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# Distributed Database Strategies In A Healthcare Record Systems

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## Abstract

The rapid development of information technology has brought various opportunities to the healthcare sector, particularly in facilitating medical examination and treatment as well as hospital management. However, in Vietnam, the healthcare software systems still have many limitations. These include such as inaccurate processing process compared to the actual requirements which are usually developed in discrete, with no common standards, and no data connection with each other. Therefore, it leads to the existence of many separate, duplicated, inaccurate and incomplete databases. A patient comes to medical examination and treatment at a new facility still has to provide the necessary information to the medical personnel from the beginning, causing delay in the treatment and management of patients. The improper system entails inconvenience in terms of storing, checking and monitoring medical records, especially when emergency cases arised. In recent years, the need to collect, store and exchange information has become more and more tangible, forming large blocks of data. The traditional database management systems and centralized data management have no longer met this requirement. Instead, distributed data management technologies development proven to be more optimum, reliable, widely used and popular. Therefore, we have studied and built an information system with a distributed database to apply to the management of medical examination and treatment at medical facilities. This paper will present the construction of information and health information system, learn the dispersion model and deploy Multi-Master replication model of MySQL Replication. Our system has satisfied the basic operations, expanding the necessary functions, thus bringing high efficiency in practical applications. The medical information and treatment system using the humanized dispersion model helps the medical examination and treatment data to be synchronized and retrieved quickly, saving time, avoiding information redundancy, thereby improving the quality of treatment for patients when requiring medical examination in many places.

Keywords: Distributed database management system, Healthcare record system, Multi-Master replication

## Introduction

Currently, the application of information technology in health sector is an urgent practical need, in order to improve the quality and shorten the medical examination and treatment time of patients. In particular, the use of software in the management of medical examination and treatment, especially for patients who must re-examine many times has been effective with many advantages such as helping doctors find information quickly and accurately, known history and disease progression. Each patient is provided a card with a unique code, health officials can access the system to review the number of visits as well as the diseases that patients have examined and treated before. When re-examination, only a code is required for the doctor to know the patient's medical history, thus reducing the waiting time for the patient because he or she does not have to repeat the procedure as the first time.

However, the software applications between hospitals are still sporadic, not close to the actual needs, there is no common standard of software system as well as data linkage with each other. The fact that a patient only needs to declare a unique code when visiting any hospital has not been implemented. When patients switch to treatment in another hospital, they have to re-register as the first time. Therefore, it is causing inconvenience in storing, checking and monitoring medical records, especially in case of emergenkriscy hospital transfer. In such cases, if the doctor does not have the correct history of the patient's medical record, he or she will not make a timely and reasonable treatment decision, inconsistency in treatment, cause dangerous for patients.

In recent years, the increasing demand for information storage and exchange, traditional database management systems (DBMS), centralized data management are no longer

relevant to the current requirements. Meanwhile, distributed database management system (DDBMS) has been increasingly used popularly because of its effectiveness and compliance with actual requirements. There are many studies on distributed database system to develop applications in many fields such as tax declaration system, air ticket booking system, climate change information system, land information system, multiple-choice test system, credit training system, school management system, sales management, human resource management, supplies management, etc. From the above requirements of the health sector and trends of the development of DDBMS, we have studied and built a system of clinic databases following the approach of DDBMS to overcome these limitations.

**Related Work**

The research project "Building an electronic medical management system in the Police Hospital of An Giang Province" by Nguyen Minh Hau (2009) has focused on the management of electronic medical records and patient information management during treatment at the clinic. The system performs well the preparation of coupons for the examination, diagnosis and inpatient treatment. However, outpatient examination and treatment has not been well supported, especially in a discrete drug store database. "Warehouse management at My An General Clinic, TP. Long Xuyen, An Giang province" by Nguyễn Việt Thắng (2010) has built a pharmaceutical management system, manages invoices for import, export and warehouse transfer according to FIFO principles. The system can calculate drug prices according to multiple requirements, sell drugs by prescription or retail.

