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Development of a Primary Health Centre Data warehouse System for Disease Management in Developing Countries

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Abstract
Disease management is a continuous, coordinated health care process that seeks to manage and improve the health status of a carefully defined patient population over the entire course of a disease. A data warehouse is a computer system designed for archiving and analysis of historical data. This paper addresses the development of a data warehouse for Primary health centres in Nigeria Local Government Areas. The data warehouse integrates data from the various primary health centers. The analytic reports from the system are accessed by the Local Government Areas officials for on-ward transmission to the State Government officials. The system is a good application that can be adopted by developing countries.

Keywords: data warehouse, disease management, primary health care

Introduction
Disease management is a continuous, coordinated health care process that seeks to manage and improve the health status of a carefully defined patient population over the entire course of a disease. It is a system of coordinated healthcare intervention and communications for populations with conditions in which patient self-care efforts are significant. A data warehouse is a computer system designed for archiving and analyzing an organisation's historical data, such as sales, salaries, or other information from day-to-day operations. A disease management system refers to an integrated health delivery system that provides patient centered care throughout the course of the disease independent of delivery site.

Over the years, primary health care centers have contributed in no small measure to monitoring and dealing with the health conditions of every individual in a particular community, which invariably is being used in determining the health level of every nation, especially when harnessed properly. Health informatics is as an evolving scientific discipline that deals
with the collection, storage, retrieval, communication and optimal use of health related data, information and knowledge (Strachan, 2001). The function of a preventive health care service can only be performed effectively when the available information at their disposal are effectively put to use.

In this paper, a data warehouse system is being developed for disease management in primary health centers in developing countries. The system will provide quality service for the healthcare centers in providing health information for planning and management and preventive healthcare to their immediate communities.

For the purpose of this paper, Ife Central Local Government area (ICLGA) Primary HealthCare Centers (PHC) is used as a case study. Data mining (knowledge discovery) is the computer-assisted process of digging through and analyzing enormous sets of data stored in data warehouse, and then extracting the meaning of the data.

Health issues are one of the most paramount indicators used in determining the condition of a Community. Hence, the health information of a community must be structured out in such a way to ensure better planning and adequate management.

In the Punch newspaper of 6th of January, 2006 there was a report of an outbreak of disaster in Ogun State with conflicting figures of total number of deaths (health officials reported 40, while government official confirm 60), and the fear that it might spread to other neighboring states. From this report, it is obvious that if adequate and prompt information had been made available to both officials when necessary, the fear of it being spread to neighboring states would have been taken care of and a casualty figure far below the conflicting ones recorded.

Hence, it is assumed that the health care centers have not been able to deliver effectively both “the preventive healthcare and health information for planning and management services” because there would have been such cases reported several days, weeks as months before the confirmed numbers of deaths, which could have prompted anti-cholera preventive action for the area by the government.

The aim of this paper is to provide useful information beneficial to the healthcare sectors in terms of management and emergency intervention by the authorities’ in-change. The specific objectives of this paper are:

(i) Design of a data warehouse for disease management
(ii) Development of software application with user interface
(iii) Use of Data Mining Technique to analyze and extract meaning of the data

Literature review

Health care touches lives. Everybody visits the doctor and many of us have been treated in hospitals. There are problems that characterize health care. There are shortages of hospital beds and patients are left to lie in corridors. Disease management is a strategy of delivery health care services using interdisciplinary clinical teams, continuous analysis of relevant data, and cost-effective technology to improve the health outcome of patients with specific diseases. It includes self-care management techniques, patient education, and provider training. Disease management provides individualized care plans based on clinical guidelines to manage individuals with treatable chronic diseases.

Traditional paper record (TPR)

In the past, cases reported at the Primary Health Care Centers are recorded in black and white, which have denied so many communities of precious talents in form of loss of life(s) because adequate and appropriate report were not given to the policy maker before budget allocations are made. This also has resulted in disease outbreaks and which tends to endanger human existence in the community.

Hospitals today generate and collect vast amounts of data in the ongoing process of providing care. Classic example of operational systems in hospitals include patient registration and order entry (HIS), image reports and scheduling (RIS), and image display and reading (PACS).

The operational systems by nature are concerned primarily with the handling of a single transaction and are optimized and normalized for transactional updates (Wong et al, 2001).

