TITLE PAGE

DESIGN AND IMPLEMENTATION OF EFFICIENT EMERGENCY HEALTHCARE MANAGEMENT MODEL USING INTEGRATED DATABASE AND DATA MINING TECHNIQUE

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A DISSERTATION SUBMITTED TO THE DEPARTMENT OF COMPUTER SCIENCE, FACULTY OF PHYSICAL SCIENCES, NNAMDI AZIKIWE UNIVERSITY, AWKA, ANAMBRA STATE IN PARTIAL FULFILMENT OF THE AWARD OF DOCTOR OF PHILOSOPHY (Ph.D) DEGREE IN COMPUTER SCIENCE.

DECEMBER, 2019

CERTIFICATION

This is to certify that the work contained in this dissertation has not been previously submitted to meet requirement for award of Ph.D degree of this institution or any other higher educational institution. To the best of my knowledge and belief this dissertation contains no materials previously published or written by another person except where due references have been made

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APPROVAL

This dissertation entitled Design and Implementation of Healthcare Management Model Using Integrated Database and Data Mining Technique carried out by Okpalla Chidimma Lilian with Registration Number 2011517010P has been read and approved by the Department of Computer Science, Faculty of Physical Sciences, Nnamdi Azikiwe University, Awka in partial fulfiment for the award of Doctor of Philosophy (Ph.D) in Computer Science.

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This dissertation is dedicated to God Almighty and to the loving memory of my beloved parents Barrister Joseph and Lady Rose Okechukwu.

ACKNOWLEDGEMENTS

ABSTRACT

Lack of adequate management and access to the patients' previous health records especially in event of emergency makes health care sector inefficient. The aim of this research is to develop and implement an efficient emergency healthcare management model for storing both present and previous health related records of patients in Nigeria such that a wide range of hospitals could share the stored information for the purpose of making prompt decisions about patients in times of emergency. Object Oriented Analysis and Design Methodology (OOADM) was employed to design the system. MySQL database engine was employed to implement the database used in this work. PHP, JavaScript programming environment and association rule data mining technique were employed to implement the software model. The result of this work is an efficient emergency healthcare management model that can be deployed in hospitals, healthcare centres, ministry of health and other healthcare parastatals. Test run of the software using confusion matrix showed an improved delivery of healthcare data by 93% using K-mean classification algorithm as against 83% using K-Nearest Neighbour Classification algorithm and 81% using Apriori classification algorithm and has the capacity to reduce time in delivering service to patients in cases of emergency by providing real time health information on patients across Nigeria.

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CHAPTER ONE

INTRODUCTION

1.1   Background of the Study

Health administration or healthcare administration is a field relating to leadership, management, and administration of hospitals, hospital networks, and health care systems. Health care (or healthcare) is the diagnosis, treatment, and prevention of disease, illness, injury, and other physical and mental impairments in human beings. Health care is delivered by practitioners in allied health, dentistry, midwifery (obstetrics), medicine, nursing, optometry, pharmacy, psychology and other health professions. It refers to the work done in providing primary care, secondary care, and tertiary care, as well as in public health (Health Administration, 2018).

Access to health care varies across countries, groups, and individuals, largely influenced by social and economic conditions as well as the health policies in place. Countries and jurisdictions have different policies and plans in relation to the personal and population-based health care goals within their societies. Health care systems are organizations established to meet the health needs of target populations. Their exact configuration varies between national and sub national entities. In some countries and jurisdictions, health care planning is distributed among market participants, whereas in others, planning occurs more centrally among governments or other coordinating bodies. In all cases, according to the World Health Organization (WHO), a well-functioning health care system requires a robust financing mechanism; a well-trained and adequately-paid workforce; reliable information on which to base decisions and policies; and well maintained health facilities and logistics to deliver quality 'medicines and technologies (Health topics, 2013). Innovation in healthcare continues to be a driving force in the quest to balance cost containment and health care quality. Innovation is considered to be a critical component of business productivity and competitive survival (Omachonu and Einspruch, 2010).

Before independence in 1960, a 10-year developmental plan (1946–1956) was introduced to enhance health care delivery. Several health schools and institutions

(Ministry of Health, several clinics and health centers) were developed according to this plan. By the 1980s, there had been great development in health care—general hospitals and several other health centers (over 10,000) had been introduced (Healthcare, 2014).

In August 1987, the Federal government of Nigeria launched its primary health care plan with the following major objectives: improve collection and monitoring of health data, improve personnel development in the health care, ensure the provision/ essential drug availability, improve on immunization programs, promote treatment of epidemic diseases, improve food supply and nutrition, improve maternal health and child care, and family planning, educate people on prevailing health problems and the methods of preventing and controlling them (Awosika, 2005). This health care plan made little impact on the health sector, as it continued to suffer major infrastructural and personnel deficit, in addition to poor public health management.

Another effort also by the Federal government to revitalize the worsening state of health was the establishment of the Nigerian Health Insurance Scheme (NHIS) in 2005 by Decree 35 of 1999 provided for the establishment of a governing council with the responsibility of managing the scheme (NHIS Decree No 35 of 1999). The objectives of the scheme were to: ensure that every Nigerian has access to good health care services, protect Nigerians from the financial burden of medical bills, limit the rise in the cost of health care services, ensure efficiency in health care services, ensure equitable distribution of health care costs among different income groups; equitable patronage of all levels of health care, maintain high standard of health care delivery services within the scheme, improve and harness private sector participation in the provision of health care services, ensure adequate distribution of health facilities within the Federation, ensure the availability of funds to the health sector for improved services. (Senate, Federal Republic of Nigeria National health bill, 2008).The objectives and functions of the NHIS (Akande, 2004), according to this present review have hardly attained any height as health care delivery continues to be limited; not equitable and does not meet the needs of the majority of the Nigerian people. This is manifest in the high infant mortality rate/poor maternal care, very low life expectancy as at 2010, and periodical outbreak of the same disease, as well as the long period of time spent for control of the various outbreaks.

The appendage program of the NHIS launched in October 2008—Millennium Development Goals—also reported little positive effect a year later. The Nigerian National Health Conference in 2006 which was attended by more than 400 participants, including high cadre dignitaries ranging from the presidency to local governments and their agencies were aimed at ensuring effective, qualitative, affordable, and accessible health care for all Nigerians beyond 2007 (Nigeria National Health Conference, 2009). According to the 2005 January issue of CARE-NET limited health insurance report concerning the NHIS, the Nigerian national health policy objective was the attainment of a level of health that will enable all Nigerians to achieve socially and economically productive lives (A CARE-NET Limited Publication, 2014). Since its lunching primary health care has not gained its right place in the priority of things. As part of the struggle to advance health care, the Nigerian senate in 2008 launched a bill for an act to provide a framework for the regulation, development, and management of a national health system and set standards for rendering health services in the federation and other matters connected with it. (Senate, Federal Republic of Nigeria National health bill 2008). In spite of the several failures of the Nigerian health care system, study had suggested that if managed well, the NHIS could be a useful ground for good health care delivery (Okaro *et al*., 2010) At its present state, it is true that the scheme does not adequately account for the needs of the Nigerian people.

In spite of the huge development in the health care in relation to the last decades, much is still needed to be done in the health care system (Adeyemo, 2005) and (Omoruan *et al*., 2009). Although the total expenditure in health amounts to 4.6% GDP, (The Library of Congress Country Studies, 2010) financial managerial competency, besides inadequate funding, remains a major problem. Current statistics show that health institutions rendering health care in Nigeria are 33,303 general hospitals, 20,278 primary health centers and posts, and 59 teaching hospital and federal medical centers (Omoruan *et al*., 2009). This represents a huge improvement in regards to the last decades; nonetheless, health care institution continues to suffer shortage.

However, the various reforms to increase the provision of health to the Nigerian people notwithstanding, percentage access to health is only 43.3% (Onwujekwe *et al.*, 2010). The inadequacy of the health care delivery system in Nigeria could be

attributed to the peculiar demographics of the Nigerian populace. About 55% of the population lives in the rural areas and only 45% live in the urban areas (Omoruan *et al.*, 2009). About 70% of the health care is provided by private vendors and only 30% by the government. (Banjoko *et al.*, 2010). Over 70% of drugs dispensed are substandard. Hence, the ineffectiveness of the NHIS had recently been attributed to the fact that the scheme represents only 40% of the entire population, and 52-60% are employed in the informal sector. Over half of the population live below the poverty line, on less than one dollar a day and so cannot afford the high cost of health care. (Steinberger *et. al*, 2008) Also, study by Akande (2004) had reported a poor referral system between the various tiers of health care which probably tells on the poor managerial functions of the health care delivery system.

The scope of the service in Nigerian hospital is basically curative and preventive and is offered in clinic unit x-ray/ ultra sound, laboratory and dental unit in the hospital. Other services include admission (ward) inpatient, physiotherapy and family planning. The records of patients in Nigerian hospitals have over time been inefficiently managed due to large numbers of patients. This usually leads to poor record keeping since it is a paper based system. The reason why the current system, efficient emergency healthcare model is used is that manual operation has led to a variety of problems and these include; unnecessary duplication of the data especially for inpatients and outpatients, inconsistency may occur since data is held more than once and hard to analyze; hence it is difficult to trace the patients' past medication data. There are several departments in the Nigerian hospital which include medicine and surgery, psychiatry, public health, ear, nose and throat, casualty, obstetrics and gynaecology among others. The emergence of computer based information system has changed the world a great deal; both large and small businesses have adopted the new technology (Jantz, 2001). This means the use of personal computers to fulfill several roles in the production of information. Therefore the documentation of patient record can now be computerized to enable easier manipulation of hospital information to bring us to this existing new world of information system. Examining the document system that is in existence at the hospital that is mostly manual, much importance has been placed on creating a system that documents the inpatient records using a computerized database system with a secure procedure for accessing it. The

integration of hospital databases would pave way for Data Mining and Knowledge Discovery to further help health-related decision makers.

Healthcare industry today generates large amounts of complex data about patients, hospitals resources, disease diagnosis, electronic patient records, medical devices etc. The large amounts of data are a key resource to be processed and analyzed for knowledge extraction that supports for cost-savings and decision making. These can only be achieved using data warehouse and data mining techniques. Patients information, past and present, is extremely vital and guides the physician in making the right decision and diagnosis.

This dissertation will explore how a wide range of hospital, and blood banks information could be useful to medical practitioners for making decisions about patients. A framework from prior research work was used to consider, devise and examine medical practitioner use of information systems for improving response services and outcomes.

1.2   Statement of the Problem

The healthcare industry generates large amounts of complex data on patients, hospitals resources, disease diagnosis, electronic patient records, medical devices, etc. It has therefore become necessary to find a way of storing these information for future use.

Often times most patients go to different hospitals for medical attention, and each of these hospitals collect and maintain its own patients' health records. As the same patient visits another hospital different health records are also collected and kept for the same patient such that different hospitals have different information for same patient, leading to a lot of redundancies and inconsistencies. But with the emergence of effective health management software these problems of inconsistencies and redundancies are expected to be reduced to the barest minimum.

To actualize the above, it becomes a matter of concern and necessity   to mine and integrate healthcare data using a functional software model such that as the world is becoming a global village, health care industry in Nigeria is turned into a global data mine that can be readily available for instant use by whomever it may concern especially in cases of emergency.

Lastly, it is worthy of note to state here that one of the strengths of western world in health care delivery is their well-managed integrated health care records. It will therefore not be out of place if Nigeria, in its quest to catch up with the current trends in technological advancement implements an information system that is capable of improving the quality of healthcare delivery.

1.3   Aim and Objectives of the Study

The aim of this work is to design and implement an efficient emergency healthcare management model using integrated database and data mining technique. The specific objectives are to:

i)   Design a system model using integrated database and data mining technique for efficient emergency healthcare

ii) Use JavaScript and PHP scripting language to implement the emergency healthcare management model which can track patients' medical history using data mining and fingerprint technology.

iii) Implement an integrated database using MySQL database engine

iv) Evaluate the performance of the new system compared with the existing system

1.4   Significance of the Study

The new system will be of immense benefit to hospital management, patients and government in the following ways.

i   It will help to boost the electronic tracking of patient's medical history thereby reducing the time it takes to retrieve patient's medical history and spell less work for the staff.

ii   It will help in identifying patients allergy especially in critical conditions can be achieved without waiting for patients to be questioned for those information

iii It will help to secure the hospital database server. This will prevent loss of vital information.