However, the system has not yet linked to the prescription in the clinic to keep the number of cases closely updated as well as a warning for the doctor during the prescription. The common advantage of the above two topics is the successful computerization of the medical system management system of the infirmary as well as the pharmaceutical management system in the pharmaceutical warehouse, helping users to handle professional operations easily and save time, make reporting statistics quickly and accurately. However, these systems have not focused on linking data between doctor prescriptions and drug depots. The system is programmed on Window Form platform instead of the web, making it difficult to maintain and upgrade.

"Deploying distributed data warehouse for climate change information system using MySql Replication" by Nguyen Thi Truc Ly et al (2013) has studied the deployment of distributed data warehouse in the field of environment. This research has presented how to build a data warehouse for climate change information system, it can be deployed on a distributed database suitable for many areas. They have introduced the stages in the process of deploying distributed database system for climate change data warehouse with MySQL Replication and proposed some remedies when the system occurred. However, this study has only focused on the Master-Slave model application without studying the advantages of Multi-Master model.

**Distributed Database Model**

DDBMS is a software system that allows to manage distributed database and ensure transparency of dispersion for users (M. Tamer Özsu et al (2011)). A commercially distributed database management system often has the following basic components: Database management, Data Communication, Data Dictionary, Distributed Database. The clinic database will be designed based on Replication distribution method. The database system of clinics is designed to be horizontal fragmented and database dispersion organization in the whole province. There will be a database containing all data in the scope of the clinic and operate independently. For the information of medical examination (examination card, prescription, birth certificate), patient information, list ICD-10 will be synchronizing between clinics by duplicating rings. Design of dispersed database model for clinics is described as Figure 1. Data on examination will be

designed and modelled synchronous on local network for polyclinics as Figure 2.

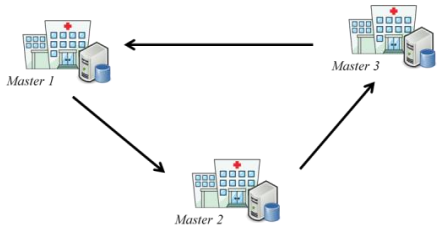


Figure 1. The replication model of the clinic.

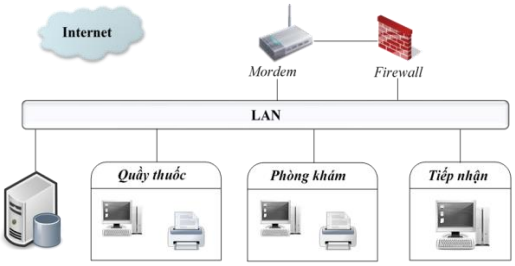


Figure 2. Network system model of the clinic.

**System Analysis and Design**

Currently, the general process of medical examination and treatment in clinics can be described as follows: when the patient arrives at the clinic, the nurse is responsible for receiving the patient. If the patient is new to the examination, the system will automatically generate a new patient code. If a patient comes to re-examine, a nurse will check the patient's previous medical examination information (history of examination, drug history, etc.) through the patient's number recorded in the old prescription to form a card for new examination. After entering the required information, the nurse will take the values for the patient before sending the records to the waiting room. In the clinic, the doctor relies on the registration list to select the patient to examine, examine the patient information, the history of medication (if any), then the doctor makes the diagnosis. Here are the following cases: (1) if the patient does not have the disease, the doctor will advise and send the patient to home; (2) if the diagnosis is made and can be treated as an outpatient, prescribe medication to the patient and let the patient go home for treatment, appoint a re-examination date; (3) If the patient has diseases that the clinic does not have the capacity and conditions for treatment, then advise the patient to provide medical examination and treatment at other hospitals.

During the examination, the doctor will enter information about diagnosis, prescriptions, and patient's condition. After the doctor completes the examination and appoints the treatment, the patient will go to the pharmacy to receive the medicine. Here the patient will receive his bill and prescription. The process of medical examination and treatment is described as in **Error! Reference source not found.**.

