fully grasp the urgency of the need. These challenges highlight the necessity for a more robust system to enhance the current blood donation infrastructure.

LIMITATION OF PREVIOUS SYSYEMS

In previous systems, searching for donors within a specific area was a significant limitation. While blood availability in major cities was generally not a major concern, rural and agricultural regions faced more challenges. Additionally, for many low-income citizens, reliable data connectivity is often not affordable. During emergency situations, hospitals and patients frequently struggle to reach registered

donors, as the donors may not be in a position to answer calls. Furthermore, there is no well-organized, centralized database to manage the details of registered donors.

PROPOSED SYSTEM AND ADVANTAGES

All records are digitized and securely stored in a well-organized database. Users can easily access the website to register as blood donors in times of need. Hospitals and patients can locate donors in their preferred area by entering a landmark as a search keyword.

The proposed system is centralized, serving as a unified platform for various purposes, while offering diverse functionalities within shared modules. Anyone with internet access and a web browser can utilize this system.

Designed to be user-friendly, the system fosters seamless interaction between donors and recipients. It eliminates the need for individuals to visit hospitals for registration, especially during pandemic restrictions like COVID-19. Hospitals and recipients have continuous access to updated records.

Since donors might not always be reachable or available during emergencies, the system sends web notifications to inform them of urgent needs. Accessible nearby during critical moments, the hospital or patient can broadcast the urgency to a city-wide group of donors with the same blood type. This ensures hospitals can connect with willing donors from other locations. The system also provides robust data security through proper authorization mechanisms.

ISSUES FACED IN BLOODLINE

1. *Preventing fake donors:* To ensure authenticity during registration, all prospective donors are required to upload valid health certificates and identification documents. Only those who meet the necessary health criteria for blood donation are allowed to proceed with the registration process.
2. *Preventing fake requests:* To address the issue of fraudulent blood requests, a secure password mechanism is implemented. Additionally, donors can verify the profile details of the requester before responding.
3. *Database maintenance:* Registered donors must update their information every 35 days. This process ensures they remain eligible for blood donation by confirming their continued good health and disease-free status.

STAKEHOLDERS

Stakeholders are sources who are responsible and accountable for the success of the website and the organization.

1. *Admin:* Admin manages donors, system users, and the smooth functioning of the website. The admin can add or remove any user from the system anytime whenever required and also carry out other necessary actions required.
2. *User:* In this module, users can create an account if they wish to donate blood. To ensure unique identification, they are assigned a username and password. Authentication requires users to provide valid identification proofs. Donors can stay informed about blood donation camps through the news dropdown. Additionally, they will receive notifications in case of emergencies.

DETAILS ABOUT BLOOD

The various constituents of blood are represented as follows:

1. *Plasma:* The medium in which the blood cells are transported around the body.
2. *Red blood corpuscles:* It carries oxygen.
3. *Platelets:* Which facilitates blood clotting and also the need for blood transfusion.
4. *White blood corpuscles:* This is the part of the immune system.
5. *Haemoglobin:* Which is an essential chemical in the body and carries oxygen from the lungs to other parts of the body.

FACTORS AND CONSTRAINTS TO BE CONSIDERED TO REGISTER

Eligible donors must be between 18 and 60 years of age. Their hemoglobin levels should not exceed 12.5 g/dL, and their weight should be greater than 45 kg. Prior to donating blood, the donor's body temperature and blood pressure must be within normal ranges. Additionally, the donor should have been disease-free for the past three years and must not have any history of drug addiction.

MODULES

The Bloodline web application comprises several key modules that facilitate seamless blood donation, search, and data handling. Each module is integrated to support user-friendly functionality and high operational reliability. Here's a breakdown of the primary modules.

Blood Type

Our website provides a feature that allows users in need to search for particular blood types. This functionality works by sending a POST request, where the search form and donor list are initially executed by retrieving details from the database, including search inputs and Dreg categories. The system then validates the request by sanitizing the POST data against the Dreg information. If the request is deemed valid, the filtered Dreg data is organized into a dictionary and returned to the page via rendering.

Find the Donor Nearby Our Area

We have implemented a search bar to help individuals find blood donors nearby. This feature was designed with the understanding that many people require blood urgently and cannot afford delays. By using this functionality, users can quickly locate and obtain blood in their vicinity, ultimately saving valuable time.

