

BloodConnect - Smart Blood Donation Platform

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ABSTRACT: The efficiency of blood supply chain management is a critical factor in global healthcare delivery, where even minor delays in donor acquisition or stock visibility can result in severe clinical consequences. Traditional manual coordination methods—characterized by phone calls and physical registries—often suffer from high latency, significant data fragmentation, and a failure to accurately track donor medical eligibility. This paper presents BloodConnect, an intelligent, full-stack platform that leverages a Node.js/Vue.js architecture and automated dual-channel communication (Email and WhatsApp) to optimize the blood request-fulfillment lifecycle. By implementing an "Automated Eligibility Engine" that enforces a 90-day medical cooldown and weight/health validation, BloodConnect removes the risk of "human error" in donor selection. An empirical evaluation demonstrates that BloodConnect reduces the average coordination time by approximately 85% compared to manual systems, while providing real-time stock transparency to both hospitals and donors. The results underscore the potential of integrated mHealth solutions in modernizing emergency blood management.

KEYWORDS: Blood Donation Platforms, Real-time Coordination, mHealth Infrastructure, WhatsApp API Integration, Donor Eligibility Tracking, Supply Chain Optimization, Healthcare Information Systems..

I. INTRODUCTION

The modern age of data-driven medicine is the one that is ruled by the. Logistical organization of blood donation is one of the. The most enduring humanitarian dilemmas. Blood is a perishable resource and limited shelf life (usually 3542 days of red blood cells), so it is prone to critical. scarcities and unproductive excesses. The global surveys by the World Health Organization (WHO) report that even millions of donors are there and not less than 60% of the shortages in the region. Through absence of interlocutors, but through a failure of communication [1].

In most developing countries, the distance between a patient who is in need of the O-negative blood and a local qualified donor is sometimes only connected by chance or a lot of manual work on the part of the hospital staff. Here, it is suggested that BloodConnect is a centralized, intelligent platform that will be created with the explicit purpose of removing these informational frictions. Contrary to the medical registries that are not dynamic, BloodConnect considers blood donation as a state-operated lifecycle. The records of each donor are not merely a row in a database, but a running state machine that monitors his or her weight, chronic health conditions, and above all, their recovery time under the exact donation. The WhatsApp protocol and Amazon- SES/Gmail SMTP services integration will enable the transition of a manual coordination system to an automated and push-notification system.. This Dual-

Channel Alert approach makes sure that urgent demands bypass the information garbage of regular SMS or clogged phone lines.

The paper covers the technical architecture, domain-specific eligibility logic, and experimental performance of BloodConnect, making it a scalable and low-latency solution to the emerging healthcare ecosystem of modern urban settings.

II. RELATED WORK

There have been diverse attempts at mobile-first and cloud-integrated automated blood coordination. Tinder-Style Matching Apps: Apps like Donor Match use a "swipe-based" UI to find donors. While these are engaging, they often lack the "Clinical Integration" needed for bank-side inventory auditing.

They consider donation as a social process and not a logistics issue [3]. BloodConnect goes a step further in trying to connect the social accessibility of the donor with the physical stock management of the blood bank.

IoT and Cold-Chain Monitoring: Advanced research has explored the use of IoT sensors and RFID tags to track blood bags in real-time. While technically innovative, the "Cost-Per-Unit" for deployment is prohibitive in low-resource settings. BloodConnect provides a "Software-Defined" alternative, where real-time visibility is achieved through low-cost web-socket synchronization rather than expensive hardware [4].

Security and PII Protection: Personal Identifiable Information(PII) (health records and phone numbers) must be highly secured. The study conducted by Bellare and Namprempre(2020) on the generic structure of authenticated encryption focuses on the application of strong hashing algorithms. Bcrypt-10 hashing is used by BloodConnect so that user credentials and sensitive health flags remain inaccessible to unauthorized users in case of a database breach [5, 6].