Patients:

i   The new system will help save patients life as the emergency healthcare management system will provide the needed patient's medical history to aid timely treatment and avert death.

Government:

i   The new system enables government to achieve better health care system for its citizens which will in turn translate to a better economy.

ii   The mortality rate will be reduced drastically as there will be timely intervention in emergency situations and thereby lives will be save.

1.5   Scope of the Study

In Nigeria, there are many health sectors which include maternity, clinics, general hospital, health centres, etc. The scope of this dissertation will concentrate on developing an efficient emergency healthcare management model that can be used by the emergency department of the above mentioned health sectors. The system will concentrate on collating data from various hospitals and storing the information on a centralized database server. This information will be accessible to medical practitioners whenever there is emergency situation via internet. The system will use data mining technique to perform interference on the current data in order to extract the patients related medical records.

1.6   Limitations of Study

In the course of the research, many constraints were encountered. These constraints were partly technical and partly man made.

Some of the constraints include:

i   The procurement of classified documents from hospitals was a very difficult task.

ii   The poor network in Nigeria delayed the work further.

1.7   Definition of Terms

Algorithm: This is a process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.

Allergy: This is a condition in which the immune system reacts abnormally to a foreign substance.

Bio data: Bio data is biographical data. It is factual kind of questions about life and work experience, as well as items involving opinions, beliefs, values and attitudes that reflect a historical perspective.

Biometric Technology: This is the process by which computerized methods are used to identify person by unique physical or behavioural characteristics.

Blood group: A blood group also known as blood type is a classification of blood based on the presence and absence of antibodies and also based on the presence or absence of inherited antigenic substance on the surface of red blood cells.

Database: A database is a collection of information that is organized so that it can easily be accessed, managed and updated.

Database Design: Database design is the organization of data according to a database model. What data must be stored and how the elements interrelate is determined by the designer.

Data Integration: This involves combining data residing in different sources and providing users with a unified view of them.

Data Mining: Data mining can be defined as the process of finding previously unknown patterns and trends in databases and using that information to build predictive models.

Database Model: A database model is a type of data model that determines the logical structure of a database and fundamentally determines in which manner data can be stored, organized and manipulated.

Electronic Medical Record (EMR): An electronic medical record is a digital version of a paper chart that contains all patient's medical history from one practice.

Fingerprint: A fingerprint in its narrow sense is an impression left by the friction ridges of a human finger.

Genotype: The genotype is the part of the genetic makeup of a cell and therefore of an organism or individual which determines one of its characteristics.

Health Care: Health care (or healthcare) is the diagnosis, treatment, and prevention of disease, illness, injury, and other physical and mental impairments inhuman beings. Integrated Database: This is a database which acts as the data store for multiple applications and thus integrates data across these applications.

Healthcare Management: This is a field relating to leadership, management and administration of public health systems, health care systems, hospitals and hospital networks.

Information System: This is a system composed of people and computers that processes or interprets information.

Knowledge Discovery: This is an interdisciplinary area focusing upon methodologies for extracting useful knowledge from data.

Management Information System: A management information system is a computerized database of financial information organized and programmed in such a way that it produces regular reports on operations for every level of management in a company.

Model: A model is a graphical, mathematical (symbolic), physical, or verbal representation or simplified version of a concept, phenomenon, relationship, structure, system or an aspect of the real world.

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical Review

Healthcare management is the profession that provides leadership and direction to organization that deliver personal health services and to divisions, departments, units or services within the organizations. Management has been defined as the process comprised of social and technical functions and activities, occurring within organizations for the purpose of accomplishing predetermined objectives through humans and other resources (Longest *et al*., 2000).

2.1.1 Functions of Healthcare Managers

Managers implement six management functions in the process of management

Planning: This requires the manager to set a direction and determine what needs to be accomplished. It means setting priorities and determining performance targets.

Organizing: This function refers to the overall design of the organization or the specific division, unit or service for which the manager is responsible. Further, it means designating reporting relationships and intentional patterns of interaction. Determining positions, teamwork assignments and distribution of authority and responsibility are critical components of this function.

Staffing: This function refers to acquiring and retaining human resources. It also refers to developing and maintaining the workforce through various strategies and tactics.

Controlling: This function refers to monitoring staff activities and performance and taking the appropriate actions for corrective action to increase performance.

Directing: This focuses on initiating action in the organization through effective leadership and motivation of and communication with subordinates.

Decision making: This function is critical to all of the aforementioned management functions and means making effective decisions based on consideration of benefits and the drawbacks of alternatives (Longest *et al*, 2000).

2.1.2 The Need for Healthcare Management

Healthcare organizations are complex and dynamic. The nature of organizations requires that managers provide leadership as well as the supervision and coordination of employees. Healthcare managers are appointed to positions of authority where they shape the organization by making important decisions. Such decisions relate to recruitment and development of staff, acquisition of technology, service additions and reductions and allocation and spending of financial resources. Decisions made by healthcare managers not only focus on ensuring that the patient receives the most appropriate, timely and effective services possible, but also address achievement of performance targets that are desired by the manager.

Managers should consider two domains as they carry out various tasks and make decisions. These domains include the external and internal domain. The external domain refers to the influences, resources and activities that exist outside the boundary of the organization but which significantly affect the organization. These factors include community needs, population characteristics and reimbursement from commercial insurers. The internal domain refers to those areas of focus that managers need to address on a daily basis, such as ensuring the appropriate number and types of staff, financial performance and quality of care (Thompson, 2007).

2.1.3 Data Mining

Data mining aims at discovering novel, interesting and useful knowledge from databases. Conventionally, the data is analyzed manually. Many hidden and potentially useful relationships may not be recognized by the analyst. Nowadays, many organizations including modern hospitals are capable of generating and collecting a huge amount of data. This explosive growth of data requires an automated way to extract useful knowledge. Thus, medical domain is a major area for applying data mining. Through data mining, we can extract interesting knowledge and regularities (Jing-song *et al*., 2011).

Health care now collects data in gigabytes per hour volume. Data mining can help with data reduction, exploration, and hypothesis formulation to find new patterns and information in data that surpass human information processing limitations. There is a proliferation of reports and articles that apply data mining and knowledge discovery in database (KDD) to a wide variety of health care problems and clinical domains and

includes diverse projects related to cardiology, cancer, diabetes, finding medication errors, and many others. Data mining methods use powerful computer software tools and large clinical databases, sometimes in the form of data repositories and data warehouses, to detect patterns in data. Within data mining methodologies, one may select from an extensive array of techniques that include, among many others, classification, clustering, and association rules (Jing-song *et al*., 2011).

2.1.4 Evolutionary steps in data mining

Data mining techniques are the result of a long process of research and have gone through various steps of evolution. Such evolution began when business data was first stored on computers and generated technologies to allow users for navigating their data in real time (Table 2.1). Data mining algorithms have existed for some years and have been implemented as reliable and understandable tools. Now it is supported by further technologies that are sufficiently mature for navigation to prospective and proactive information delivery. In the evolution from business data to business information various steps have been noticed (Saunders, 2017).

Table 2.1: Evolutionary steps of data mining (Saunders, 2017)

Evolutionary Step	Business Question	Enabling Technologies	Product Providers	Characteristics
Data Collection (1960s)	"What was my total revenue in the last five years?"	Computers, tapes, disks	IBM, CDC	Retrospective, static data delivery
Data Access (1980s)	"What were unit sales in New England last March?"	Relational databases (RDBMS), Structured Query Language (SQL), ODBC	Oracle, Sybase, Informix, IBM, Microsoft	Retrospective, dynamic data delivery at record level
Data Warehousing & Decision Support (1990s)	"What were unit sales in New England last March? Drill down to Boston."	On-line analytic processing (OLAP), multidimensional databases, data warehouses	Pilot, Comshare, Arbor, Cognos, Microstrategy	Retrospective, dynamic data delivery at multiple levels
Data Mining (Emerging Today)	"What's likely to happen to Boston unit sales next month? Why?"	Advanced algorithms, multiprocessor computers, massive databases	Pilot, Lockheed, IBM, SGI, numerous startups (nascent industry)	Prospective, proactive information delivery

(Source: Saunders, 2017)

2.1.5 Data mining process

Primarily, the data mining requires a standard process, data store or warehouse, technologies and expertise. A data mining process must be reliable and repeatable by people with little data mining skills. However, a standard data mining process should involve the following tasks

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1. Job understanding – determines the job objectives, job background, data-mining objective, situation assessment, risk and controversies, success criteria, etc.

2. Data understanding – collects initial data, describe data, explore data, and verify the data quality.

3. Data preparation – involves data set description, data selection, assessment, consolidation, cleaning, derive data attributes, data formatting, etc.

4. Process modelling – identifies modeling techniques based on data mining objectives, parameter setting and generate test designs, model assessments, etc.

5. Process evaluation – evaluates results, review the process, approve the model, and determine the forward steps for possible actions or decisions.

6. Deployment – plans for monitoring and maintenance, produce final reports, reviews experiences, presents documentation, etc. In fact, data mining was broadly involves in the interpretation and validation of discovered patterns to ensure the real information being discovered for knowledge representation. Extensively it uses the techniques from machine learning, statistics, pattern discovery algorithms, and many other fields. In data mining, most commonly used techniques are – decision trees, nearest neighbor classification, neural networks, rule induction, K-means clustering, genetic algorithm, bayesian networks, etc. (Han and Kamber, 2001)

Figure 2.1 shows the data mining process which consists of the following five steps:

1.   Select a target data set: The data needed for the data mining process may be obtained from many different and heterogeneous data sources. This first step obtains the data from various databases, files, and non electronic sources. With the help of one or more human experts and knowledge discovery tools, we choose an initial set of data to be analyzed.

2.   Data preprocessing: The data to be used by the process may have incorrect or missing data. There may be anomalous data from multiple sources involving different data types and metrics. There may be many different activities performed at this time. We use available resources to deal with noisy data. We decide what to do about missing data values and how to account for time-sequence information.

3.   Data transformation: Attributes and instances are added and/ or eliminated from the target data. Data from different sources must be converted into a

common format for processing. Some data may be encoded or transformed into more usable formats. Data reduction may be used to reduce the number of possible data values being considered.

4.   Data mining: A best model for representing the data is created by applying one or more data mining algorithms. Based on the data mining task being performed, this step applies algorithms to the transformed data to generate the desired results.