Information Systems in Health Care

There are two categories of information systems in health care namely administrative and clinical information systems (Coffin et al, 2004). The administrative applications include accounting application for billing and cost accounting. Clinical Information Systems are designed for processing transactions related to medical diagnosis, treatment and follow-up.
Hospitals today generate and collect vast amounts of data in the ongoing process of providing care. Classic example of operational systems in hospitals include patient registration and order entry (HIS), image reports and scheduling (RIS), and image display and reading (PACS). Operational systems by nature are concerned primarily with the handling of a single transaction and are optimized and normalized for transactional updates (Wong et al, 2001).

**Made In Nigeria Primary Healthcare Information System (MINPHIS)**

Since 1991, a computerized system for storing and reporting patient record data has been operating and under refinement in the Obafemi Awolowo University Teaching Hospital, based in Ile-Ife, Nigeria (Afolabi, 2004).

The MINPHIS application keeps patient records and generates various reports for health management and research purposes. The reports include the patient status, medical history and admissions plus indicators like length of stay per patient, discharge summaries, mortality and morbidity data, and operations. The application can answer ad hoc queries from medical researchers (e.g. cases of cholera for a period per geographical location for specific age group or sex or both). It can also provide performance information relevant to particular health care professionals, such as the mortality rates for patients treated by a particular staff member. MINPHIS is modularized and structured design, there are about eight modules namely; In-patient, Out-patient, laboratory, pharmacy, billing, administration, diagnosis and bed status. The flow of program start from registering patients which is part of the In-patient module, all other modules can be accessed if patient registration process is completed.

Generated information by MINPHIS application system can be used for self-appraisal by medical staff or for formal appraisal by hospital managers (Afolabi, 2004).

**Shortcomings of the Existing Systems**

MINPHIS has no direct impact on the poor as it is not actually implemented at the grass root level (primary healthcare) but is being deployed at the tertiary level. However, poor women and men form the majority of the patients whose data are being used by managers and policy-makers to try to improve health planning decisions.

Wong et al (2002) modeled and integrated multiple neuroimaging modalities, including Magnetic Resonance Tomography (MRI), Computed Tomography (x-ray CT), Positron Emission Tomography (PET), Magnetic Resonance Spectroscopy (MRS) and associated clinical and research data to support neurological diagnosis and neuroimaging research. This work is a development of an image medical data warehouse framework for multimedia management, data analysis, and research and access services.

The existing disease management systems have no direct impact on the poor, since it is not implemented at the grass root level i.e. primary health care, but they are being deployed at the tertiary level. Hence, this paper proposes a disease management system that can be implemented at the grass root level.

**Data warehousing in Developing Countries**

Data warehousing technique has been experiencing a large increase in the industry in the developed countries (McDonald & Nasir, 2006). But this is not so in developing countries. There are actually information systems that are being used e.g. MINPHIS, but virtually no data warehousing implementation. Hence, this paper proposes development of a data warehouse system for disease management in primary health care.

**Methodology**

Due to the recent trends in the world of technology, the use of computers to solve most of our social, economic and health problem is fast becoming a must so as to ensure effectiveness and perfection. Computers have had a considerable impact on many aspect of life, hence the need to develop a data warehouse for disease management so that the required efficiency and effectiveness is obtained.

The following are the research methods used:

- Interview with medical personnel and other unit head in the day-to-day running of the Primary Healthcare Centre (PHC).
- The design and development of a data warehouse to store the information that will comprise the reported health cases/issues, using MySQL.
- Development of a well defined interface in form of Meta database using PHP Scripting Language.
- Implementation and testing of the application system.
Proposed System

The programming approach adopted for the development of disease management using data warehousing is Microsoft Visual Basic 6.0 and Microsoft SQL Server 2000 for relational database management.

Model Design of the Proposed System

The flow diagram of the proposed system is depicted in figure 4.1 below. Considering the fast rate at which technology is moving, it is now very important to move with the trend of technology and abandon the old ways of accumulation of papers, files and document, which make it look cumbersome for government policy makers to actively take time to go through uncollated papers and move gradually to computerized ways, which is more user-friendly and easier to use for policy makers to effect appropriate health policy as at when due and required.

