The Comprehensive Management System of Dialysis Patients: Creation and Application of the Database

Yoshinori Shima and Takashi Yasuda

(Received for Publication: February 20, 2007)

Abstract

Patients with chronic kidney disease need long-term appropriate support and management by the medical staff for the maintenance of a good quality of life. For this purpose, the multidisciplinary medical staff should utilize a wide variety of clinical information from the dialysis patients. Recent progress in technology has given us the advantage of treating the information systemically and comprehensively, which results in the utilization of information for maximum effectiveness. We, therefore, aimed to develop a database of the comprehensive information of dialysis patients in order to improve our support and care for them.

We chose the database items primarily from the clinical information essential for the maintenance of dialysis therapy. We then developed the framework of the database to satisfy the purposes of long term storage, accessibility, and multidirectional information analysis of the wide variety of clinical information. Moreover, we created the network environment in the Integrated Care Center for Kidney Disease, where all medical staff can access the database from terminal machines without the requirement of specific application. The security system was also designed for the network. In the output mode, windows for statistical work data and visual processing of the accumulated data were planned.

In total 964 items were selected for the database. The relational database system DB2® (IBM) was used for the database management and HyperText Markup Language (HTML) format was adopted for the network environment. Every personal computer at the Integrated Care Center for Kidney Disease was connected to the server via the network system in the center, which is a closed network without connection to the external network. A personal certification system within the application was employed for security measures. Accumulated data were converted into the visual processing window using Microsoft Access® (Microsoft) through Open Database Connectivity (ODBC). Utilization of the World Wide Web browser facilitates intuitive manipulation for the users.

In conclusion, by using this system, instant access to every patients’ information becomes possible for all medical staff in the Integrated Care Center for Kidney Disease.

Key Words
Dialysis patients, Database, Web, Local area network

Introduction

Patients with chronic kidney disease need long-term appropriate support and management from medical staff in order to maintain a good quality of life. Dialysis patients have a long history of underlying illness during pre-dialysis periods and some of them survive more than three decades on dialysis. After being introduced to dialysis at the Integrated Care Center for Kidney Disease in our hospital, almost all the patients move to satellite outpatient dialysis clinics for maintenance dialysis therapy,
and refer to our hospital again for their comorbid illnesses. Dialysis patients usually suffer from a number of comorbid illnesses including brain, eye, heart, peripheral vessels, bone, muscle and skin diseases in addition to their underlying kidney disease. Therefore, a multidisciplinary approach to the clinical information and comprehensive management of it are indispensable for appropriate support and care of dialysis patients\(^1\).

We, therefore, aimed to create a database of comprehensive information of dialysis patients, and further, establish a database network through which the medical staff can browse, input, and retrieve the patients’ data anytime from anywhere using one of several personal computers located throughout the facility.

**Methods**

1. **Selection of clinical information for the database fields**
   
   Items for the database field were chosen primarily from the information which was essential for maintenance dialysis\(^2\). Other information essential for medical care was also added. In order to gather important items comprehensively, we performed a hearing investigation from the dialysis nurses and clinical engineers and surveyed the medical records, operation records, and dialysis charts. Then, the authors exchanged views about the necessity of each item and selected items based on whether it is an item of long term and recurrent necessity \(^3,4\).

2. **The database server and system**
   
   The Windows 2000 server was chosen for the operation system because of its system stability, easy recovery at the time of system failure, and the applicability of the existing network.

   Assembling each item for the database was arranged primarily along the lines of workflow and the sorting of medical record. The framework of the database was developed on the principles of enabling long term storage, multiple retrieval, and multidirectional information analysis of the variety of patient clinical information. Stable long term operation was also a targeted\(^5\).

3. **Network environment**
   
   In order to use the assets of our existing network, personal computers were chosen as terminal machines. We planned to create a network where every medical staff member would be able to access the databases from terminal machines without the need of a special application. A security system was also designed.

4. **The input and management of information**
   
   The fundamental idea behind the whole operation system is simplification of input operation and eliminating mistakes as much as possible. In order to reduce handwritten input, a program for the automatic conversion and importing of information into electronic media, such as laboratory results, and for automatic calculation was developed.

   Concerning the output mode, the progress note of clinical course and laboratory results, the windows for statistical data and the visual processing of the accumulated data were planned.