5.   Interpretation/ evaluation: The output from step 4 was examined to determine if what has been discovered is both useful and interesting. Decisions are made about whether to repeat previous steps using new attributes and/ or instances. How the data mining results are presented to the users is extremely important because the usefulness of the results is dependent on it. Various visualization and GUI strategies are used at this last step (Jing-song *et al*., 2011).
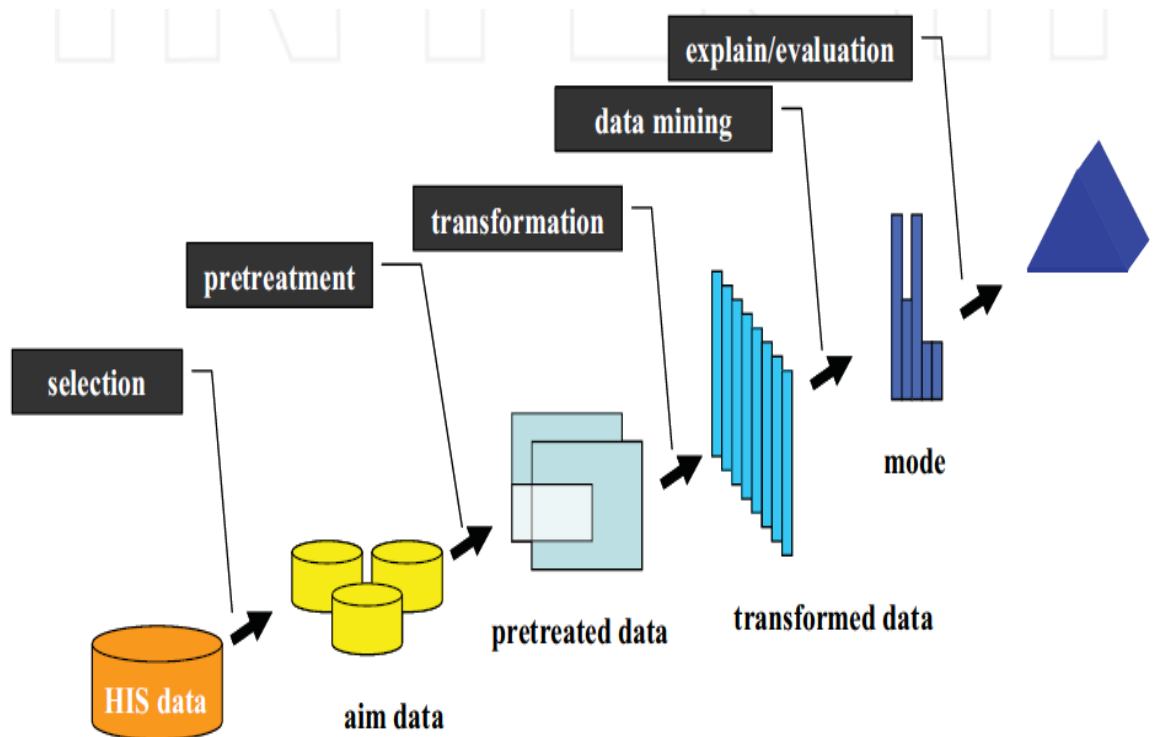
Figure 2.1: Data mining Process (Jing-song *et al*., 2011).

2.1.6   Data Mining Algorithms

A data mining algorithm is a set of heuristics and calculations that creates a data mining model from data. To create a model, the algorithm first analyzes the data you

provide, looking for specific types of patterns or trends. The algorithm uses the results of this analysis to define the optimal parameters for creating the mining model. These parameters are then applied across the entire data set to extract actionable patterns and detailed statistics.

The mining model that an algorithm creates from your data can take various forms, including:

a   A set of clusters that describe how the cases in a dataset are related.

b   A decision tree that predicts an outcome, and describes how different criteria affect that outcome.

c   A mathematical model that forecasts sales.

d   A set of rules that describe how products are grouped together in a transaction, and the probabilities that products are purchased together (Yang and Wu, 2006).

There are different data mining algorithms which include:

I   The k-means algorithm

The k-means algorithm is a simple iterative method to partition a given dataset into a user specified number of clusters, k. This algorithm has been discovered by several researchers across different disciplines, most notably Lloyd (1957). A detailed history of k-means along with descriptions of several variations are given in (Jain, 1999).

The algorithm operates on a set of d-dimensional vectors,

$$D = \{\mathbf{x_i} \mid i = 1, \ldots, N\}, \tag{2.1}$$

where

$\mathbf{x_i} \in \_d$ denotes the ith data point. The algorithm is initialized by picking k points in $\_d$ as the initial k cluster representatives or "centroids". Techniques for selecting these initial seeds include sampling at random from the dataset, setting them as the solution of clustering a small subset of the data or perturbing the global mean of the data k times. Then the algorithm iterates between two steps till convergence:

Step 1: Data Assignment. Each data point is assigned to its *closest* centroid, with ties broken arbitrarily. This results in a partitioning of the data.

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Step 2: Relocation of "means". Each cluster representative is relocated to the center (mean) of all data points assigned to it. If the data points come with a probability measure (weights), then the relocation is to the expectations (weighted mean) of the data partitions. The algorithm converges when the assignments (and hence the **cj** values) no longer change.

The algorithm execution is visually depicted in the model below. Note that each iteration needs $N \times k$ comparisons, which determines the time complexity of one iteration. The number of iterations required for convergence varies and may depend on N, but as a first cut, this algorithm can be considered linear in the dataset size. One issue to resolve is how to quantify "closest" in the assignment step. The default measure of closeness is the Euclidean distance, in which case one can readily show that the non-negative cost function

$$\sum_{i=1}^{N} \left(\underset{j}{\operatorname{argmin}} \|\mathbf{x_i} - \mathbf{c_j}\|_2^2 \right)$$

<center>K means algorithm   (2.2)</center>

will decrease whenever there is a change in the assignment or the relocation steps, and hence convergence is guaranteed in a finite number of iterations. The greedy-descent nature of k-means on a non-convex cost also implies that the convergence is only to a local optimum, and indeed the algorithm is typically quite sensitive to the initial centroid locations.

Limitations

In addition to being sensitive to initialization, the k-means algorithm suffers from several other problems. First, observe that k-means is a limiting case of fitting data by a mixture of k Gaussians with identical, isotropic covariance matrices ($\_ = \sigma 2\mathbf{I}$), when the soft assignments of data points to mixture components are hardened to allocate each data point solely to the most likely component. So, it will falter whenever the data is not well described by reasonably separated spherical balls, for example, if there are non-covex shaped clusters in the data. This problem may be alleviated by rescaling the data to "whiten" it before clustering, or by using a different distance measure that is more appropriate for the dataset. For example, information-theoretic clustering uses the KL-divergence to measure the distance between two data points

representing two discrete probability distributions. It has been recently shown that if one measures distance by selecting any member of a very large class of divergences called Bregman divergences during the assignment step and makes no other changes, the essential properties of k-means, including guaranteed convergence, linear separation boundaries and scalability, are retained . This result makes k-means effective for a much larger class of datasets so long as an appropriate divergence is used (Barnejee *et al*., 2005).

II   The Apriori algorithm

Description of the algorithm

One of the most popular data mining approaches is to find frequent itemsets from a transaction dataset and derive association rules. Finding frequent itemsets (itemsets with frequency larger than or equal to a user specified minimum support) is not trivial because of its combinatorial explosion. Once frequent item sets are obtained, it is straightforward to generate association rules with confidence larger than or equal to a user specified minimum confidence. Apriori is a seminal algorithm for finding frequent item sets using candidate generation (Agrawal and Srikant, 1994). It is characterized as a level-wise complete search algorithm using anti-monotonicity of itemsets, "if an item set is not frequent, any of its superset is never frequent". By convention, Apriori assumes that items within a transaction or itemset are sorted in lexicographic order. Let the set of frequent itemsets of size k be Fk and their candidates be Ck . Apriori first scans the database and searches for frequent itemsets of size 1 by accumulating the count for each item and collecting those that satisfy the minimum support requirement. It then iterates on the following three steps and extracts all the frequent item sets.

1. Generate $Ck+1$, candidates of frequent item sets of size k +1, from the frequent item sets of size k.
2. Scan the database and calculate the support of each candidate of frequent item sets.
3. Add those item sets that satisfies the minimum support requirement to $Fk+1$.

The Apriori algorithm is shown below. Function apriori-gen in line 3 generates $Ck+1$ from Fk in the following two step process:

1. Join step: Generate *RK*+1, the initial candidates of frequent item sets of size $k + 1$ by taking the union of the two frequent item sets of size k, *Pk* and *Qk* that have the first $k-1$ elements in common.

RK+1 = *Pk* ∪ *Qk* = {*iteml, . . . , itemk*−1, *itemk , itemk_* }

Pk = {*iteml , item2, . . . , itemk*−1, *itemk* }

Qk = {*iteml , item2, . . . , itemk*−1, *itemk_* }

where, *iteml* <*item2* <· · · <*itemk* <*itemk_* .

2. Prune step: Check if all the item sets of size k in *Rk*+1 are frequent and generate *Ck*+1 by removing those that do not pass this requirement from *Rk*+1. This is because any subset of size k of *Ck*+1 that is not frequent cannot be a subset of a frequent item set of size $k + 1$.

Function subset in line 5 finds all the candidates of the frequent item sets included in transaction *t*. Apriori, then, calculates frequency only for those candidates generated this way by scanning the database. It is evident that Apriori scans the database at most *k*max+1 times when the maximum size

of frequent item sets is set at *k*max. The Apriori achieves good performance by reducing the size of candidate sets .

However, in situations with very many frequent item sets, large item sets, or very low minimum support, it still suffers from the cost of generating a huge number of candidate sets

Algorithm 1 *Apriori*

F_l=(Frequent itemsets of cardinality 1);

for($k = 1$; $F_k \neq \phi$; $k + +$) do begin

$\quad C_{k+1}$ = apriori-gen(F_k); //New candidates

$\quad$ for all transactions $t \in$ Database do begin

$\quad\quad C'_t$ = subset(C_{k+1}, t); //Candidates contained in t

$\quad\quad$ for all candidate $c \in C'_t$ do

$\quad\quad\quad c.count + +$;

$\quad$ end

$\quad F_{k+1} = \{C \in C_{k+1} \quad | c.count \geq \text{minimum support} \}$

end

end

Answer $\cup_k F_k$;

Apriori Algorithm   (2.3)

The impact of the algorithm

Many of the pattern finding algorithms such as decision tree, classification rules and clustering techniques that are frequently used in data mining have been developed in machine learning research community. Frequent pattern and association rule mining is one of the few exceptions to this tradition. The introduction of this technique boosted data mining research and its impact is tremendous. The algorithm is quite simple and easy to implement. Experimenting with Apriori-like algorithm is the first thing that data miners try to do.

III   *k*NN: *k*-nearest neighbor classification

Description of the algorithm

One of the simplest and rather trivial classifiers is the Rote classifier, which memorizes the entire training data and performs classification only if the attributes of the test object match one of the training examples exactly. An obvious drawback of this approach is that many test records will not be classified because they do not

exactly match any of the training records. A more sophisticated approach, k-nearest neighbor (kNN) classification (Tan *et al.*, 2006), finds a group of k objects in the training set that are closest to the test object, and bases the assignment of a label on the predominance of a particular class in this neighborhood. There are three key elements of this approach: a set of labeled objects, e.g., a set of stored records, a distance or similarity metric to compute distance between objects, and the value of k, the number of nearest neighbors. To classify an unlabeled object, the distance of this object to the labeled objects is computed, its k-nearest neighbors are identified, and the class labels of these nearest neighbors are then used to determine the class label of the object.

The Algorithm provides a high-level summary of the nearest-neighbor classification method.

Given a training set D and a test object $x = ^{(\mathbf{x'}, y')})$, the algorithm computes the distance (or similarity) between z and all the training objects $(\mathbf{x}, y) \in D$ to determine its nearest-neighborlist, Dz. ($\mathbf{x}$ is the data of a training object, while y is its class. Likewise, $\mathbf{x}\_$ is the data of the test object and $y\_$ is its class.)Once the nearest-neighbor list is obtained, the test object is classified based on the majority class of its nearest neighbors:

$$\text{Majority Voting: } y' = \operatorname*{argmax}_{v} \sum_{(\mathbf{x}_i, y_i) \in D_z} I(v = y_i),$$

 kNN algorithm   (2.4)

where v is a class label, yi is the class label for the ith nearest neighbors, and $I(\cdot)$ is an indicator function that returns the value 1 if its argument is true and 0 otherwise.

Issues

There are several key issues that affect the performance of kNN. One is the choice of k. If k is too small, then the result can be sensitive to noise points. On the other hand, if k is too large, then the neighborhood may include too many points from other classes. Another issue is the approach to combining the class labels. The simplest method is to take a majority vote, but this can be a problem if the nearest neighbors vary widely in their distance and the closer neighbors more reliably indicate the class of the object. A more sophisticated approach, which is usually much less sensitive to

the choice of *k*, weights each object's vote by its distance, where the weight factor is often taken to be the reciprocal of the squared distance:

$$\text{Distance-Weighted Voting: } y' = \underset{v}{\arg\max} \sum_{(\mathbf{x}_i, y_i) \in D_z} w_i \times I(v = y_i).$$

kNN Algorithm issues   (2.5)

The choice of the distance measure is another important consideration. Although various measures can be used to compute the distance between two points, the most desirable distance measure is one for which a smaller distance between two objects implies a greater likelihood of having the same class (Yang and Wu, 2006).