From the flow diagram, the PHC1, PHC2, and PHC3 is where all the different data from various PHCs will be collated manually by the Community Health Extension Workers (CHEW) and the data is stored into the Data Warehouse (DW) located at the Central PHC level, which is made available for the LGA official in form of information after it has been analyzed and meaningful information is extracted using Data Mining technique. The LGA will then make this necessary information available to the state ministry of health (SMH) with whom is rested the responsibility of policy formulation. The SMH thereafter appropriately executes the health policy decided upon.
State Ministry of Health (SMH)

Local Government Area (L.G.A)

Central PHC Data Warehouse (DW)

PHC$_1$ (CHEW$_1$)

PHC$_2$ (CHEW$_2$)

PHC$_3$ (CHEW$_3$)

Information} Data Mining Technique

Collation

Figure 4.1 Flow diagram of the proposed system
The database tables to be used in the disease management system to gather patient’s records for data mining include:

**PHC dbf**: This holds the required information about the Primary Health Center (PHC) registration. The structure is outlined as in Table 4.1a.

**Disease dbf**: This file handles new disease registration. The structure is outlined as in Table 4.1b:

**Report dbf**: This database file handles patients health complaines (Reported cases). The structure is outlined as in Table 4.1c:

**Staff dbf**: This database file handles the New Staff registration module. The structure is as in Table 4.1d

### Table 4.1a: PHC dbf

<table>
<thead>
<tr>
<th>FIELD NAME</th>
<th>FIELD TYPE</th>
<th>FIELD SIZE</th>
<th>INDEX</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHC_Code</td>
<td>Character</td>
<td>10</td>
<td>Yes</td>
<td>PHC Code</td>
</tr>
<tr>
<td>Date</td>
<td>Date/Time</td>
<td>5</td>
<td>No</td>
<td>Date of Registration</td>
</tr>
<tr>
<td>Location</td>
<td>Character</td>
<td>30</td>
<td>No</td>
<td>PHC Location</td>
</tr>
<tr>
<td>PHC_Head</td>
<td>Character</td>
<td>30</td>
<td>No</td>
<td>Name of PHC Head</td>
</tr>
</tbody>
</table>

### Table 4.1b: Disease dbf

<table>
<thead>
<tr>
<th>FIELD NAME</th>
<th>FIELD TYPE</th>
<th>FIELD SIZE</th>
<th>INDEX</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease_Code</td>
<td>Character</td>
<td>12</td>
<td>Yes</td>
<td>Disease Code</td>
</tr>
<tr>
<td>Description</td>
<td>Character</td>
<td>50</td>
<td>No</td>
<td>Description of Disease</td>
</tr>
<tr>
<td>Registered_By</td>
<td>Character</td>
<td>30</td>
<td>No</td>
<td>Disease Registered By</td>
</tr>
</tbody>
</table>

### Table 4.1c: Disease dbf

<table>
<thead>
<tr>
<th>FIELD NAME</th>
<th>FIELD TYPE</th>
<th>FIELD SIZE</th>
<th>INDEX</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rec_Id</td>
<td>Character</td>
<td>10</td>
<td>Yes</td>
<td>Record ID</td>
</tr>
<tr>
<td>Date</td>
<td>Date/Time</td>
<td>8</td>
<td>No</td>
<td>Date of Complain</td>
</tr>
<tr>
<td>Time</td>
<td>Date/Time</td>
<td>8</td>
<td>No</td>
<td>Time of Complain</td>
</tr>
<tr>
<td>PHC_Code</td>
<td>Character</td>
<td>10</td>
<td>No</td>
<td>PHC code</td>
</tr>
<tr>
<td>Disease_Code</td>
<td>Character</td>
<td>10</td>
<td>No</td>
<td>Disease Code</td>
</tr>
<tr>
<td>Description</td>
<td>Character</td>
<td>10</td>
<td>No</td>
<td>Description</td>
</tr>
<tr>
<td>Remarks</td>
<td>Character</td>
<td>30</td>
<td>No</td>
<td>Remarks</td>
</tr>
<tr>
<td>Full_Name</td>
<td>Character</td>
<td>30</td>
<td>No</td>
<td>Patient Full Name</td>
</tr>
<tr>
<td>Area</td>
<td>character</td>
<td>30</td>
<td>No</td>
<td>Patient Area</td>
</tr>
<tr>
<td>Age</td>
<td>Numeric</td>
<td>4</td>
<td>No</td>
<td>Patient Age</td>
</tr>
<tr>
<td>Sex</td>
<td>character</td>
<td>6</td>
<td>No</td>
<td>Patient Sex</td>
</tr>
<tr>
<td>Marital_Status</td>
<td>character</td>
<td>14</td>
<td>No</td>
<td>Patient Marital Status</td>
</tr>
<tr>
<td>Previous_Records</td>
<td>character</td>
<td>30</td>
<td>No</td>
<td>Patient Previous Records</td>
</tr>
<tr>
<td>Status</td>
<td>character</td>
<td>30</td>
<td>No</td>
<td>Patient Status</td>
</tr>
</tbody>
</table>

