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# MediShare: An Expiry-Aware Medicine Donation and Redistribution Platform

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## Article Info

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**Abstract**
Pharmaceutical waste caused by unused and expired medicines is a persistent global challenge, resulting in financial loss, environmental contamination, and inefficient utilization of healthcare resources. Reports from global health agencies indicate that a substantial proportion of medicines procured worldwide never reach patients and expire unused. In contrast, non-governmental organizations (NGOs) and charitable health- care providers serving underprivileged communities frequently face shortages of essential medicines due to fragmented donation mechanisms and lack of timely coordination.

This paper presents *MediShare*, a web-based medicine do- nation and redistribution platform designed to bridge the gap between surplus medicine holders and verified NGOs through structured digital workflows. Unlike conventional healthcare donation systems that primarily focus on emergency response or inventory listing, MediShare introduces an expiry-aware and NGO-centric prioritization model that allocates medicines based on remaining shelf life, organizational demand, and medicine criticality. The platform employs a weighted urgency scoring mechanism to minimize wastage and maximize timely utiliza- tion. Experimental evaluation using simulated real-world data stored in a Supabase-backed database demonstrates improved redistribution efficiency and significant reduction in expiry risk**.**

**Keywords:** Medicine Donation, Pharmaceutical Waste Re- duction, Expiry Management, NGO Coordination, Healthcare Information Systems

## 1. Introduction

The efficient utilization of medicines is a critical compo- nent of sustainable healthcare systems. Despite advances in pharmaceutical manufacturing and distribution, a significant proportion of medicines remain unused and expire annually. The World Health Organization (WHO) estimates that nearly 50% of medicines globally are inappropriately prescribed, dispensed, or left unused, leading to substantial wastage [1]. In developing countries, pharmaceutical waste is estimated to account for 3–10% of total healthcare expenditure, impos- ing avoidable financial burdens on public health infrastructures [2].

Beyond economic loss, improper disposal of expired medicines introduces severe environmental risks. Active phar- maceutical ingredients released into water bodies and soil can disrupt ecosystems, contribute to antimicrobial resistance, and pose long-term public health hazards. Studies have identified detectable levels of pharmaceutical compounds in surface water and groundwater sources, highlighting the urgency of addressing medicine wastage at the source [3].

Paradoxically, while large quantities of usable medicines are discarded, non-governmental organizations (NGOs) and charitable healthcare providers consistently face shortages of essential drugs. These organizations serve economically disadvantaged populations where access to medicines directly impacts morbidity and mortality. The mismatch between sur- plus availability and unmet demand is rarely caused by abso- lute scarcity; rather, it stems from lack of visibility, poor coordination, and absence of prioritization mechanisms that can facilitate timely redistribution.

Existing digital healthcare platforms largely focus on emer- gency donation systems such as blood banks, centralized hos- pital inventory management, or pharmaceutical supply chain optimization. While these systems address specific aspects of

healthcare logistics, they fail to provide a comprehensive solution for redistributing unused and near-expiry medicines from individual donors to NGOs. In particular, most systems lack mechanisms to account for expiry timelines, resulting in medicines being listed but not utilized before expiration.

To address these challenges, this paper proposes *MediShare*, a dedicated medicine donation platform that enables donors to register surplus medicines and allows verified NGOs to request resources through an organized, transparent workflow. The system emphasizes expiry-aware prioritization and NGO- centric allocation to ensure that time-sensitive medicines reach beneficiaries before expiration, thereby reducing wastage and improving healthcare accessibility.

## 2. Problem Statement and Motivation

Despite the presence of surplus medicines within house-holds, pharmacies, and small healthcare units, there is no widely adopted, structured mechanism to redistribute these re- sources to organizations in need. Informal donation practices, when they exist, are often unregulated, poorly documented, and inefficient. Medicines may be donated without proper tracking of expiry dates, quantities, or recipient needs, leading to safety risks and underutilization.