2.1.7 Health care Data Mining Applications

There is vast potential for data mining applications in healthcare. Generally, these can be grouped as the evaluation of treatment effectiveness; management of healthcare, customer relationship management, detection of fraud and abuse.

2.1.7.1 Treatment effectiveness

Data mining applications can be developed to evaluate the effectiveness of medical treatments. By comparing and contrasting causes, symptoms, and courses of treatments, data mining can deliver an analysis of which courses of action prove effective (Milley, 2000). For example, the outcomes of patient groups treated with different drug regimens for the same disease or condition can be compared to determine which treatments work best and are most cost-effective (Kincade, 2017) Along this line, United HealthCare has mined its treatment record data to explore ways to cut costs and deliver better medicine (Young and Pitta, 2016). It also has developed clinical profiles to give physicians information about their practice patterns and to compare these with those of other physicians and peer-reviewed industry standards. Similarly, data mining can help identify successful standardized treatments for specific diseases. In 1999, Florida Hospital launched the clinical best practices initiative with the goal of developing a standard path of care across all campuses, clinicians, and patient admissions (Kolar, 2010). Other data mining applications related to treatments include associating the various side-effects of treatment, collating common symptoms to aid diagnosis, determining the most effective drug

compounds for treating sub-populations that respond differently from the mainstream population to certain drugs, and determining proactive steps that can reduce the risk of affliction (Milley, 2000).

2.1.7.2   Healthcare management

To aid healthcare management, data mining applications can be developed to better identify and track chronic disease states and high-risk patients, design appropriate interventions, and reduce the number of hospital admissions and claims. For example, to develop better diagnosis and treatment protocols, the Arkansas Data Network looks at readmission and resource utilization and compares its data with current scientific literature to determine the best treatment options, thus using evidence to support medical care (Kincade, 2017).   Also, the Group Health Cooperative stratifies its patient populations by demographic characteristics and medical conditions to determine which groups use the most resources, enabling it to develop programs to help educate these populations and prevent or manage their conditions (Kincade, 2017).

Group Health Cooperative has been involved in several data mining efforts to give better healthcare at lower costs. In the Seton Medical Center, data mining is used to decrease patient length-of-stay, avoid clinical complications, develop best practices, improve patient outcomes, and provide information to physicians—all to maintain and improve the quality of healthcare (Dakins, 2001). As another example, Blue Cross has been implementing data mining initiatives to improve outcomes and reduce expenditures through better disease management. For instance, it uses emergency department and hospitalization claims data, pharmaceutical records, and physician interviews to identify unknown asthmatics and develop appropriate Interventions (Kincade, 2017). Data mining also can be used to identify and understand high-cost patients (Silver *et al*., 2001)

Johnson (2001) has suggested that, at a higher level, data mining can facilitate comparisons across healthcare groups of things such as practice patterns, resource utilization, length of stay, and costs of different hospitals. Recently, Sierra Health Services has used data mining extensively to identify areas for quality improvements, including treatment guidelines, disease management groups, and cost management

(Schuerenberg, 2003). Data mining can be used to analyze massive volume of data and statistics to search for patterns that might indicate an attack by bio-terrorists (Piazza, 2002). The Lightweight Epidemiological Advanced Detection Emergency Response System (LEADERS) is one such effort. In the past, LEADERS has uncovered several disease outbreaks. Data mining also can be used for hospital infection control (Kreuze, 2001) or as an automated early-warning system in the event of epidemics.

2.1.7.3   Customer relationship management (CRM)

While customer relationship management is a core approach in managing interactions between commercial organizations—typically banks and retailers—and their customers, it is no less important in a healthcare context. Customer interactions may occur through call centers, physicians' offices, billing departments, inpatient settings, and ambulatory care settings.

As in the case of commercial organizations, data mining applications can be developed in the healthcare industry to determine the preferences, usage patterns, and current and future needs of individuals to improve their level of satisfaction (Biafore, 2012). These applications also can be used to predict other products that a healthcare customer is likely to purchase, whether a patient is likely to comply with prescribed treatment or whether preventive care is likely to produce a significant reduction in future utilization.

Through the use of data mining, Customer Potential Management Corp. has developed a Consumer Healthcare Utilization Index that provides an indication of an individual's propensity to use specific healthcare services, defined by (Brannigan, 2015) major diagnostic categories, selected diagnostic related groups or specific medical service areas.

This index, based on millions of healthcare transactions of several million patients, can identify patients who can benefit most from specific healthcare services, encourage patients who most need specific care to access it, and continually refine the channels and messages used to reach appropriate audiences for improved health and long-term patient relationships and loyalty (Paddison, 2000 and Milley 2000) has suggested that the data mining of patient survey data can help set reasonable

expectations about waiting times, reveal possible ways to improve service, and provide knowledge about what patients want from their healthcare providers. Also,

Hallick (2001) has suggested that CRM in healthcare can help promote disease education, prevention, and wellness services. Lastly, pharmaceutical companies can benefit from healthcare CRM and data mining, too. By tracking which physicians prescribe which drugs and for what purposes, pharmaceutical companies can decide whom to target, show what is the least expensive or most effective treatment plan for an ailment, help identify physicians whose practices are suited to specific clinical trials (for example, physicians who treat a large number of a specific group of patients), and map the course of an epidemic to support pharmaceutical salespersons, physicians, and patients (Brannigan, 2015). Pharmaceutical companies can also apply data mining to huge masses of genomic data to predict how a patient's genetic makeup determines his or her response to a drug therapy (Thompson and Roberson, 2000).

2.1.7.4   Fraud and Abuse

Data mining applications that attempt to detect fraud and abuse often establish norms and then identify unusual or abnormal patterns of claims by physicians, laboratories, clinics, or others. Among other things, these applications can highlight inappropriate prescriptions or referrals and fraudulent insurance and medical claims. For example, the Utah Bureau of Medicaid Fraud has mined the mass of data generated by millions of prescriptions, operations and treatment courses to identify unusual patterns and uncover fraud (Milley,2000). As a result of fraud and abuse detection, ReliaStar Financial Corp. has reported a 20 percent increase in annual savings, Wisconsin Physician's Service Insurance Corporation has noted significant savings and the Australian Health Insurance Commission has estimated tens of millions of dollars of annual savings (Christy, 2014).

In conclusion, data mining applications in healthcare can have tremendous potential and usefulness. However, the success of healthcare data mining hinges on the availability of clean healthcare data. In this respect, it is critical that the healthcare industry consider how data can be better captured, stored, prepared, and mined.

Possible directions include the standardization of clinical vocabulary and the sharing of data across organizations to enhance the benefits of healthcare data mining applications.

Further, as healthcare data are not limited to just quantitative data, such as physicians' notes or clinical records, it is necessary to also explore the use of text mining to expand the scope and nature of what healthcare data mining can currently do. In particular, it is useful to be able to integrate data and text mining (Cody *et al*., 2002). It is also useful to look into how digital diagnostic images can be brought into healthcare data mining applications. Some progress has been made in these areas (Megalooikonomou and Herskovits, 2016).

2.1.8   Knowledge Discovery

Knowledge discovery is a non-tedious procedure for identifying effective and potential benefits amid data. It is known from the figure below that data mining is one of the important processes of knowledge discovery. From the definitions by the scholars, it is clear that the usage of data mining is an analysis process within a series of knowledge discovery. As time changes the term ''data mining'' gradually replaces ''knowledge discovery''. Purpose of data mining is to uncover the rules that are helpful to decision process from massive data.

Knowledge Discovery (Figure 2.2) as a Process involves:
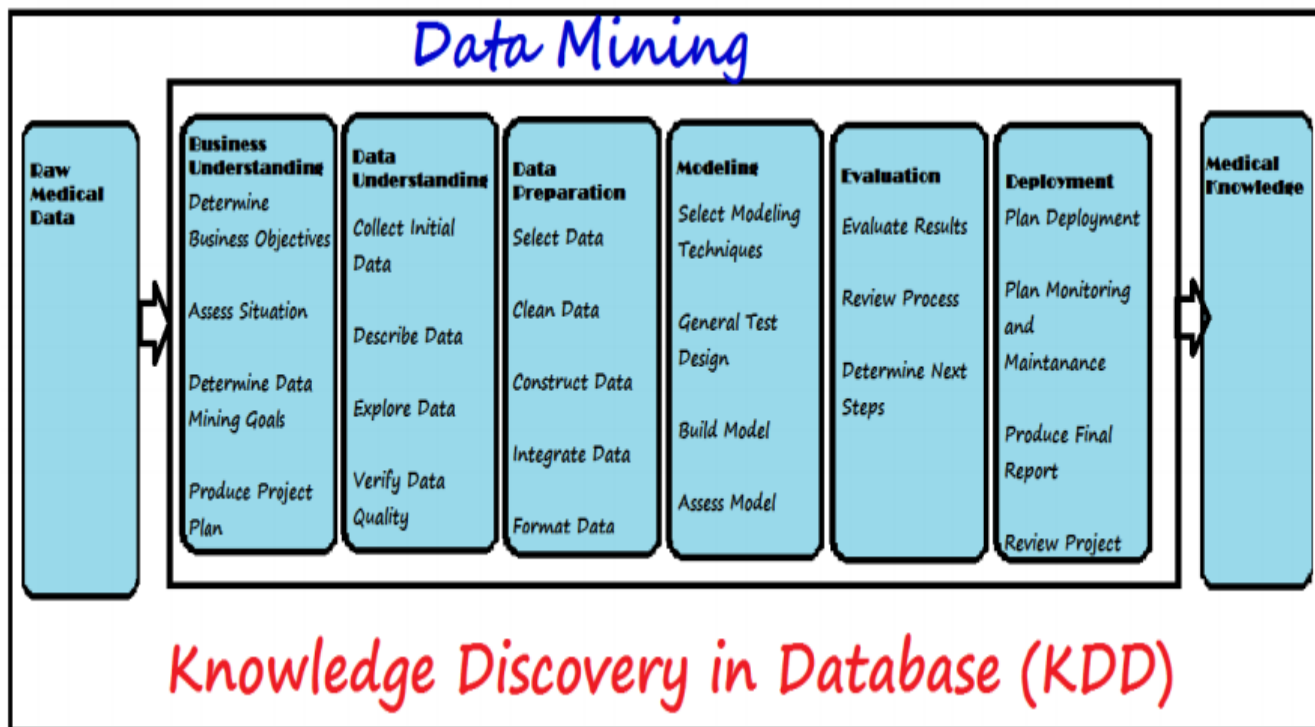
Figure 2.2: Knowledge Discovery. Source: (Mannila, 2015).

1. Data cleaning (to remove noise and inconsistent data)

2. Data integration (where multiple data sources may be combined)

3. Data selection (where data relevant to the analysis task are retrieved from the database)

4. Data transformation (where data are transformed or consolidated into forms appropriate for mining by performing summary or aggregation operations, for instance)

5. Data mining (an essential process where intelligent methods are applied in order to extract data patterns)

6. Pattern evaluation (to identify the truly interesting patterns representing knowledge based on some interestingness measures

7. Knowledge presentation (where visualization and knowledge representation techniques are used to present the mined knowledge to the user) Steps 1 to 4 are different forms of data preprocessing, where the data are prepared for mining. The data mining step may interact with the user or a knowledge base. The interesting patterns are presented to the user and may be stored as new knowledge in the knowledge base. Note that according to this view, data mining is only one step in the

entire process, albeit an essential one because it uncovers hidden patterns for evaluation.

We agree that data mining is a step in the knowledge discovery process. However, in industry, in media, and in the database research milieu, the term data mining is becoming more popular than the longer term of knowledge discovery from data.

Data cleaning and data integration techniques may be performed on the data. The database or data warehouse server is responsible for fetching the relevant data, based on the user's data mining request. (Mannila, 2015).