**Results**

1. **Selected items for the database fields**
   
   A total of 964 items were selected. These items were classified roughly into 3 categories as: the patient’s basic information, information concerning dialysis therapy, and information concerning patients moving in and out. The basic information consisted of the primary disease, histological findings from kidney biopsy, laboratory data, and results of imaging tests such as CT and MRI scans. The information concerning the dialysis included medication records and operation records. The information of move-in and move-out included the name of out-patient satellite dialysis clinics and the dates of moving-in and moving-out. Representative essential items for the dialysis patient care are shown in Table 1.

2. **Assembly of the database server**
   
   We employed the relational database management system DB2\(^6\) (IBM) because of its usability, long-term stability and network capabilities from many directions.

3. **Network environment**
   
   HyperText Markup Language (HTML) format with Internet Information Service (IIS) was adopted as the Network environment. Assembly of the database server and network are shown in Figure 1. The existing network system in the Integrated Care Center for Kidney Disease was used for this comprehensive management system of dialysis patients. Every personal computer within the network was connected to the server via the intranet, and users can
The key record of the relational database is patient’s ID, and the patient’s basic information is recorded in relation to the patient’s ID. The events and treatments are recorded as a list of contents under the History of patients column. Also, detailed contents of the events and treatments are recorded respectively in the tables of items. In addition, the laboratory results are managed by another database.

use the database without the requirement of special applications (Fig. 2). This method offers the advantages of terminal device adaptation such as PDA.

A closed network without connection to the external network and a personal certification system in the application was employed for security measures. Users can access the database using their own ID and password, and an automatic logout function was provided in the case of no operation during the arranged setting time.

4. Input and management of information

The input data include basic patient information, histological findings from kidney biopsy, serial laboratory and imaging test results, dialysis information, operation records, and records concerning the patients’ status such as move-in and move-out information. A coding conversion program enabled the laboratory data to be imported automatically into the database from electronic media.

Table 1. Skeleton Brief of Selected Database Items

<table>
<thead>
<tr>
<th>Table</th>
<th>Number of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients basic information</td>
<td>42</td>
</tr>
<tr>
<td>Patients closeup information</td>
<td>23</td>
</tr>
<tr>
<td>Patients information for doctor</td>
<td>107</td>
</tr>
<tr>
<td>History of patients event information</td>
<td>48</td>
</tr>
<tr>
<td>Therapy of Total PD</td>
<td>58</td>
</tr>
<tr>
<td>Therapy of PD</td>
<td>57</td>
</tr>
<tr>
<td>Therapy of QUANTUM PD</td>
<td>67</td>
</tr>
<tr>
<td>Therapy of CAPD</td>
<td>18</td>
</tr>
<tr>
<td>Hemodialysis information</td>
<td>25</td>
</tr>
<tr>
<td>Medical record of patient</td>
<td>28</td>
</tr>
<tr>
<td>Operation of PTA</td>
<td>22</td>
</tr>
<tr>
<td>Operation of arteriovenous shunt for dialysis</td>
<td>22</td>
</tr>
<tr>
<td>Operation of catheter insertion for CAPD</td>
<td>84</td>
</tr>
<tr>
<td>Peritoneal linked CAPD</td>
<td>80</td>
</tr>
<tr>
<td>Medical record of CAPD</td>
<td>40</td>
</tr>
<tr>
<td>Renal biopsy</td>
<td>130</td>
</tr>
<tr>
<td>Calculation of PST</td>
<td>120</td>
</tr>
<tr>
<td>Calculation of Ccr</td>
<td>29</td>
</tr>
<tr>
<td>Table of working staff</td>
<td>13</td>
</tr>
<tr>
<td>Table of code</td>
<td>15</td>
</tr>
<tr>
<td>Total items</td>
<td>964</td>
</tr>
</tbody>
</table>

The comprehensive management system of dialysis patients.

Figure 1. A block diagram showing the databases system.

Each client has PC accesses to database server with IIS and WAS on Local Network.

IIS: Internet Information Service
WAS: Web Sphere Application Server
PC: Client PC

dia. Pull-down menus were fixed in many items of manual input.

Windows for the output information were composed of the basic patient information, progress notes of clinical courses taken, serial laboratory and imaging test results, serial dialysis records, serial records of operations, special test records including biopsy, move-in and move-out records, windows for statistical work data, visual processing of the accumulated data. Calculated results drawn from the multitude of laboratory data including peritoneal equilibrium tests and parameters of dialysis efficiency such as creatinine clearance of the kidney and the peritoneum were also displayed automatically (Fig 3–7).

Accumulated data were converted into visual...
processing windows using Microsoft Access® (Microsoft) through Open Database Connectivity (ODBC).