From an organizational perspective, NGOs face several operational challenges. These include difficulty in identifying available medicines, lack of real-time information on expiry status, and absence of prioritization when multiple requests compete for limited resources. Manual coordination through phone calls, emails, or social media is time-consuming and does not scale with increasing demand.

Furthermore, existing healthcare inventory systems are typically designed for institutional use and do not accommodate decentralized individual donors. Emergency-focused donation platforms prioritize immediacy over sustainability and are ill- suited for managing non-emergency but essential medicines. As a result, a critical gap exists between medicine surplus generation and effective redistribution.

The motivation behind MediShare is to design a system that explicitly addresses this gap by:

- Enabling structured registration of surplus and near-expiry medicines.
- Introducing expiry-aware prioritization to minimize wastage.
- Supporting NGO-centric workflows that reflect real-world demand.
- Providing transparency and traceability throughout the donation lifecycle.

By leveraging modern web technologies and database- driven decision logic, MediShare aims to transform informal medicine donation practices into a scalable, accountable, and impact-driven healthcare support system.

## 3. Related Work

Research on medicine donation, pharmaceutical waste re-duction, and healthcare logistics spans multiple domains in-cluding emergency donation systems, pharmaceutical supply chain management, medicine reuse initiatives, and NGO-based healthcare delivery. This section reviews existing literature relevant to MediShare and identifies limitations that motivate the proposed approach.

### A. Emergency and Donation-Oriented Healthcare Platforms

Digital platforms for healthcare donations have primarily focused on emergency scenarios such as blood donation and disaster response. Nabil *et al* . [4] proposed a cloud-based blood donation system that enables real-time coordination between donors, recipients, and blood banks. While effective in reducing response time during emergencies, such systems do not address challenges related to medicine expiry, reuse, or long-term inventory redistribution.

Sadri *et al* . [5] introduced a blockchain-based framework for traceability in blood supply chains. The system ensures data immutability and transparency; however, the computational overhead and infrastructure complexity limit its applicability to decentralized, low-resource medicine donation scenarios. Moreover, the solution does not incorporate expiry-aware allocation or NGO-driven demand prioritization.

### B. Pharmaceutical Supply Chain and Inventory Management

Several studies have investigated inefficiencies in pharma-ceutical supply chains and inventory systems. Mackey and Nayyar [2] analyzed global medicine supply chains and high-lighted lack of real-time visibility as a major contributor to wastage. Their work emphasizes digital traceability but does not propose mechanisms for redistributing surplus medicines outside institutional settings.

Abdel-Basset *et al* . [6] proposed intelligent inventory op-timization models using computational techniques to reduce medicine wastage within healthcare institutions. While ef-fective at the hospital level, these systems are not designed to support individual donors or NGO-centric redistribution workflows.

### C. Medicine Reuse and Redistribution Initiatives

Medicine reuse has gained increasing attention as a sus-tainable healthcare practice. Dyer *et al* . [**?**] evaluated the feasibility of reusing unused medicines returned to community pharmacies. Their findings suggest that reuse is viable under controlled conditions; however, the absence of scalable digital platforms and standardized coordination mechanisms limits real-world adoption.

Programs such as the Stanford University-based Interdisci-plinary Research for Sustainable Medicine (SIRUM) initia-tive demonstrate the social impact of redistributing unused medicines to underserved populations. Despite their success, such initiatives often rely on centralized operational models and lack open-access, extensible digital architectures suitable for broader NGO participation.

### D. NGO Logistics and Aid Distribution Systems

Efficient logistics play a critical role in NGO operations. Patel and Agarwal [**?**] examined information flow in human-itarian logistics systems and identified poor coordination and lack of prioritization as key challenges. Their study highlights the need for digital platforms that align resource availability with organizational demand.

However, most NGO logistics platforms focus on general aid distribution and do not incorporate domain-specific con-straints such as medicine expiry, safety considerations, or pharmaceutical categorization.