Simply select the required blood group from the dropdown menu, then choose the state where the blood is needed, followed by the corresponding state of city. After submitting the request, the website will display details of nearby registered donors whose blood group matches the required one (Figure 1).

Donor Registration Form

Donors can be categorized into two groups: returning donors, who contribute blood on a regular basis, and walk-in donors, who donate occasionally or for the first time. We have integrated a form for donor parties to register themselves as donors. The form will ask the first name, last name, date of birth, number, email, address, password, state name, blood group, etc. We have applied all types of constraints in the form so that false or wrong information is cast aside.

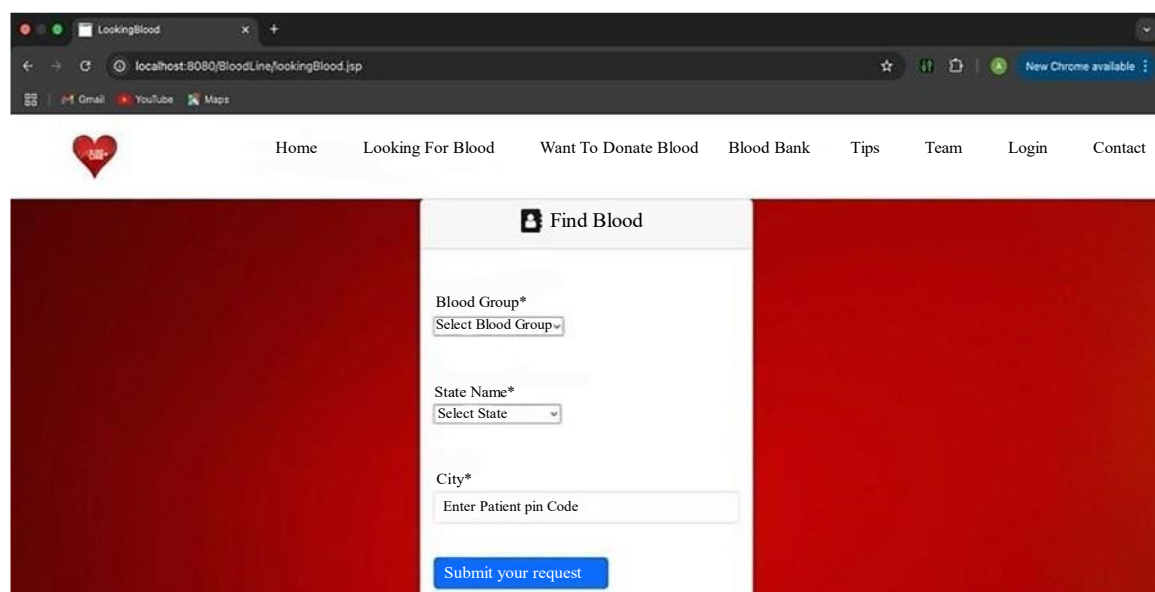


Figure 1. Blood request form page.

Figure 2. Donor registration page.