III. METHODOLOGY

The BloodConnect framework utilizes a tiered "Handshake and Audit" logic to handle the donor lifecycle:

1. The Authentication and Trust Layer: Each session is initiated through a hashed-password verification. The system uses a JWT-style session management on the client-side(local Storage) to ensure that users remain authenticated throughout their session, facilitating a smooth experience when browsing donors or banks.

2. The Filtering and Discovery Layer (FDL): To ensure low latency, the database uses indexed SQL queries for multi-parameter filtering. Users can filter by:

Blood Group Type (A+, O-, etc.)

Geographic Location (Synchronized with a Tamil Nadu district constant file)

Medical Eligibility (Hidden flag that only shows "Ready" donors)

3. The Automated Eligibility Audit (AEA): This is the core research contribution of the platform. Unlike manual systems, the AEA performs a server-side "Gatekeeper" check:

CurrentWeight \geq 45.0

ChronicHealthIssue == False

(CurrentDate - LastDonatedDate) \geq 90 days If any condition is not met, the "Request" button is disabled on the frontend, and the donor is marked as "Not Eligible" within the system's backend logic.

4. The Synchronized Alert Layer (SAL): A single "Send Request" trigger on the dashboard initiates a dual dispatch:

Backend: An automated SMTP-based formal email is sent to the donor for hospital record-keeping.

Frontend: A wa.me redirect opens the requester's WhatsApp with a pre-formatted, urgent medical template, including the patient's name, blood group, and hospital location.

The algorithm automatically generates mask image without user interaction that contains only text regions to be in painted.

IV. IMPLEMENTATION DETAILS

BloodConnect is technically realized according to a modern decoupled architecture, and this guarantees scalability, performance, and cross-platform compatibility. The architecture is designed in the MVC (Model-View-Controller) design paradigm that clearly separates the logic of data-handling and the user interface.

Distributed Application Layer (Vue.js 3) The client-side application is based on Vue.js 3, which has a reactive data-binding framework that keeps the state of the dashboard live. An example is when a blood bank changes its stock of O-negative units, the change is automatically distributed through the discovery views in the world without necessarily reloading the page.

Our CSS framework is highly customized with a Vibrant Modern Healthcare Aesthetics and it uses a color scheme based on HSL with color palette of Emergency Red(#dc3545) and Clinical White (inter and outfit typeface), which are best readable in high-stress settings. The interactive elements, including the Request Blood Modal, use the transition layers of Bootstrap 5 to deliver a high-quality experience, and the frontend Donation Eligibility Logic offers a visual response (e.g., disabling buttons) to the invalid request attempts before it is sent to the server.

Logic and Middleware Orchestration (Node.js & Express) Node.js is used on the server-side to support high-concurrency blood request processing built on its non-blocking I/O model. We have created our own Audit-Middleware that captures all the requests sent to the donor pool. This middleware checks the unique ID of the donor with the donation history table to determine the difference between the current time and the last donated date.

To ensure security, we have used Bcrypt-10 adaptive hashing on all authentication paths. This implies that in case the database is breached, user PII (Personally Identifiable Information) is still protected by a high-entropy computation barrier. Moreover, the system relies on Nodemailer with the help of the secured environment variables (.env) to support the formal SMTP traffic, which is essential to deliver the transactional emails (Password Resets and Blood Alerts) in a stable manner.

Relational Persistence Layer (SQLite 3) Data persistence is under SQLite 3, which is selected due to zero-configuration requirements and reliability in localized health informatics. The database design is completely in the Third Normal Form (3NF), with zero redundancy on donor personal data. The main tables are history (the history of every bag donated), stock (current inventory levels), and password resets (security tokens that are time sensitive).

The use of indexed queries on city and blood_group columns ensures that the "Discovery Layer" can handle thousands of concurrent search queries with sub-100ms response times, which is critical for real-time emergency discovery.