### Table 4.1d: Staff dbf

<table>
<thead>
<tr>
<th>FIELD NAME</th>
<th>FIELD TYPE</th>
<th>FIELD SIZE</th>
<th>INDEX</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff_Name</td>
<td>Character</td>
<td>10</td>
<td>Yes</td>
<td>New Staff ID</td>
</tr>
<tr>
<td>Staff_Address</td>
<td>Character</td>
<td>10</td>
<td>No</td>
<td>Staff Address</td>
</tr>
<tr>
<td>PHC</td>
<td>Character</td>
<td>10</td>
<td>No</td>
<td>Staff PHC</td>
</tr>
<tr>
<td>Qualification</td>
<td>Character</td>
<td>10</td>
<td>No</td>
<td>Staff Qualification</td>
</tr>
<tr>
<td>Specialization</td>
<td>Character</td>
<td>10</td>
<td>No</td>
<td>Staff Specialization</td>
</tr>
<tr>
<td>Position</td>
<td>Character</td>
<td>10</td>
<td>No</td>
<td>Staff Position</td>
</tr>
<tr>
<td>Sex</td>
<td>Character</td>
<td>6</td>
<td>No</td>
<td>Staff Sex</td>
</tr>
<tr>
<td>Age</td>
<td>Numeric</td>
<td>4</td>
<td>No</td>
<td>Staff Age</td>
</tr>
<tr>
<td>Marital_Status</td>
<td>Character</td>
<td>30</td>
<td>No</td>
<td>Staff Marital Status</td>
</tr>
<tr>
<td>Address</td>
<td>Character</td>
<td>30</td>
<td>No</td>
<td>Staff Address</td>
</tr>
<tr>
<td>Phone_No</td>
<td>Character</td>
<td>15</td>
<td>No</td>
<td>Staff Phone No</td>
</tr>
</tbody>
</table>
**Implementation**

This section entails how the Disease management system was implemented and it tries to discuss the usage of the new system. Firstly we consider the system requirement for the new system to run, followed by the User Interaction of the new system.

**System Requirement**

The systems requirements are classified into two namely:

1. Hardware requirement
2. Software requirement

**Hardware requirement**

The new developed software basically requires running on a computer machine with minimum configuration of a processor speed not less than a Pentium I, CDROM drive for installation, 64MB Ram and above.

**Software requirement**

The newly developed Disease Management System is required to run on a Windows operating system, this can be Windows 98, Windows ME, Windows 2000 or Windows XP with the Microsoft SQL Server database engine running on it.

**User Interaction**

Users of the new package can interact with the software through Graphical User Interfaces which are in the form of input and output forms. The input forms are used to populate and modify records in the database; all records are entered to the database through the input forms. While the output forms which are in form of Views and Reports displays registered data in a processed and required form, Views also displays Search results.

**Conclusion**

This work has contributed to the area of disease management especially in primary health care area. It has been demonstrated that data warehousing can be applied in developing a computerized system in disease management. The developed disease management system will go a long way in helping to control endemic situations and help the government in proper planning and budget, through statistical data gotten from the system. The system will enable medical statistician the ability to get readily available processed data from the system to know the occurrences of a particular disease in a particular area so that they can advise for proper budgeting to eradicate or control such outbreak in such area. The computerized system will reduce paper work, improve services, and reduce delays and inaccuracies in the overall routines, while improving health needs of affected area. The major aim of this system is to get readily available processed data of health complains in a particular area for data mining so as to predict which disease needs attention or control rather than budgeting for diseases which are non-existent in such area. Diseases which are more prominent would require urgent attention by the government when budgeting for the affected area through the various Primary Health Centers located in such area.

**Future Work**

The data mining, the decision support and the information visualization aspect of this work are for future work. The data mining technique will enable scattered raw data to be in needed form required by medical statistician for planning and improving the well being of citizens of such region by the system prompting for diseases that are close or within the endemic values set by the user of the system.

**REFERENCES**


Appendix

![Main Menu for Disease Management System.](image-url)