

# Design and Application Research on Lightweight Community Healthcare Management System

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## ABSTRACT

Aiming at prominent problems in grassroots medical institutions in China, such as low informatization level, high operation cost, complex and difficult-to-use systems, and weak data security, this paper designs and implements a lightweight, low-cost, easy-to-operate and security-compliant community healthcare management system. Adopting Python Django back-end architecture and lightweight front-end technology, the system constructs five core modules: patient files, registration and consultation, prescription management, drug inventory, and permission security, forming an one-stop digital management solution for grassroots medical institutions. Pilot applications were carried out in 8 grassroots medical institutions in Chaoyang District, Tongzhou District and Shunyi District of Beijing. The results show that the system features convenient deployment, low learning threshold and strong stability, which can effectively shorten patients' waiting time, improve doctors' work efficiency, standardize diagnosis and treatment processes, and protect patients' privacy and security. It has good promotion value and social significance.

**KEYWORDS:** *Grassroots Healthcare; Healthcare Informatization; Community Healthcare Management System; Lightweight; SaaS Model.*

## 1. INTRODUCTION

With the advancement of the "Healthy China 2030" strategy and the continuous improvement of the tiered diagnosis and treatment system, grassroots medical institutions have become the "nerve endings" of China's medical service system. According to statistics, there are a large number of grassroots clinics, community health service centers and township health centers nationwide, but the informatization coverage rate is less than 30%. Most institutions still adopt traditional management modes such as paper files, manual registration and manual prescriptions, leading to prominent problems including **disorganized files, inefficient processes, extensive management and insecure data**, which seriously restrict the improvement of grassroots medical service quality.

Current medical information systems are polarized: large hospital information systems (HIS, EMR) have complete functions but are expensive, complex to deploy and high in maintenance costs, which are unaffordable for grassroots institutions; small medical software has single functions, poor compatibility,

insufficient stability and no guarantee of data security, making it difficult to support daily diagnosis and treatment management. Grassroots medical institutions have long faced the dilemma of **being unable to afford, unable to use well, and afraid to use**, and the market is in urgent need of an integrated medical management system tailored for grassroots, lightweight, low-cost, zero-threshold and security-compliant.

Based on the actual needs of grassroots healthcare, this paper designs a lightweight community healthcare management system, completes architecture design, function implementation, pilot application and effect analysis, and provides a practical solution for the inclusive digital transformation of grassroots healthcare.

## 2. Current Situation and Pain Point Analysis of Grassroots Healthcare Informatization

### 2.1. Industry Status

The state has successively issued policies such as the **14th Five-Year Plan for National Health**

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Informatization\* and the \*Action Plan for Capacity Improvement of Grassroots Medical and Health Institutions\*, clearly proposing to accelerate the digital construction of grassroots healthcare and promote the popularization of electronic health records, electronic prescriptions and telemedicine. However, grassroots medical institutions generally have the characteristics of \*\*small scale, limited funds, weak technical personnel and scattered distribution\*\*, resulting in an overall lag in informatization construction and a slow process of digital transformation.

## 2.2. Core Pain Points

1. **Disorganized Patient File Management**: Paper files are easy to lose, difficult to find and update in a timely manner, leading to poor continuity of diagnosis and treatment;
2. **Inefficient Diagnosis and Treatment Processes**: Manual registration, handwritten prescriptions and disordered queuing result in long waiting time for patients and heavy workload for doctors;
3. **Poor Adaptability of Existing Systems**: Large systems are expensive and complex to operate; small software has incomplete functions and poor stability;
4. **Prominent Data Security Risks**: Lack of encryption and permission control leads to easy leakage of patients' privacy and compliance risks;
5. **Weak Technical Capability of Personnel**: Medical staff have limited IT background, resulting in high learning costs and difficulty in mastering complex systems.

## 2.3. Market Gap

Currently, there is a clear market gap in the lack of **lightweight, low-cost, easy-to-operate, full-featured and highly secure** dedicated management systems for grassroots healthcare, and the digital needs of grassroots medical institutions have long been unmet.

## 3. Overall System Design

### 3.1. Design Objectives

Centered on the core objectives of **inclusive grassroots healthcare, ease of use, safety and efficiency, and low cost**, the system aims to:

- Adopt a lightweight architecture to reduce hardware dependence and adapt to outdated equipment;
- Achieve zero-threshold operation with a concise interface and intuitive processes requiring no training;

- Cover full-scenario needs including patient management, registration, prescriptions, drugs and security;
- Ensure security compliance through data encryption, permission classification and log tracking, meeting healthcare data security standards.

### 3.2. System Architecture Design

Adopt a **B/S architecture with separated front and back ends and modular development**:

- **Back-end**: Python 3.8 + Django 4.2, featuring high efficiency, stability, built-in permission and security mechanisms, supporting rapid iteration;
- **Front-end**: HTML5 + CSS3 + JavaScript, lightweight design with fast response speed, adapting to low-configuration terminals;
- **Database**: MySQL 8.0, ensuring data consistency, integrity and traceability;
- **Deployment Mode**: One-click deployment supporting Windows/Linux, completed within 5 minutes without professional IT personnel.

### 3.3. Core Functional Module Design

#### 3.3.1. Patient File Management Module

Records patients' basic information, medical history, allergy history, consultation records and medication history, supporting quick retrieval, modification and export, establishing standardized electronic health records to ensure continuity of diagnosis and treatment.

#### 3.3.2. Registration and Consultation Management Module

Supports online/offline registration, queuing and calling, consultation registration and doctor scheduling, optimizing consultation processes and reducing patients' waiting time.

#### 3.3.3. Prescription Management Module

Standardizes electronic prescription entry, review, printing and archiving, automatically associated with the drug library, reducing medication errors and improving prescription standardization.