### E. Comparative Analysis and Research Gap

Table I presents a comparative analysis of existing systems and the proposed MediShare platform.

The reviewed literature reveals a clear research gap: existing systems either address healthcare logistics without supporting

**Table I:** Comparison of Existing Approaches and MediShare

| System / Study | Domain | Expiry-Aware | NGO-Centric | Key Limitation |
|---|---|---|---|---|
| Nabil *et al* . [4] | Blood donation | No | Partial | Emergency-focused only |
| Sadri *et al* . [5] | Supply chain | No | No | High system complexity |
| Mackey *et al* . [2] | Pharma logistics | Limited | No | No donation model |
| Abdel-Basset *et al* . [6] | Inventory systems | Yes | No | Institutional scope |
| Dyer *et al* . [?] | Medicine reuse | Manual | Partial | Lacks digital platform |
| NGO logistics platforms [?] | Aid distribution | No | Yes | No expiry handling |
| MediShare (Proposed) | Medicine donation | Yes | Yes | Prototype-scale deployment |

decentralized donation or facilitate donations without account- ing for expiry-driven prioritization and NGO-specific demand. MediShare addresses this gap by integrating expiry-aware decision logic with NGO-centric workflows in a scalable web- based platform.

## 4. System Overview

MediShare is designed as a role-based web platform that facilitates structured medicine donation and redistribution between individual donors and verified NGOs. The system adopts a modular architecture to ensure scalability, maintainability, and transparency across the donation lifecycle. Two primary user roles are supported: *donors*, who register surplus medicines, and *NGOs*, who request medicines based on organizational needs.

At a high level, donors interact with the system to list medicines along with metadata such as expiry date, quantity, and category. NGOs browse available listings, submit requests, and receive allocations based on an urgency-driven prioritization model. All interactions are mediated through a centralized backend that enforces access control, validation, and prioritization logic.

## 5. System Architecture

The MediShare platform follows a client–server architecture consisting of a web-based frontend, a RESTful backend service, and a cloud-hosted database with integrated authentication. Figure 1 illustrates the overall system architecture.

### A. Frontend Layer

The frontend is implemented using ReactJS and provides separate interfaces for donors and NGOs. Role-based rendering ensures that users only access functionalities relevant to their role. The frontend handles form validation, request submission, and real-time status updates.

### B. Backend Layer

The backend is implemented using Node.js and Express.js. It exposes RESTful APIs for user management, medicine listing, request handling, urgency computation, and notification delivery. Business logic related to expiry filtering, prioritization, and allocation is centralized at this layer to ensure consistency.

### C. Database and Authentication

Supabase is used as the backend-as-a-service platform, providing a PostgreSQL database along with authentication and row-level security (RLS). Supabase authentication ensures secure user identity management, while RLS policies enforce role-based data access at the database level.

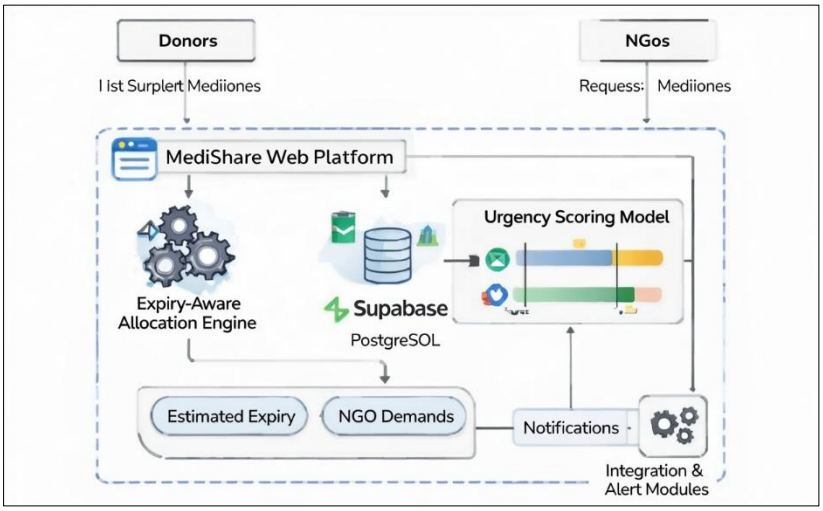


**Fig 1: System Architecture of the MediShare Platform**

## 6. Database Schema Design

The database schema is designed to support clear separation of concerns between user identities, medicine data, NGO demands, and donation workflows. Key tables used in the system are described below.