5. Clinical utility

Utilization of World Wide Web browser facilitated intuitive manipulation for the users. By using this system, instant access to every patient’s information became possible for all the medical staff in the Integrated Care Center for Kidney Disease. This enabled the staff to detect any changes in disease trajectory early. This database enabled greater, more effective information-sharing among the multidisciplinary medical staff.

Discussion

Medical staff members from a myriad of disciplines are involved in dialysis patient care due to the complexity of the condition of having chronic renal failure. These staffs include nephrologists, nurses, and clinical engineers in the Integrated Care Center for Kidney Disease, as well as dietitians, social workers, and pharmacists. Medical doctors from other fields such as ophthalmologists, cardiologists, vascular surgeons and so on are also engaged in the management of dialysis patients. Dialysis patients usually have many comorbid illnesses and thus need to access a number of medical resources. Based on these reasons a database of comprehensive information concerning the records of dialysis patients is essential for effective clinical practice.

In the mid 1990’s, computer technology and information processing have made rapid progress. Network environments such as the World Wide Web began to prevail. Terminal equipment such as personal computers, personal digital assistance (PDA), and cellular phones were also developed to enable fast, convenient access to the network. These advancements in technology give us the advantage of being able to gather the information systemically and comprehensively, to acquire information on anybody, anywhere, anytime, and to utilize information for maximum effectiveness.

We saw the potential to develop a database and
network system for dialysis patients utilizing this recent advancement in technology. We chose Hyper Text Markup Language (HTML) format for connection to the server and users can access database, without the need of any special application, by their personal computers. Choosing the HTML format enabled user intuitive operation, just like internet surfing, without installation of special software. Prompt access to almost all the necessary information for each patient enables immediate, accurate and precise decision making for the medical staff at the time of urgent referral of the registered patients.
patients from satellite clinics or at the time when patients are being rushed to our hospital in an emergency situation. Time and materials required for filing hard copy reports and documents has also been reduced by this system.

Using this database and network, sharing intelligence, which was previously possessed by each occupation such as doctors, nurses, or clinical engineers, was facilitated and inter-occupational communication was thus achieved. Accumulation of data seems to bring not only better management of the individual patient but also the management of all dialysis patients through better understanding of the whole clinical pathological process involved in chronic renal failure.

Although some of the data input operates automatically, there is much data requiring manual input. This is really time consuming and monotonous work for the busy medical staff and often results in partial or complete data loss. We, therefore, need to appoint some staff to input data in order to avoid such issues from arising.

A closed network is the most efficient method to protect patient information. In addition to the closed network, we included a personal certification system within the application to further ensure security measures. However, dialysis patients frequently use satellite out-patients dialysis clinics. Therefore, it is necessary to develop the external connection to the satellite clinics safely in the future for information-sharing with clinics and for a comprehensive data collection.

In conclusion, by using this system, instant access to every patient’s information becomes possible for all medical staff in the Integrated Center for Kidney Disease. In addition, this database provided a very valuable information-sharing resource for the multidisciplinary medical staff.

Reference

1) Tabata T and Kawasaki T. [blood purification, methodology] blood purification, Assessment of adequacy of dialysis according to the variety of blood purification method; application of com-


患者管理システム データベース構築と応用

島 芳憲 安田 隆

抄 録

腎疾患の患者は、長期間にわたる全身管理を要し、様々な原疾患や種々の合併症に対し、継続的な管理や治療が必要となる。そのためには、原疾患や合併症の情報、個人歴、手術歴や透析歴などの記録、および各種検査結果などの継続性を持った情報などを長期にわたり記録し、その中から検索や解析が可能でなければならない。

1990年代半ばから、ネットワーク環境は、一気に普及し、情報の流動性が増している。さらに、コンピューター技術も飛躍的進歩をしてきており、ワイヤレスネットワークなどにも支えられ、携帯電話端末や PDA など様々なデバイスが接続され、「いつでも、どこでも、だれでも」コンピューターを意識しないで情報を利用できる環境が作られている。

今回、我々は、既存の腎臓病センター内のネットワークを利用し、複数のパーソナルコンピューターにより、特別なアプリケーションに依存せずに利用できるデータベースシステムを構築した。データベースでは、患者の基本情報、腎生検の所見、検査の結果、透析の処方、手術の所見、画像の検査、転入・転出などの情報を長期的に管理できるように構造を決定した。さらに、情報の入力や検索および閲覧を、「いつでも、どこでも、だれでも」利用できる運用システムを構築した。

聖マリアンナ医科大学 内科学(腎臓・高血圧内科)