2.1.9   Electronic Medical Record (EMR)

The Electronic Medical Record comprises health-related information that is created by health care providers on behalf of a patient, such as diagnostic tests or prescriptions for medications. The main objective of an EMR is to improve the ability of a care provider to document observations and findings and to provide more information on treatment of persons in his or her care. EMR can also provide the underlying patient information for functions such as drug-drug interactions, recommended care practices or interpretation of data to support and improve clinical decisions (The National Alliance for Health Information Alliance Technology, 2008). However, these functions are limited by the extent of the information available in a provider-focused EMR within a single health care organization, hence the need to document how EMR is utilized and supports medical services in centers that use EMR system.

2.1.9.1   Importance of EMR

The EMR is expected to replace paper-based medical records as the primary source of medical history for each person seeking health care, while still complying with all clinical, legal and administrative requirements in developed countries (Janusz, 2003). Enormous investment has gone into computerized hospital information systems worldwide. The estimated cost for each large hospital is about 50 million United States dollars per year and in most developed countries, yet the overall benefits and costs of hospital information systems have rarely been assessed (Friedman, 2016). When systems are evaluated worldwide, about three quarters are considered to have failed and there is no evidence that they improve the productivity of health care professionals (Gibbs, 2016). In Malawi, to date Baobab Health Trust has issued

unique patient identity (ID) numbers and barcode labels to roughly 1.1 million patients, and since Baobab Health Trust's inception it has received roughly $1.1 million in funding. If all Baobab Health Trust had achieved were issuing nationally unique IDs this might not be considered a cost effective intervention by many, but in reality, Baobab has achieved far more than this, with currently over 30,000 patients being managed daily using the Baobab Health Trust electronic medical system.

To date, the digitization of health care typically has focused simply and solely on electronic records for patients. Most EMR systems are relational databases with a finite number of intra-enterprise applications and are limited to in-house use by health care facilities. Very few of these systems have realized fully functional, scalable, distribution capabilities, not to mention interoperability with external systems. This short-sighted tendency to build large-scale but restrictive automated systems that ignore the interactive nature of health care has resulted in limited operational success and acceptance (Wullianallur, 2009).

Electronic records have the potential to improve the quality of health care delivery and reduce costs (Hillestad, 2005). Accurate and up-to-date health information is critical. When an individual seeks health care, in order to provide effective and timely treatment, the provider needs to have information about the patient, including known allergies, chronic conditions, current medications and other pertinent health care data. However, such information is not always readily available. It may sometimes be available but incomplete or inaccurate, depending on whether the patient's records have been updated or not.

Though there have been challenges and failures in the implementation of EMR, their potential benefits are numerous. Some of the benefits are: complete and accurate information; universal and timely access to a patient's lifetime health information; knowledgeable sources to direct a patient to the appropriate care and substantially fewer medical errors. The EMR may exist in a distributed database, accessible from anywhere through a networked environment or a mobile smart card that a patient carries with him/her. If appropriate security measures are adopted, computerization also provides greater protection of confidential information via sophisticated keys and access controls. Additionally, the EMR system helps improve the quality of patient

visit documentation and data, free up facility storage space, improve efficiency by eliminating time spent hunting down lost charts and provide immediate, simultaneous access to patient records (Janusz, 2003).

Imagine the day when EMR systems will warn the caregiver when a patient being treated is allergic to medication prescribed, will provide the latest research on treatment modalities, and will organize volumes of information about a patient's chronic condition. When linked to the World Wide Web (example via web services), EMRs can provide customized patient-related information retrieval via push technology (Friedman, 2016). This capability will enable access to data from anywhere in the world. EMR has the ability to generate a complete record of a clinical patient encounter as well as supporting other care-related activities directly or indirectly via interface including evidence-based decision support, quality management and outcomes reporting (Chaudhry, 2006).

2.1.9.2   Challenges of EMR

The EMR raises issues of confidentiality, privacy and security (Shortliffe, 2016). Advances in information technology, the need to cut costs of health care delivery, and consumer demands for more effective and better-quality care have all hastened the exploration of alternatives for storing and retrieving health care information, and yet the implementation of EMR faces several technical challenges. Compared to other industries, the acceptance of information technology in health care has been slow (Carter, 2000). Compounding this is the limited experience available in deploying applications, which has resulted in a steeper learning curve for health care organizations.

A number of problems have been identified with the EMR, including increased provider time, computer down time, lack of standards, and threats to confidentiality. Studies at (some) institutions in America (Fiscella, 2006) have shown that electronic order entry increases the amount of time physicians spend entering a prescription. In a study by Powner, physician residents require more minutes per day using computerized order entry, although internal medicine residents using the order entry gained half of that time back in cost savings elsewhere (Powner, 2006). Furthermore, the study showed a high overall rate of user satisfaction of the system. Developing means to streamline order entry for residents are now a priority.

Another concern with EMR systems is computer down time. Although the threat of not having access to the right piece of information at the right time is real, the increasing reliability of computer systems makes this less of a problem. At Oregon Health Sciences University, for example, the daily scheduled down time has been reduced over the last several years from 1 hour to 10 minutes (Hersh, 2002). Most hospital computer systems and the databases that run on them are being designed for non-stop usage.

A more significant problem with EMR systems is the lack of standards to interchange information. While a number of standards exist to transmit pure data, such as diagnosis codes, test results, and billing information, there is still no consensus in areas such as patient signs and symptoms, radiology and other test interpretation, and procedure codes. Although some associate the National Library of Medicine's Unified Medical Language System (UMLS) with a comprehensive clinical vocabulary, its goal is much more modest, to serve just as a meta-thesaurus linking terms across different terminology systems (Sager, 2014).

A related problem to standards is that a large proportion of clinical information is "locked" in form of narrative text. Although a number of systems have been successful in limited domains, the technology for natural language processing (NLP) is still unable to interpret narrative text with the accuracy required for research and patient care applications. While NLP is difficult for well-written published medical documents, it is even harder for medical charts that contain poorly structured, highly elliptical language, with frequent misspellings to boot. Even if such language could be parsed, the lack of an underlying framework makes its semantic interpretation more difficult (Sager, 2014). Some have proposed to solve this problem with menu-driven data collection systems, but these have generally been successful only in limited areas, such as obstetric ultrasound (Bates, 2015). Baobab Health Trust has adopted the system of using only categorical data elements that can be selected from menus wherever possible for the reasons described above. Since the system does not use narrative text in most cases it makes the use of an entirely touch screen-driven system that much more feasible.

A final concern about the EMR is the problem of security and patient confidentiality. This problem, of course, exists independent of the EMR, as a great deal of medical information abstracted from paper records, already exists in electronic repositories. Well-known privacy experts have documented the threats that misuse of this information has on personal privacy (Korpman, 2012). As noted above, the paper record is no barrier to duplication, as medical records are routinely copied and faxed among health care providers and insurance companies already. While some fear the EMR will exacerbate this problem, others note that computer-based records, with appropriate security, are potentially more secure than paper based records. Most medical centers already have security. Employees given access are usually required to sign a confidentiality statement indicating their understanding of the privacy of patient data.

At most centers, a password is required to enter the system, although some institutions also use a physical device, such as a key card. Virtually all systems also keep an audit trail of who accessed which patient's data, providing a retrospective mechanism for discipline should breaches of security occur (Bates, 2015). While there is an array of technologies, including encryption and authentication that could erect barriers between medical information and its unauthorized use, it must also be noted that there is a tradeoff, as every computer user knows, between security and ease-of-use. Since the pace of medical care in emergency settings as well as busy clinical areas can be hectic, providers may become frustrated with layers of security. Challenges to the implementation of the EMR in primary care practice and in resource poor settings are huge and may seem outside the priority agenda in this era of public health emergencies. However, the information generated during routine medical consultation and its capture in the EMR could provide valuable information of public health interest. As elsewhere, challenges to adoption are great, but a successful implementation for a specific setting will require comprehensive modelling of the local medical practice and a coordinated approach, involving all stakeholders.

2.1.10 Review of Electronic Medical Record in Developed Countries

Countries such as the United States, United Kingdom and Australia have mature and advanced healthcare infrastructures that receive substantial funding and support from their governments. Although significant failures still exist in these systems, there is

strong support and motivation to accomplish goals associated with comprehensive development of successful medical information technology systems (Avison, 2007). These countries are able to make significant investments in research to develop information systems that would meet the need of their particular healthcare system. This is in sharp contrast to the healthcare infrastructure of many developing countries. For many of these countries the delivery and management of healthcare services alone comes with many challenges. In many of these countries, implementers of healthcare information technology based solutions are faced with complex challenges such as inadequate funding, lack of resources and weak healthcare infrastructure. When EMR systems were first introduced, it was widely believed that their broad adoption will lead to major health care savings, reduce medical errors, and improve health (Fonkych, 2005). But there has been little progress toward attaining these benefits. The United States trails a number of other countries in the use of EMR systems. Only 15–20 percent of U.S. physicians' offices and 20–25 percent of hospitals have adopted such systems. Barriers to adoption include high costs, lack of certification and standardization, concerns about privacy, and a disconnection between who pays for EMR systems and who profits from them (Fonkych, 2005).

Despite the appeal of EMR, available data suggest that the majority of office practices in the United States, especially smaller offices, do not have this technology (Fonkych, 2005). For example, using 2003 data from the National Ambulatory Medical Care Survey, Burt and Sisk reported that an average of 17.6 % doctors used EMRs in their office-based practices (Fonkych, 2005). In contrast, other countries, such as Australia and the United Kingdom, are nearing universal adoption of EMRs (Fonkych, 2005) In Massachusetts in 2005, only 18% of medical and surgical office practices reported using EMRs. Larger practices that provided primary care and those with other computerized systems were more likely to have adopted EMRs. Among practices with EMRs, most systems did not include advanced functionalities, such as order entry for medications, laboratory tests and diagnostic imaging. While 58% of practices with EMRs had electronic clinical decision support available, more than 1 in 4 practices indicated that a majority of their clinicians were not actively using that support.

In 1995, Newton performed a study titled "The first implementation of a computerized care planning system in the UK". The implementation included both a

new way of structuring work, using the nursing process and a new technology which was the use of computers. The results showed that it took more than a year after implementation until the nurses' negative attitudes towards the system shifted to positive attitudes. The study also showed a significant improvement in the quality of care planning (Dahm, 2008). In their review on the use of computers in a health care setting, Smith (2005) found no conclusive evidence that could provide the foundation for an effective computer implementation strategy. However, more common use of computers in society today has increased the use of computers in nursing and also made it possible to implement standardized care plans in EMR (Smith, 2005).

Timmons described nurses' resistance to using computerized systems for planning nursing care; their resistance did not entail direct refusal, but was instead quite subtle. They tended to minimize use of the system or postpone it to another time or to the next work shift. Timmons considered that the nurses' behavior was characterized by resistance to changes in the nursing process and to the technology (Dahm, 2008). Smith and others investigated charting time before and after computer implementation and found that no change had occurred. The advantage of using the software was observed when the technology and the concept brought together the care plans and subsequent documentation. This shows that use of the system improved the function and meaning of the care plan process (Smith, 2005).

2.1.10.1 Review of Electronic Medical Record in Developing Countries and Sub Saharan Africa

In Africa, millions of people die every year, and Sub-Saharan Africa, in particular, shows little progress towards achieving five of the six health-related Millennium Development Goals (MDG) targets. Countries in this region require health information systems that will enable them to generate the data needed to monitor progress towards the achievement of the targets. (World Health Organization, 2009)

Just five years ago, the use of electronic medical records (EMRs) in resource-poor countries in the Global South was, at best, experimental. Few organizations thought their usage was realistic, and fewer still had deployed such systems. The handful of projects that used an EMR system fell mainly into two groups: those that used expensive commercial software in specialist projects and private hospitals and those

that developed the software in-house, usually to manage a specific disease (McGrath, 2004). Since then, several successful medical information systems and EMRs have been implemented in developing countries and information technology is much more widely available in resource-poor areas. These factors, along with recognition of the benefits of EMRs in improving quality of care in developed countries, have created a broad interest in the use of health information technology systems (HIT) in the management of diseases such as HIV and drug-resistant TB (McGrath, 2004).