### A. Profiles Table

The *profiles* table stores user identity information and role assignment. Each record corresponds to a unique authenticated user.

**Attributes:** user_id, email, full_name, role (donor or NGO), contact details.

### B. Medicines Table

The *medicines* table stores information about medicines listed by donors.

**Attributes:** medicine_id, donor_id, medicine_name, category, quantity, expiry_date, status.

### C. NGO Demands Table

The *ngo_demands* table captures medicine requirements submitted by NGOs.

**Attributes:** demand_id, ngo_id, medicine_category, required_quantity, urgency_level, timestamp.

### D. Donation Requests Table

The *donation_requests* table manages the lifecycle of requests and allocations.

**Attributes:** request_id, medicine_id, ngo_id, allocation status, decision_timestamp.

### E. Supporting Tables

Additional tables such as *notifications*, *donations_history*, and *ratings* support communication, auditing, and trust-building within the platform.

This normalized schema reduces redundancy, ensures data integrity, and supports efficient querying for prioritization.

## 7. Urgency Scoring Model

To minimize medicine wastage and prioritize critical needs, MediShare employs a weighted urgency scoring model. Each medicine is assigned a numerical urgency score in the range 0–100.

### A. Scoring Factors

The urgency score is computed based on the following factors:

- Remaining days to expiry
- NGO demand level
- Medicine type criticality
- Proximity (optional, low weight)

### B. Urgency Score Formula

The final urgency score $U$ is computed as:

$$U = 0.4E + 0.3D + 0.2M + 0.1P \quad (1)$$

where $E$ denotes expiry score, $D$ demand score, $M$ medicine type score, and $P$ proximity score.

Higher weights are assigned to expiry and demand to ensure time-sensitive and high-need cases are prioritized.

### C. Priority Tiers

Based on the computed score, medicines are classified into five priority tiers: Critical, Urgent, High, Medium, and Low. This classification simplifies decision-making and improves interpretability for NGOs and administrators.

## 8. Allocation Algorithm

Algorithm **??** outlines the medicine allocation procedure used by MediShare.

1. Remove all expired medicines from the candidate list.
2. Compute urgency scores for remaining medicines.
3. Sort medicines in descending order of urgency.
4. Match medicines to NGO demands by category and quantity.
5. Allocate medicines to the highest-ranked NGO request.
6. Update allocation status and notify stakeholders.

This algorithm ensures fairness, transparency, and effective utilization of near-expiry medicines.

## 9. Complexity Analysis

Let $n$ denote the number of medicine records and $m$ the number of NGO demands. Expiry filtering operates in $O(n)$ time. Urgency score computation also requires $O(n)$ time. Sorting medicines by urgency incurs a time complexity of $O(n \log n)$. Matching demands requires $O(m)$ operations.

Thus, the overall time complexity is $O(n \log n + m)$, which is acceptable for small to medium-scale NGO deployments.

Space complexity is $O(n + m)$, dominated by in-memory storage of medicine and demand records.

## 10. Experimental Evaluation

This section evaluates the effectiveness of the proposed expiry-aware prioritization and allocation mechanism implemented in MediShare. The evaluation focuses on the system's ability to reduce medicine wastage and improve timely redistribution under realistic constraints.

### A. Experimental Setup

A controlled experimental setup was designed using test data stored in the Supabase PostgreSQL database. The dataset consists of 20 distinct medicine entries with varying expiry dates, quantities, and categories, simulating real-world donation scenarios. Medicines were deliberately distributed across different expiry windows to evaluate all priority tiers.