#### 3.3.4. Drug Management Module

Realizes drug warehousing, outbound, inventory early warning, expiration reminder and classified management, reducing operational losses and avoiding expired drugs.

#### 3.3.5. Data Security and Permission Management Module

Adopts Role-Based Access Control (RBAC) with hierarchical permission isolation; stores encrypted

data, performs regular backups and retains operation logs to protect patients' privacy and data security.

#### 4. System Implementation and Key Technologies

##### 4.1. Development Environment

- Operating System: Windows 10, Linux CentOS 7;
- Back-end: Python 3.8, Django 4.2;
- Front-end: HTML5, CSS3, JavaScript;
- Database: MySQL 8.0;
- Deployment Tool: Automated installation package supporting one-click deployment.

##### 4.2. Key Technologies

1. **Lightweight Optimization Technology**: Simplifies code structure, optimizes resource loading and reduces redundant functions to lower hardware resource occupation;
2. **RBAC Permission Classification Technology**: Precisely controls permissions of administrators, doctors and nurses to prevent unauthorized operations;
3. **Data Encryption Technology**: Adopts the AES encryption algorithm to encrypt sensitive information such as patients' ID numbers, contact information and medical history, and uses the HTTPS protocol for transmission to prevent data leakage;
4. **One-Click Deployment Technology**: Packages environmental dependencies, database scripts and configuration files, enabling grassroots institutions to complete deployment automatically by double-clicking the installation package without manual configuration.

##### 4.3. System Advantages

- **Low Cost**: Free basic functions with value-added services paid on demand, adapting to grassroots budgets;
- **Ease of Use**: Interface tailored to grassroots medical staff's usage habits with simplified processes and zero learning costs;
- **Full-Featured**: Covers the entire diagnosis and treatment process, meeting daily management needs of grassroots institutions;
- **High Security**: Complies with the *Cybersecurity Law* and the *Guidelines for Big Data Security in Health Care*, ensuring data compliance.

#### 5. System Application and Effect Analysis

##### 5.1. Pilot Application Situation

Supported by the technical team of the School of Information, Beijing Wuzi University, the system was

piloted in 8 grassroots medical institutions in **Chaoyang District, Tongzhou District and Shunyi District of Beijing**, including **2 community health service centers, 3 community health service stations and 3 small private clinics**, covering common grassroots healthcare scenarios such as general practice, chronic disease management, elderly health and children's preventive health care.

There are 42 medical staff in pilot institutions with an average age of 43, among whom **71%** have no professional IT training experience. Daily equipment is mostly ordinary office computers configured from 2018 to 2020 with network bandwidth generally ranging from 10 to 20 Mbps, which is consistent with the typical status of grassroots medical institutions in suburban Beijing. System deployment was completed within **15 minutes** without on-site professional IT personnel.

##### 5.2. Application Effects

###### 5.2.1. Significant Improvement in Diagnosis and Treatment Efficiency

- Average consultation duration for patients: reduced from **38 minutes** to **14 minutes**, shortened by **63.16%**;
- Average queuing waiting time: reduced from **22 minutes** to **5 minutes**, shortened by **77.27%**;
- Average daily consultation volume of doctors: increased from **18** to **27 visits**, with consultation efficiency improved by **50%**.

###### 5.2.2. Improvement in Standardization of Diagnosis and Treatment Management

- Electronic health record filing rate: increased from **58%** to **100%**;
- Electronic prescription rate: increased from **42%** to **97%**;
- Prescription compliance rate: increased from **64%** to **98%**;
- Drug inventory accuracy rate: increased from **76%** to **99.5%**;
- Omission rate of patients' allergy history: reduced from **31%** to **below 2%**, significantly improving medication safety.

###### 5.2.3. Significant Reduction in Operational Costs

Pilot institutions do not need to invest in high software procurement costs, with free basic functions and annual operation and maintenance costs of less than 1,000 yuan. Compared with traditional commercial systems, **annual informatization investment is reduced by more than 90%**,

significantly alleviating the economic burden of grassroots institutions.

#### 5.2.4. Obvious Improvement in Service Satisfaction

During the pilot period, 300 patient satisfaction questionnaires were randomly distributed, and 287 valid questionnaires were recovered. The results show that patient satisfaction increased from \*\*78% to 96%\*\* before the pilot, and medical staff job satisfaction increased from \*\*72% to 93%\*\*, creating a more harmonious doctor-patient relationship.

#### 5.3. Social Value

The system promotes the inclusive digital transformation of grassroots healthcare, facilitates the implementation of tiered diagnosis and treatment, narrows the urban-rural gap in healthcare informatization, standardizes grassroots diagnosis and treatment behaviors, reduces medical errors, protects patients' privacy and security, safeguards the rights and interests of doctors and patients, and provides grassroots support for the construction of Healthy China.

### 6. Conclusion and Prospect

#### 6.1. Conclusion

The lightweight community healthcare management system designed and implemented in this paper accurately meets the core needs of grassroots medical institutions for low cost, ease of use and high security, effectively solving pain points such as disorganized files, inefficient processes, expensive systems and insecure data. Pilot applications prove that the system has practical functions, strong stability and high promotion potential, which can quickly empower the digital transformation of grassroots healthcare with significant economic and social value.

#### 6.2. Prospect

Future optimization will focus on three aspects: first, \*\*function iteration\*\* to add chronic disease management, intelligent follow-up and medical insurance settlement docking modules; second, \*\*technical upgrading\*\* to introduce lightweight AI-assisted diagnosis and intelligent medication reminder functions; third, \*\*scale promotion\*\* to rely on the technical resources of the School of Information, Beijing Wuzi University, improve the national grassroots institution service network, build a grassroots healthcare digital platform and contribute to the high-quality development of grassroots healthcare.

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