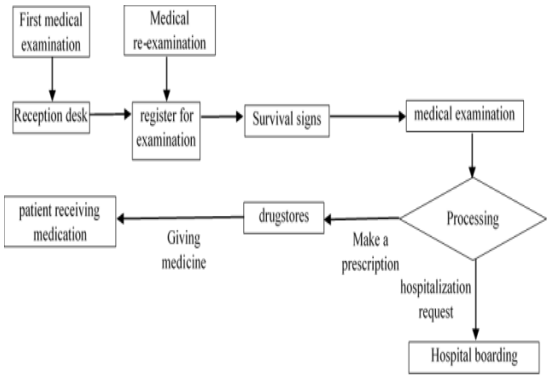


Figure 3. Process of medical examination and treatment.

**Algorithm to improve drug delivery system**

The feature of the clinic system has been improved compared to the fact that the drug store is linked to a doctor's prescription. The state of medicine in the warehouse is always visible to the doctor when prescribing, including warning of the quantity remaining, returning the drug between the doctor's prescription and the medicine store of the clinic. The block diagram for treatment and delivery of drugs is shown in Figure 4 and Figure 5. Based on the batches of drug import, the update of the number of medicines is updated according to the following principles: reduce the number of drugs in the FIFO method, increase the number of drugs by LIFO method.

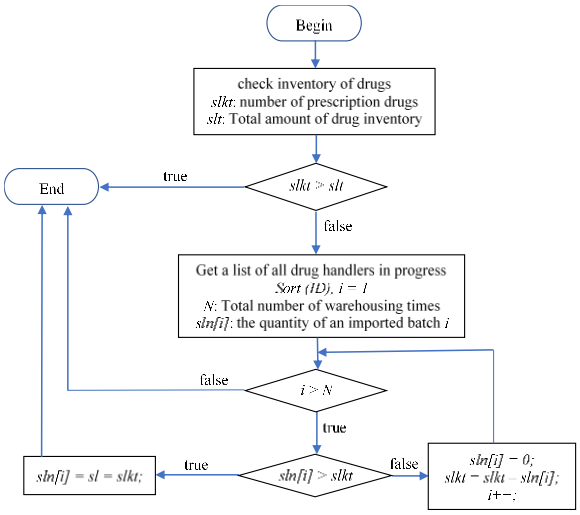


Figure 4. Block diagram reduces the amount of drugs in stock when prescribing.

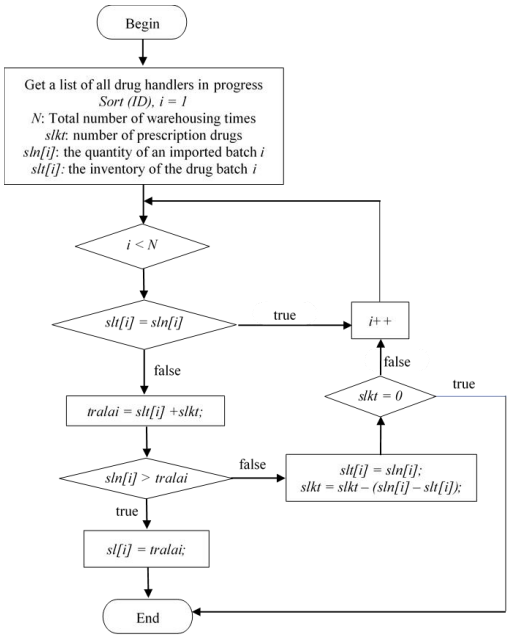


Figure 5. Block diagram to return medicine in the drug store when prescribing.

## Hiện Thực Chương Trình

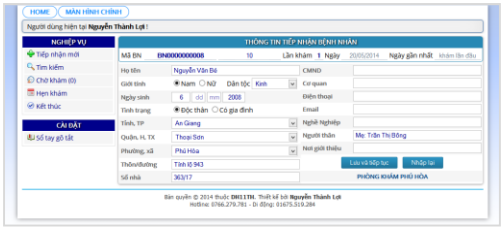

Figure 6. User interface of adding new patient information.