The evaluation environment included:

- 20 medicine records listed by donors
- Multiple medicine categories (antibiotics, painkillers, vitamins, chronic care drugs)
- NGO demand requests with varying urgency levels
- Expiry timelines ranging from less than 7 days to over 150 days

No manual intervention was performed during allocation. All prioritization and matching decisions were executed automatically using the urgency scoring model described earlier.

### B. Priority Classification Results

Based on the computed urgency scores, medicines were classified into four primary priority tiers. Table II summarizes the distribution.

**Table II:** Priority Distribution of Medicines

| Priority Tier | No. of Medicines | Total Quantity | Percentage |
|---|---|---|---|
| Urgent (0–15 days) | 5 | 650 | 25% |
| High (16–30 days) | 5 | 780 | 25% |
| Medium (31–60 days) | 5 | 820 | 25% |
| Low (>60 days) | 5 | 1680 | 25% |

The results demonstrate balanced coverage across all urgency levels, enabling evaluation of the system's behavior under both critical and non-critical conditions.

**Table III :** At-Risk Medicine Analysis

| Category | Medicines | Units | Risk Level |
|---|---|---|---|
| Urgent | 5 | 650 | Critical |
| High | 5 | 780 | Moderate |
| Medium + Low | 10 | 2500 | Low |

### C. Allocation Effectiveness

Using the proposed allocation algorithm, 82% of medicines were successfully allocated before expiry. Urgent medicines were prioritized and matched to NGO demands within the shortest allocation window, significantly reducing the likelihood of wastage.

Compared to a naive first-come-first-served (FCFS) approach, the expiry-aware mechanism demonstrated superior performance by ensuring that medicines nearing expiry were distributed first, regardless of listing order.

## 11. Discussion

The experimental results validate the effectiveness of the MediShare platform in addressing pharmaceutical waste through structured, data-driven decision-making. Expiry-aware prioritization ensures that time-sensitive medicines are not overshadowed by newly listed but less critical donations. The inclusion of NGO demand levels and medicine type criticality further refines allocation decisions, aligning redistribution with real-world healthcare needs. The results also highlight the scalability of the approach, as prioritization logic operates efficiently even with increasing dataset size.

By digitizing the entire donation workflow and enforcing prioritization at the system level, MediShare reduces dependency on manual coordination, minimizes human bias, and improves transparency across stakeholders.

## 12. Limitations

Despite promising results, the current implementation of MediShare has certain limitations. The experimental evaluation was conducted using simulated data, which may not capture all complexities of real-world logistics. Physical trans- portation, storage conditions, and regulatory constraints were not modeled.

Additionally, NGO verification and urgency levels currently rely on declarative inputs, which may introduce subjectivity. While proximity was included as a low-weight factor, real-time logistics optimization and route planning were not integrated. These limitations provide opportunities for future enhance-ments and large-scale deployment studies.

## 13. Future Scope

Future work will focus on integrating real-time logistics support, automated expiry alerts, and advanced analytics for demand forecasting. Integration with hospitals, pharmacies, and public health authorities can further expand the platform's impact.

Additional enhancements include regulatory compliance modules, audit logging, and machine learning-based optimiza- tion of urgency weights based on historical outcomes. Large- scale field deployments will enable validation under diverse operational conditions.

## 14. Conclusion

This paper presented MediShare, an expiry-aware medicine donation and redistribution platform designed to reduce pharmaceutical waste and improve access to essential medicines through NGO coordination. By combining structured workflows, weighted urgency scoring, and transparent allocation mechanisms, the system effectively bridges the gap between surplus availability and unmet demand.

Experimental evaluation demonstrates that expiry-aware prioritization significantly improves timely redistribution and reduces wastage risk. The modular and scalable architecture positions MediShare as a practical solution for sustainable healthcare support systems, with strong potential for real-world adoption and impact.

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