In 2001, the Departments of Medicine and Child Health and Pediatrics at Moi University, Eldoret and the Department of General Internal Medicine and Geriatrics at the Indiana University School of Medicine, in collaboration with the Moi Teaching and Referral Hospital in Eldoret, Kenya, established the Academic Model for Prevention and Treatment of HIV/AIDS (AMPATH) (Siika, 2005). The AMPATH Medical Record System (AMRS) was the first functioning comprehensive electronic medical record system committed to managing and improving the quality and efficiency of care for patients with HIV/AIDS in sub-Saharan Africa. It has played a significant role in patient care in all AMPATH sites. It has standardized patient data collection and made data retrieval much faster than the traditional paper-based record. It has enabled evidence-based decision-making for patient encounters and for the health system. The AMRS is affordable and represents a model system for recording critical HIV/AIDS data in resource poor settings that will be delivering an increasing amount of HIV care. This model will also allow those funding the rapid increase in the provision of HAART to know the return they are getting on their investment and hopefully encourage continued treatment of the worst medical disaster to ever befall humanity.

While most sophisticated EMRs in low-income regions are in large cities, where infrastructure and staffing needs are more easily met, Partners in Health (PIH) pioneered web-based EMRs for HIV and TB treatment in rural areas (Allen, 2006). The HIV-EMR, developed in Haiti, was deployed in two Rwandan health districts starting in August 2005. In less than six months (August 2005 through January 2006), the EMR tracked over 800 patients on ARV treatment. The addition of new features and adaptation to local needs was happening concurrently with the rapid scale-up and evolution of the medical program itself. The EMR in Rwanda provides support for

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patient monitoring, program monitoring, and research. Patient monitoring includes information for care of individuals, such as historical medical summaries and alerts. This is especially useful given the large distances between the clinics. The EMR in Rwanda also has an instrument to predict drug requirements and aid pharmacists in packing.

PIH in Rwanda learnt that well-trained data entry persons are required to maintain an EMR system; the team also learnt that at least 4 months of on job-training is needed to properly train data entry persons. Data entry persons must have the ability to solve problems and follow up ambiguous or suspect data, and IT support persons must be available. Care providers must also be trained to properly report changes in treatment.

2.1.11 Review of Paper-Based Medical Record

Despite the documented benefits of the EMR, most clinical encounters are still recorded by hand in a paper record. This is not without reason. Dick and Steen (2014) noted that the traditional paper record is still used due to its familiarity to users, portability, ease of recording "soft" or "subjective" findings, and its brows-ability for non-complex patients. There is also a sense of ownership of paper records, due to their being only one copy, which increases the sense of their security (although it will be noted below that this may be a false sense of security).

Nonetheless, there are many problems with paper-based medical records. The first is that the record can only be used in one place at one time. This is a problem for patients with complex medical problems, who interact with numerous specialists, nurses, physical therapists, etc. Another problem is that paper records can be much disorganized. Not only can they be fragmented across different physician offices and hospitals, as noted above, but the record at each location itself can often be disorganized, with little overall summary. In most paper records, pages are added to the record as they are generated chronologically, making the viewing of summarized data over time quite difficult.

Another problem with the paper record is incompleteness. In an analysis of U.S. Army outpatient clinics, Tufo and Speidel (2015) found as many as 20% of charts had missing information, such as laboratory data and radiology reports, a finding consistent with more recent observations (Korpman and Lincoln, 2012).

A final problem with the paper-based record is security and confidentiality. Although usually ascribed as a problem of the EMR, there are attributes of the paper record that increase its vulnerability to access by non-privileged outsiders. Its difficulty in duplication leads to a great deal of photocopying and faxing among providers and institutions. Furthermore, abstractions of the paper record are stored in large databases, such as those of the Medical Information Bureau, which are maintained by health insurance companies to prevent fraud but contain medical information of more than 12 million Americans (Rothfeder, 2013).

The problems of the paper-based record listed above are magnified in this new era of health care fueled by managed care. Managed care systems, typified by health maintenance organizations (HMO's), act as both health care insurer and provider. The traditional indemnity insurer operates in a fee-for-service environment where the providers are reimbursed based on charges billed. The managed care organization, on the other hand, is provided a fixed fee per patient, which gives it the incentive to keep patients healthy and provide care cost effectively. The benefits and drawbacks of managed care are beyond the scope of this thesis, but suffice it to say that managed care will play an increasingly larger role in the provision of American health care, and successful managed care organizations require cost efficiency, which in turn requires effective management of information.

There are many areas where improved information management can aid managed care organizations. For example, because many of these organizations provide comprehensive health care for their subscribers, they need effective communication between different providers, ancillary staff, and/or hospitals. Likewise, they need to determine whether those groups are providing cost effective care and not ordering excessive laboratory tests, x-rays, etc. Finally, these organizations often try to control the use of expensive medications and substitute their use with cheaper but equally effective ones.

Even outside the context of managed care, the efficiencies in communication and cost will be desired by society in general as the cost of health care continues to consume larger proportions of the gross domestic product. All payers, even traditional fee-for-service insurance companies, are beginning to require it.

Although the complete EMR does not currently exist, portions of the medical record have been computerized for many years. The most heavily computerized aspects are the administrative and financial portions. On the clinical side, the most common computerized function has been the reporting of laboratory results, usually made easier with the installation of automated equipment for laboratory specimen testing.

As more information recording functions become computerized (that is, clinician dictations transcribed into word processing systems), increasing proportions of the record are computerized as well.

Dick and Steen note that all comprehensive EMR's share several common traits (Dick & Steen, 2014). First, they all contain large data dictionaries that define their contents. Second, all data are stamped with time and date so that the record becomes a permanent chronological history of the patient's care. Third, the systems have the capability to display data in flexible ways, such as flow sheets and graphical views.

Finally, they have a query tool for research and other purposes. A number of successful EMR implementations have been in place for decades. One of the earliest ambulatory care record systems was COSTAR (Computer-Stored Ambulatory Record), developed at Massachusetts General Hospital in Boston (Barnett, 2013) patient registration and scheduling, storage and retrieval of clinical data, and financial capabilities such as billing. The core COSTAR system is in the public domain so that other vendors and institutions can modify and enhance it. Another well-known ambulatory system is the Regenstrief Medical Record System at Indiana University (McDonald, 2014) which implements similar functions but is also well known for its capacity for physician decision support.

There have also been a number of long-standing EMR systems for hospitals. The HELP (Health Evaluation through Logical Processing) system was developed at the University of Utah and Latter-Day Saints (LDS) Hospital in Salt Lake City (Warner *et al*., 2015). Similar to the Regenstrief system, it attempts to actively assist physician decision-making by providing alerts of potentially problematic situations and reminders for routine care.

Most of the above systems, as well as newer ones, have evolved with computer and network technology itself. Most systems initially consisted of dumb terminals

connected to mainframes or minicomputers, but have since evolved into microcomputer-based networks embracing client-server architectures. Future technologies, such as voice recognition or pen-based input, will likely cause further evolution of these systems.

2.1.12 Access to the Emergency Medical System

A national emergency number speeds up the process and guarantees that all relevant agencies are warned and involved. In high-income countries, access to the emergency medical system is almost always made by telephone, but the coverage and reliability of the telephone link varies between countries. The growth in the use of mobile telephones is having a helpful effect on crash notification (Peden *et al.*, 2004). For the European Union, 112 is the emergency telephone number which allows European citizens in distress to the emergency services in all Member States. It was established by Council Decision of 29 July 1991 and reinforced through the Directive 98/10/EC and now to be found in the Universal Service Directive. According to the European Commission it has now been implemented in all EU countries, although the number is little known by EU citizens according to European Commission monitoring. No information is available about the time taken to answer this emergency call number and no EU standard exists for call receipt.

In vehicle emergency notification systems, 'Mayday' systems aim to reduce the time between when the crash occurs and when medical services are provided. By improving information transfer between the trauma care physician and emergency medical service personnel, they aim for faster and more appropriate treatment. In 2000, Autolive and Volvo introduced one of the world's first post-crash safety systems.

Automatic Crash Notification (eCall) which is currently under development takes the safety benefits of Mayday systems further by providing emergency responders with data that indicates the severity of the crash and the nature of injuries sustained. A Finnish study has estimated that such a system might reduce between 4-8% of road deaths and 5-10% of motor vehicle occupant deaths in Finland (Virtanen *et al.*, 2006).

An efficient call receiving system is essential to avoid wasted time. A variety of models exists but has not been studied. In some Member States, calls are answered by the ambulance services or the emergency medical services, in others by other emergency services – police and fire service – and then appropriate calls are

transferred to the emergency medical system. A prior direct over indirect contact is to be preferred (Buylaert, 2012). It is not known whether all countries have standards for call receipt, although several countries have developed call receipt performance indicators.

In Europe, calls received by the Emergency Medical System either results in:

a   Automatic dispatch of an emergency ambulance requiring the call taker to give accurate identification of the location of the incident and to mobilize the emergency crew;

b   Selective dispatch depending on the perceived nature and urgency of the incident and the process of doing this is known as Emergency Medical Dispatch.

    The functions of the Emergency Dispatch System are:

i   Prioritization by level of urgency (triage) to determine the speed of response

ii   Prioritization by level of need to determine type of response

iii   Provision of pre-ambulance arrival instructions in first aid and scene management

iv   Communication with those on the scene and in the receiving hospital.

Clinical experts across Europe believe that all calls to the Emergency Medical System in Europe should be transferred as soon as possible to a trained dispatcher able to make a layered response using an appropriate Emergency Dispatch System (Buylaert, 2012).

A computerized system which promotes the call taker, records responses, supports decision making and provides information for audit and quality assurance is considered essential (Nicholl, 2014). There are various ways of operating emergency medical dispatch systems: the essential elements which have been identified are the use of a standard protocol, the need for medical supervision, audit of operations and the training of dispatchers (Buylaert, 2012).

2.1.12.1   Emergency Rescue Systems

Emergency rescue requires effective coordination between all the emergency services. The objective is to ensure speedy first aid and transport to an appropriate treatment centre. There needs to be close professional cooperation at the scene between fire-fighters, coastguards and police (who may arrive first at the scene) and the emergency medical service personnel.

Emergency medical technicians who staff an ambulance who carry out basic pre-hospital care techniques to save lives and limit disability. However, research shows that the level of training and the degree of professionalism involved varies (Huemer, 2012). The important status of the emergency medical technician is often not well recognized, is seen as an accessory for the fire department, or is even left to volunteers. The establishment of minimum standards at European Union level has been recommended by clinical experts in Europe (Buylaert, 2012). Non-medical emergency services need to be trained in basic life support in order to provide immediate first aid. There also needs to be cooperation between the fire-fighting services and medical personnel when victims are not readily accessible and special training is organized in many Member States to this effect. One issue, in particular, is the need for safe extrication of victims and awareness of the rescue services of special hazards such as un-deployed airbags.

Land ambulances are used in the majority of road collisions in Europe. The standardization of equipment in ambulances in Europe has been recommended, together with the development of appropriate vehicle and driver safety standards, given the considerable number of crashes involving ambulances (Buylaert, 2012).

A research overview by Elvik and Vaa (Elvik, 2004) indicates that the faster a road casualty can gain access to expert first aid, the greater the chance of survival and full recovery. Research shows that:

a   In general, road traffic deaths increase with increasing ambulance response time which is strongly related to population density

b   The proportion of fatal crashes is lowest where ambulance availability is best and highest where ambulance availability is poor.

2.1.12.2   Pre-Hospital Medical Care

A recent survey of pre-hospital literature found only 24 randomized controlled trials and concluded there was insufficient data to provide a strong evidence base for the effectiveness of many common pre-hospital interventions (Bunn et.al, 2013). The World Health Organization (Sasser, 2005) distinguishes between basic and advanced systems of pre-hospital care.