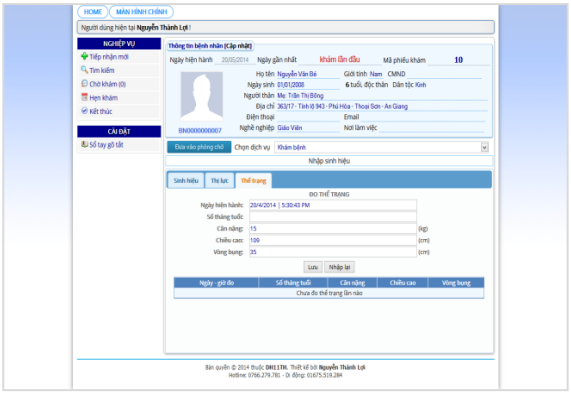

Figure 7. User interface of examination registration.

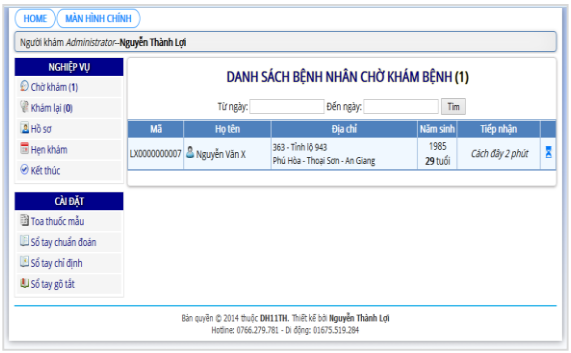


Figure 8. User interface of waiting for medical examination.

## Implementation and Evaluation

Our system has been implemented and evaluated on the hardware system with the configuration shown in Table 1.

**Table 1**. Hardware configuration of the clinic system

| | **Server** | **Workstation** |
|---|---|---|
| CPU | Intel Core i7 | Intel Core i3 |
| Hard Driver | SATA 320GB | SATA 160GB |
| RAM | DRAM 8GB | DRAM 4GB |

The workstations at each stage of the process are physically connected to the server machine via the LAN model of DOMAIN (client-server).

**Software**

*Server*: Windows Server operating system 2016, install Web Server, PHP, MySQL by installing one of the general software packages such as Vertrigo, Appserv, XamPP, USB Webserver.

*Workstation*: Window 10, ... and web browsers such as IE, Mozilla Firefox, Opera, Chrome, Safari.

**Implementation of distributed DBMS models**

Each database located in each clinic is a Data Mart with medical information for patients in that clinic and some other clinics. This is a data warehouse dispersed in a homogeneous dispersed model, all data places use open source DBMS MySQL. To configure two-way replication, we configured the three master-slave replication models as follows: (1) server 1 is master, server 2 is slave; (2) server 2 is master, server 3 is slave; (3) server 3 is master, server 1 is slave. The master is the server for the server's data warehouse. The slaves do not duplicate all databases on the master, but replicate the corresponding Data Mart. When the data changes on master, the data will be automatically replicate to the slave, and when the data changes on the slave, it will also be automatically replicate to the master.

**Server settings**

We have implemented 3 servers that have been installed MySQL Server. Server 1 has an IP address of 192.168.159.1, server 2 has an IP address of 192.168.159.128, server 3 has an IP address of 192.168.159.129, Database on 3 servers needs to synchronize named *phongkham*. This system, after being locally applied in a clinic, has met the requirements in the medical examination and treatment process. The dispersed experimental model of the clinic's data warehouse with MySQL Replication ensures the goals of research. The database is replicated synchronously and quickly retrieved. However, the system still has some limitations as follows: (1) loss of deployment costs is static IP, server for each office; (2) loss of temporary synchronization for 2 nodes when one of the network system nodes is offline. However, the model can improve the temporary loss of synchronization through the standby server for each node.

**Conclusion**

This article has presented the research and application of distributed database on medical examination and treatment of clinics and hospitals. We have studied

and deployed Multi-Master Replication model, presenting theoretical research on distributed database, thereby enabling the development of large systems in dispersed environment and wide use scope. The clinic system software system has been built with basic functions along with some necessary utilities. The system is designed in the direction of data dispersion, the medical data is synchronized in the servers of each clinic. However, the system still has some limitations that are not interested in private information of patients, can only be implemented with 3 master models in the internal network environment (LAN), not implemented through a connection of internet.

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