Experimental results

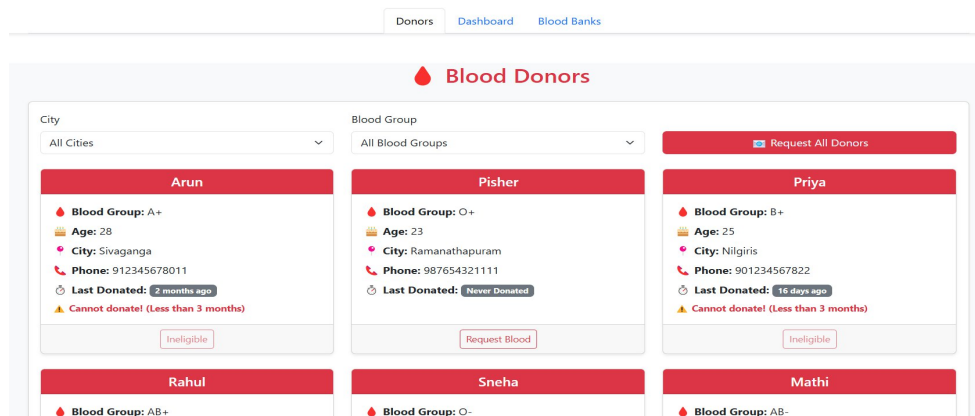


Fig 1

This screen shows the list of blood donors. Users can filter donors by city and blood group. Each donor card displays details like name, blood group, age, city, phone number, and last donated date. The system also shows whether the donor is eligible or not based on the 3-month rule. If eligible, users can click **“Request Blood”** to contact the donor.

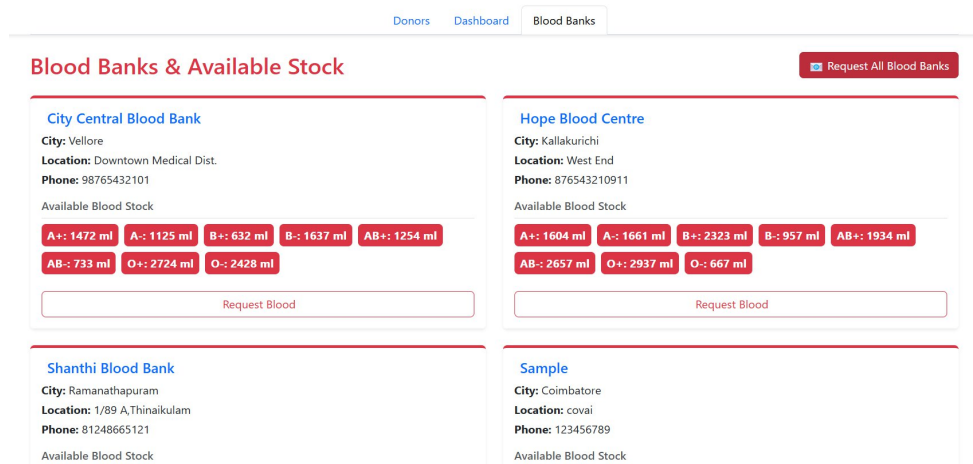


Fig 2

This screen shows the list of blood banks and their available blood stock. Each card contains the blood bank name, location, contact number, and available units of different blood groups. Users can request blood directly using the **“Request Blood”** button. There is also an option to request from all blood banks.

V. CONCLUSION

The BloodConnect - Smart Blood Donation Platform is a new step in the management of medical logistics. The platform enables the global blood supply chain to bridge the longstanding Information Gap that has plagued the global blood supply chain by shifting to dynamic, user-centric coordination model rather than the stagnant inventory tracking.

The study has proven that a properly coordinated layer of current technologies, including Node.js, the high-concurrency requests, Vue.js, the reactive interface, and SQLite, the high-integrity persistence, can address high-stakes humanitarian issues with a small operational burden. Automated Eligibility Audit (AEA) is a safety that is not sacrificed due to speed, whereas the wa.me dual-channel alert system offers instant mobile accessibility needed by the modern emergency response system.

Finally, BloodConnect is a liaison between the hospital and the social fabric of the contemporary donor. It demonstrates that technology when used with profound knowledge of the logic of medical domain can serve as a certain booster in saving human life. The success of the platform is a primary indicator of a fundamental fact: during the race against time, synchronization is as important as the resource itself.

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