Basic Life Support (BLS): Consists of emergency medical care to restore or sustain vital functions (airway, respiration, circulation) without specialized medical

equipment and to limit further damage in the period preceding the arrival of specialized, advanced emergency medical care.

Advanced Life Support (ALS): Medical care given by medical doctors and nurses trained in critical care medicine with the use of specialized technical equipment, infusion of fluids and drugs aimed to stabilize or restore vital functions. Advanced life support is an integral part of a system of emergency medical services that needs adequate medical supervision.

While advanced systems are impressive and undoubtedly benefit some patients, WHO states that there is little evidence that they are inherently superior to systems that offer basic pre-hospital care. They may also hinder the overall provision of pre-hospital care if they lead system planners to divert scarce resources from basic interventions that benefit large numbers of patients to interventions that benefit fewer patients. With few exceptions (such as early defibrillation for victims of cardiac arrest), most advanced interventions have not been scientifically proven to be effective because the necessary randomized trials have not been conducted. In contrast, improved outcomes have been documented after bystanders and health-care providers have been educated to provide the fundamental elements of trauma care (Sasser, 2005).

Scientific knowledge about the efficacy of pre-hospital medical care techniques is, thus, still evolving. The optimal approach needs to be determined for different types of trauma patients and well-controlled studies need to be carried out to address this question further. It is clear, however, that only essential treatment should be given so there is no unnecessary waste of time. Measures to protect the victim from further injury, basic life support measures such as providing a free airway and techniques used to aid breathing are considered essential.

Mouth to mouth resuscitation and mask bag valve ventilation and decompression are also essential techniques. Measure to reduce circulatory failure and maneuvers started for immobilizing possible fractures to prevent further damage are also considered to be essential treatments (Buylaert, 2012).

Those who provide basic pre-hospital trauma care have had formal training in pre-hospital care, scene management, rescue, stabilization and transport (World Health Organization, 2009). Essential basic pre-hospital care techniques can be delivered by emergency medical technicians staffing ambulances. Advanced techniques can only be provided by:

i   Paramedics (emergency medical technicians who have received further training) example in the UK

ii   Nurses specialized in critical care example in the Netherlands

iii   Physicians in mobile intensive care units which is a system widely used in Europe example in Belgium, Germany, France, Italy.

In order to make the best use of resources, a two-tier system has been set up in some European countries comprising emergency medical technicians as the first tier and mobile intensive care units as a second tier.

Different factor needs to be taken into account in the decision about the appropriate hospital for the road traffic victim such as type of injuries, services available at the hospital, comparative distances and times to reach hospitals, and regulations concerning the transport of injured people.

Triage is the term applied to the process of classifying patients at the scene according to the severity of their injuries to determine how quickly they need care. Careful triage is needed to ensure that resources available in a community are properly matched to each victim's needs. Formal algorithms or protocols need to be developed to ensure that community resources are used properly to care for trauma patients; these algorithms must exist for both the pre-hospital and hospital setting. Failure to develop protocols may lead to over-triage or under-triage.

Over-triage occurs when non-critical patients are sent to facilities offering the highest level of care. Under-triage occurs when critically injured patients are treated at the local level or sent to facilities that are not properly equipped to meet their needs. This may result in increased morbidity and mortality among patients with otherwise treatable injuries care (Sasser, 2005).

Physician input is needed throughout the planning, implementation, evaluation and audit of the Emergency Medical System. Medical control and direction of pre-hospital care is essential and at the local level, a knowledgeable and committed health-care professional should be identified to serve as the medical director. In urban areas, an experienced hospital-based physician trained in accident and emergency medicine, anesthesiology or critical care, or trauma surgery, and ideally trained or experienced in pre-hospital care, may be best suited to this role. In rural communities where a physician may not be available, the most experienced nurse or paramedical professional should fill this role. It is important that qualified individuals be assigned

responsibility for assuring the availability and quality of pre-hospital care in their community, whether it is delivered through paid health-care providers or local volunteers care (Sasser, 2005).

Major road crashes which involve multiple casualties; Contributory factors include fog and excess speed (Buylaert, 2012). Large numbers of injured persons may also result from collisions involving buses or Lorries carrying explosive, toxic or inflammable chemical products. A disaster planning document is needed to strengthen the capacity of local and regional governments, health-care providers and public health organizations to react to such events (Sasser, 2005). Best practice indicates that a region-wide trauma team is the optimal means of dealing with such events utilizing such a disaster plan. Post impact care is coordinated by hospital-based medical teams who are trained in disaster management and in collaboration with the ambulance, police and the fire service. Efficient rescue involves on-site triage and immediate care, evacuation and hospital admission speed (Buylaert, 2012).

2.1.13   Patient Data and information systems

According to Ramakrishnan and Gehrke (2010), database is a collection of data, typically describing the activities of one or more related organizations. For example, a university database might contain information about the following:

i   Entities such as students, faculty, courses, and classrooms.

ii   Relationships between entities, such as students' enrollment in courses, faculty teaching courses, and the use of rooms for courses.

A database management system, or DBMS, is software designed to assist in maintaining and utilizing large collections of data, and the need for such systems, as well as their use, is growing rapidly (Ramakrishnan and Gehrke, 2010).

The collection and documentation of data on road traffic injury consequences and the different phases of post impart care are essential to identify priority areas, monitor progress and check that investments are being appropriately directed. Detailed information on victim's medical information, injury severity and health outcomes is needed for a better understanding of the scope for savings through post crash care. The recording of injury severity in hospitals; the measurement of road crash survivor outcomes; and post injury measures of disability (at least on discharge from hospital or at 30 days post impact), to be included in routine hospital statistics linked to

national crash data (Buylaert, 2012). It concluded that data should be collected by all Member States of the European Union for auditing the performance of the Emergency Medical Services. The review highlighted the need for regulations for performing post-mortems or radiological investigations in all road traffic deaths should be formulated.

The following data represent the information necessary to support the ongoing evaluation of pre-hospital care systems. The patient care record should be based on the International Classification of External Causes of Injury (Ware, 2015) and the WHO Injury Surveillance Guidelines.

These should include at minimum sufficient information to answer the following questions:

a   Who was injured and who provided care?

b   What caused the injury and what was done to treat it?

c   When did it occur?

d   Where did the injury occur?

e   How did the patient respond to treatment (outcome)?

The medical director or field supervisor has several simple but effective ways of ensuring the quality of pre-hospital care by listening in on radio or other communications, direct observation, report review, critical incident review, outcome studies, continuing education and maintaining discipline.

2.1.14 Biometric System

The word "biometrics" comes from the Greek language and is derived from the words bio (life) and metric (to measure). Biometrics refers to metrics related to human characteristics. Biometrics authentication (or realistic authentication) is used in computer science as a form of identification and access control. It is also used to identify individuals in groups that are under surveillance (Biometrics: Overview, 2012)

Biometric systems use a person's physical characteristics (like fingerprints, irises or veins), or behavioural characteristics (like voice, handwriting or typing rhythm) to determine their identity or to confirm that they are who they claim to be. (Bolle *et al.*, 2003) Biometric data are highly unique to each individual, easily obtainable

non-intrusive, time invariant (no significant changes over a period of time) and distinguishable by humans without much special training (Jain, 1999). Biometric data are highly unique to each individual, easily obtainable non-intrusive, time invariant that is no changes over period of time, distinguishable by humans without much special trainings. Biometric identifiers are categorized as physiological versus behavioural characteristics.

A physiological biometric would identify ones voice, DNA, hand print, iris, a behavioural biometrics is related to the behaviour of a person, including typing rhythm, and signature (Calabrese, 2009). The tradition or conventional means of access control include knowledge based methods such as password or pin and token based method such as passport, driver's license, ID card. These methods are prone to fraud because pin numbers could be forgotten and hacked and the token could be lost, duplicated or stolen. To address the need for robust, reliable and fool proof personal identification, authentication and systems will necessarily require a biometric component.

Fingerprint Identification

Fingerprint identification is referred to as dactyloscopy. It is the process of comparing questioned and known fingerprint against another fingerprint to determine if the impressions are from the same finger or palm (Ashbaugh and David, 2013)

Fingerprints are made of a series of ridges and furrows on the surface of the finger and have a core around which patterns like swirls, loops, or arches are curved to ensure that each print is unique. (Maltoni *et al.*, 2004) An arch is a pattern where the ridges enter from one side of the finger, rise in the center forming an arc, and then exit the other side of the finger. (Henry and Edward, 2015)

The loop is a pattern where the ridges enter from one side of a finger, form a curve, and tend to exit from the same side they enter. In the whorl pattern, ridges form circularly around a central point on the finger. The ridges and furrows are characterized by irregularities known as minutiae, the distinctive feature upon which finger scanning technologies are based. Minutiae points are local ridge characteristics that occur at either a ridge bifurcation or a ridge ending. The ridge ending is the point at which a ridge terminates. Bifurcations are points at which a single ridge splits into

two ridges. Minutiae and patterns are very important in the analysis of fingerprints since no two fingers have been shown to be identical.

It includes two sub-domains: one is fingerprint verification and the other is fingerprint identification

There are five stages involved in finger-scan verification and identification:

1. Fingerprint Image Acquisition

2. Image Processing

3. Locating Distinctive Characteristics

4. Template Creation

5. Template Matching (Hoku *et al*., 2015).

Fingerprint Authentication

Biometric authentication technologies such as face, finger, hand, iris, and speaker recognition are commercially available today and are already in use. A biometric system is essentially a pattern recognition system that operates by acquiring biometric data from an individual, extracting a feature set from the acquired data, and comparing this feature set against the template set in the database. Depending on the context, a biometric system may operate either in verification mode or identification mode. (Anil *et al.*, 2004)

Verification mode: In the verification mode, the system validates a person's identity by comparing the captured biometric data with her own biometric template(s) stored system database. In such a system, an individual who desires to be recognized claims an identity, usually via a PIN Personal Identification Number), a user name, a smart card, etc., and the system conducts a one-to-one comparison to determine whether the claim is true or not (example "Does this biometric data belong to Bob?"). Identity verification is typically used for positive recognition, where the aim is to prevent multiple people from using the same identity. (O'Gorman, 2002.)

Identification mode: In the identification mode, the system recognizes an individual by searching the templates of all the users in the database for a match. Therefore, the system conducts a one-to-many comparison to establish an individual's identity (or fails if the subject is not enrolled in the system database) without the subject having to claim an identity (example "Whose biometric data is this?"). Identification is a critical component in negative recognition applications where the system establishes whether the person is who she (implicitly or explicitly) denies to be. The purpose of negative

recognition is to prevent a single person from using multiple identities. Identification may also be used in positive recognition for convenience (the user is not required to claim an identity).

While traditional methods of personal recognition such as passwords, PINs, keys, and tokens may work for positive recognition, negative recognition can only be established through biometrics. (O'Gorman, 2002).

2.1.15   Database Models for patients' data and information system

A database model is a type of data model that determines the logical structure of a database and fundamentally determines in which manner data can be stored, organized, and manipulated. Common logical data models for databases include:

i   Hierarchical database model

ii   Network model

iii   Relational model

iv   Entity–relationship model (Codd, 2015)

2.1.15.1   Hierarchical model

In a hierarchical model (Figure 2.3), data is organized into a tree-like structure, implying a single parent for each record.
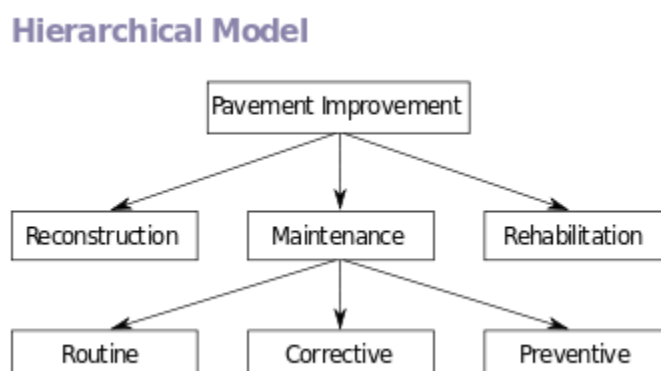
Figure 2.3: Hierarchical model. Source: (Elmasri and Navathe 2012).