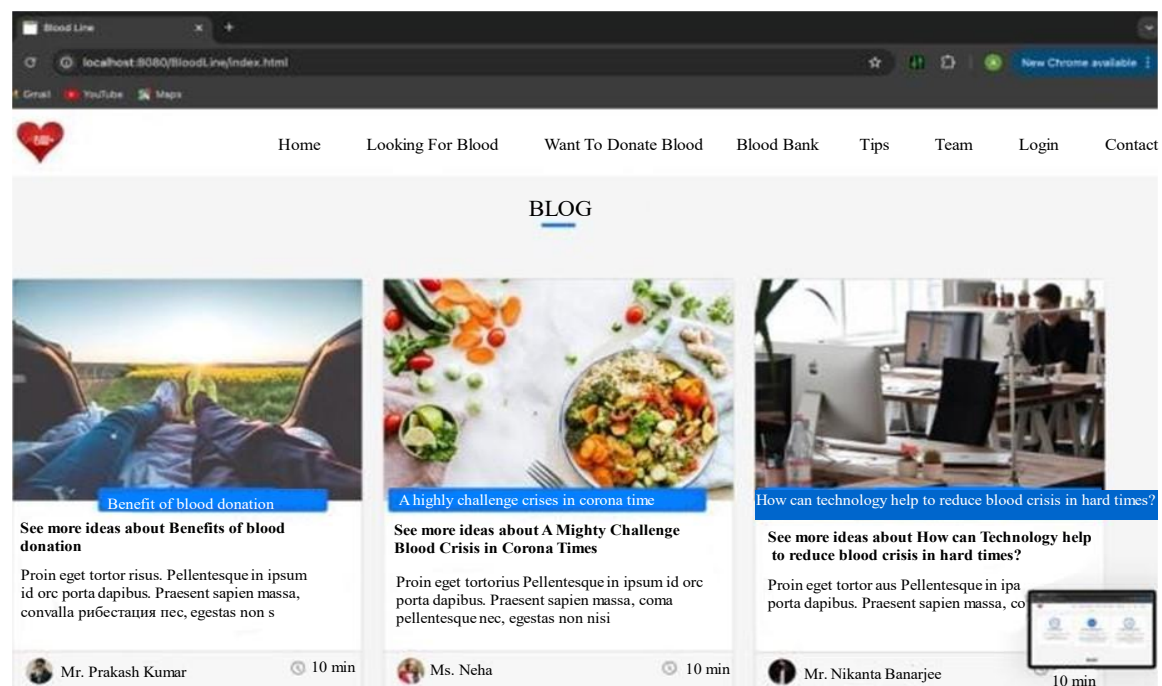


Figure 3. Blog section on blood donation.

Same post request is used initially, data gets filled into the parameters through validation and must and should fields, later as usual data gets connected and stored in Dreg category of the database if all the valid and verify conditions of the library models has been satisfied. After the successful rendering, summarized data gets visible on the screen (Figure 2).

Blogs

It is the part or portion of the site where the health beneficial various blogs are presented or updated usually to spread awareness about the health related contents (Figure 3).

Some More Shots of Site

This visual module includes UI screenshots that demonstrate the various functionalities of the Bloodline website. These images showcase the clean interface, search functionality, donor form, blog section, and other elements of the user journey, helping stakeholders understand the platform's real-time usability and design efficiency (Figures 4–6).

OTHER USES/ SCOPES OF WEBSITE

Our website effectively collects and integrates vital information related to blood donation and reception, helping to manage critical situations more efficiently. In emergencies where swift coordination and prompt action are crucial to saving as many lives as possible, our analytics-enhanced system ensures that the right individuals are directed to the appropriate locations at the right time to offer assistance.

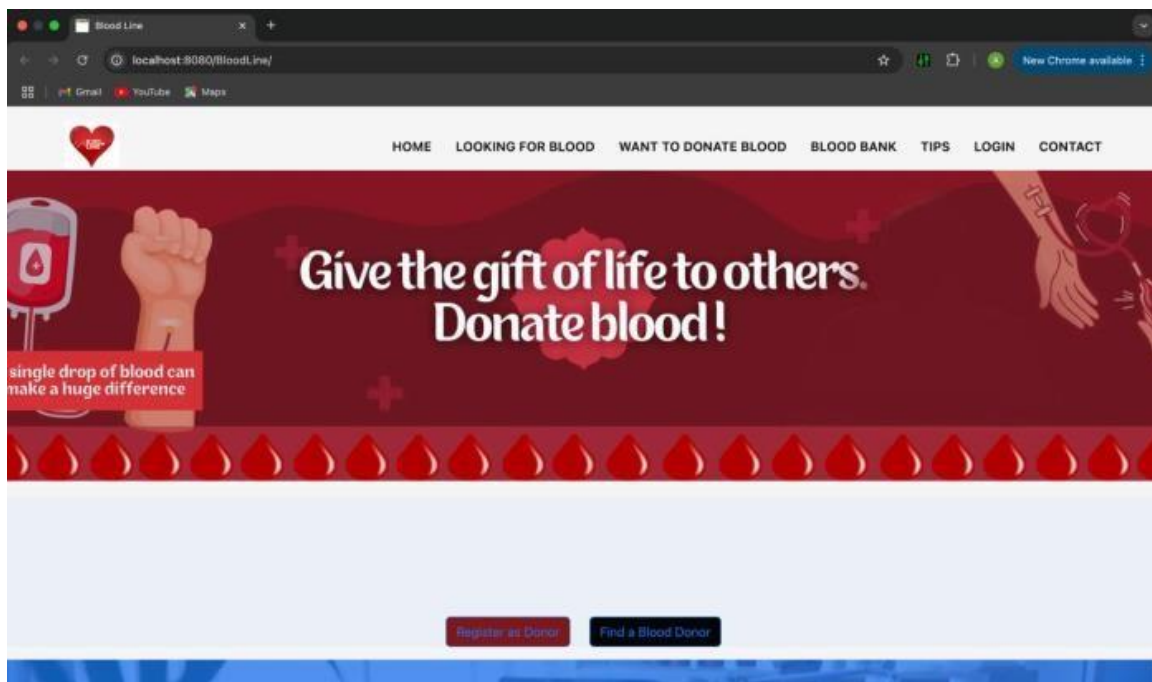


Figure 4. Give the gift of life.

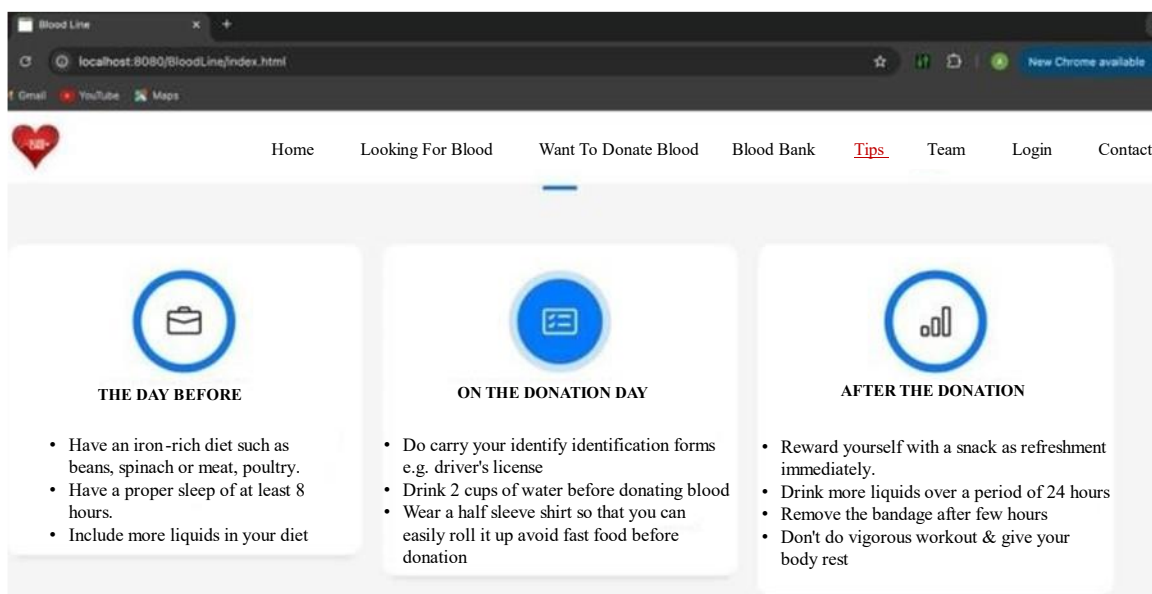


Figure 5. Steps to follow before, during, and after blood donation.



Figure 6. Tips for blood donation.

The platform also facilitates blood donation camps by evaluating donor eligibility. Initially, eligibility is assessed based on the date of the last donation and the required minimum interval between donations. Additional medical assessments are carried out by doctors during health camps. If any infection or medical condition is discovered during a checkup or treatment, the respective medical practitioner (MP) will inform us, and we will update the website accordingly.

In the future, we plan to develop a generalized mathematical model leveraging data mining tools and analytics to study different donor groups. We are also focused on building a mobile application connected to the website to expand our reach and improve connectivity with a larger audience.

CONCLUSION

The proposed system offers a web-based application that proves highly effective for emergency services. It becomes particularly valuable during urgent situations by providing donor information filtered by location and blood type. The platform enables donors to communicate with one another using a ChatBot API, helping them stay informed about emergencies.

The system incorporates a well-organized database to store all registered records securely. It also provides updates and information related to the ongoing coronavirus pandemic. Developing this project allowed us to gain insights into the advanced technologies required to create a web-based application. Moreover, it heightened our awareness of how blood donation can save lives, inspiring us to donate blood regularly and encouraging others to do the same.

Additionally, a comprehensive database has been established to store historical data on blood donations and receptions, as well as data from donation camps. This will enable data-driven decision-making and analytical insights for future planning.

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