A sort field keeps sibling records in a particular order. Hierarchical structures were widely used in the early mainframe database management systems, such as the Information Management System (IMS) by IBM, and now describe the structure of XML documents. This structure allows one one-to-many relationship between two types of data. This structure is very efficient to describe many relationships in the real world; recipes, table of contents, ordering of paragraphs/verses, any nested and sorted information.

2.1.15.2   Network model

The network model (Figure 2.4) expands upon the hierarchical structure, allowing many-to-many relationships in a tree-like structure that allows multiple parents.
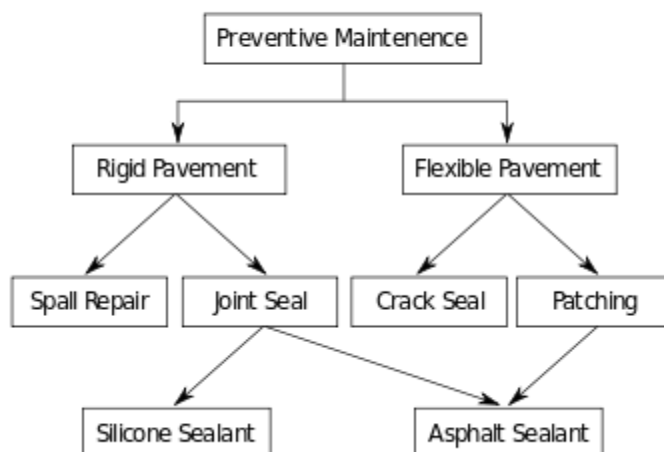
Figure 2.4: Network model. Source: (Elmasri and Navathe, 2012).

It was most popular before being replaced by the relational model, and is defined by the CODASYL specification.

The network model organizes data using two fundamental concepts, called records and sets. Records contain fields (which may be organized hierarchically, as in the programming language COBOL). Sets (not to be confused with mathematical sets) define one-to-many relationships between records: one owner, many members. A record may be an owner in any number of sets, and a member in any number of sets.

A set consists of circular linked lists where one record type, the set owner or parent, appears once in each circle, and a second record type, the subordinate or child, may appear multiple times in each circle. In this way a hierarchy may be established between any two record types, example, type A is the owner of B. At the same time another set may be defined where B is the owner of A. Thus all the sets comprise a general directed graph (ownership defines a direction), or network construct. Access to records is either sequential (usually in each record type) or by navigation in the circular linked lists.

The network model is able to represent redundancy in data more efficiently than in the hierarchical model, and there can be more than one path from an ancestor node to a descendant. The operations of the network model are navigational in style: a program maintains a current position, and navigates from one record to another by following the relationships in which the record participates. Records can also be located by supplying key values.

Although it is not an essential feature of the model, network databases generally implement the set relationships by means of pointers that directly address the location of a record on disk. This gives excellent retrieval performance, at the expense of operations such as database loading and reorganization.

Popular DBMS products that utilized it were Cincom Systems' Total and Cullinet's IDMS. IDMS gained a considerable customer base; in the 1980s, it adopted the relational model and SQL in addition to its original tools and languages.

Most object databases (invented in the 1990s) use the navigational concept to provide fast navigation across networks of objects, generally using object identifiers as "smart" pointers to related objects. Objectivity/DB, for instance, implements named one-to-one, one-to-many, many-to-one, and many-to-many named relationships that can cross databases. Many object databases also support SQL, combining the strengths of both models.

2.1.15.3   Relational model

The relational model (Figure 2.5) was introduced by Codd in 1970 as a way to make database management systems more independent of any particular application. It is a

mathematical model defined in terms of predicate logic and set theory, and systems implementing it have been used by mainframe, midrange and microcomputer systems.
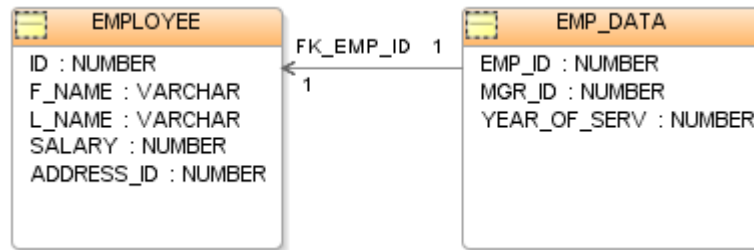
Figure 2.5: Relational model (Codd, 2015).

The products that are generally referred to as relational databases in fact implement a model that is only an approximation to the mathematical model defined by Codd. Three key terms are used extensively in relational database models: relations, attributes, and domains. A relation is a table with columns and rows. The named columns of the relation are called attributes, and the domain is the set of values the attributes are allowed to take.

The basic data structure of the relational model is the table, where information about a particular entity (say, an employee) is represented in rows (also called tuples) and columns. Thus, the "relation" in "relational database" refers to the various tables in the database; a relation is a set of tuples. The columns enumerate the various attributes of the entity (the employee's name, address or phone number, for example), and a row is an actual instance of the entity (a specific employee) that is represented by the relation. As a result, each tuple of the employee table represents various attributes of a single employee (Codd, 2015)

2.1.15.4 Entity-Relationship Model

The entity-relationship (ER) data model (Figure 2.6) allows us to describe the data involved in a real-world enterprise in terms of objects and their relationships and is widely used to develop an initial database design. The ER model is important primarily for its role in database design. It provides useful concepts that allow us to move from an informal description of what users want from their database to a more detailed and precise description that can be implemented in a DBMS. We begin with

an overview of database design in order to motivate our discussion of the ER model. Within the larger context of the overall design process, the ER model is used in a phase called conceptual database design.
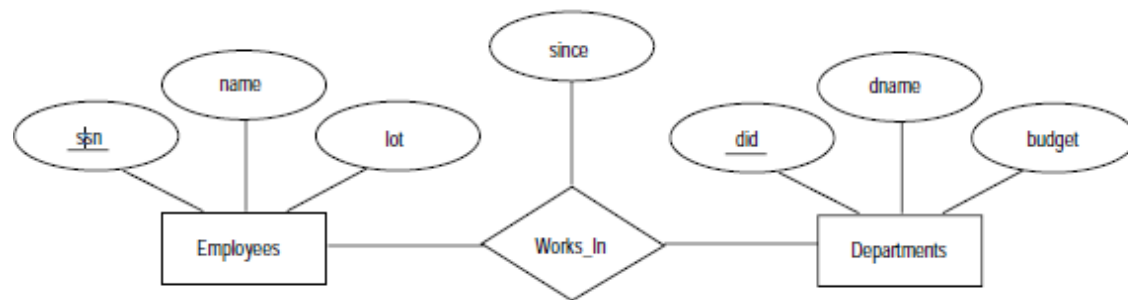
Figure 2.6: Example of Entity Relational Model (Ramakrishnan and Gehrke, 2010)

2.1.16   Overview of Database Design

The Entity relationship database design process can be divided into three steps.

(1) Requirements Analysis: The very first step in designing a database application is to understand what data is to be stored in the database, what applications must be built on top of it, and what operations are most frequent and subject to performance requirements. In other words, we must find out what the users want from the database.

Database design tools: Design tools are available from RDBMS vendors as well as third-party vendors. Sybase and Oracle, in particular, have comprehensive sets design and analysis tools. This is usually an informal process that involves discussions with user groups, a study of the current operating environment and how it is expected to change, analysis of any available documentation on existing applications that are expected to be replaced or complemented by the database, and so on. Several methodologies have been proposed for organizing and presenting the information gathered in this step, and some automated tools have been developed to support this process.

(2) Conceptual Database Design: The information gathered in the requirements analysis step is used to develop a high-level description of the data to be stored in the database, along with the constraints that are known to hold over this data. This step is often carried out using the ER model, or a similar high-level data model.

(3) Logical Database Design: We must choose a DBMS to implement our database design, and convert the conceptual database design into a database schema in the data model of the chosen DBMS. We will only consider relational DBMSs, and therefore,

the task in the logical design step is to convert an ER schema into a relational database schema (Ramakrishnan and Gehrke, 2010).

2.1.17 Data Integration

Data integration (Figure 2.7) involves combining data residing in different sources and providing users with a unified view of these data (Lenzerini, 2002). This process becomes significant in a variety of situations, which include both commercial (when two similar companies need to merge their databases) and scientific (combining research results from different bioinformatics repositories, for example) domains. Data integration appears with increasing frequency as the volume and the need to share existing data explodes (Lane, 2006).

2.1.17.1   History of Data Integration
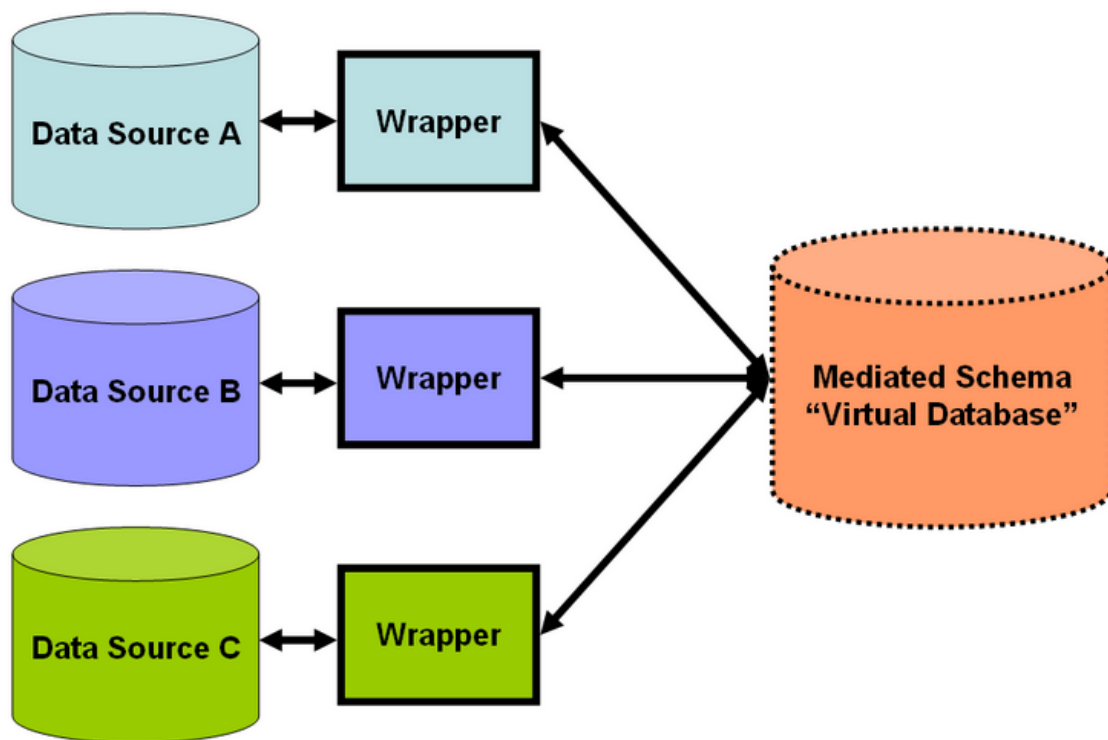
Figure 2.7: Data Integration . Source: (Shubhra,2009)

Issues with combining heterogeneous data sources under a single query interface have existed for some time. In the early 1980s, computer scientists began designing systems for interoperability of heterogeneous databases (Smith, 2005). The first

data integration system driven by structured metadata was designed at the University of Minnesota in 1991, for the Integrated Public Use Microdata Series (IPUMS). IPUMS used a data warehousing approach, which extracts, transforms, and loads data from heterogeneous sources into a single view schema so data from different sources become compatible (Ruggles *et al.*, 2015). By making thousands of population databases interoperable, IPUMS demonstrated the feasibility of large-scale data integration. The data warehouse approach offers a tightly coupled architecture because the data are already physically reconciled in a single query able repository, so it usually takes little time to resolve queries (Widom, 2014).

2.1.18 The way forward for the Nigerian health care system

Several flaws in the health care system could have been averted through adequate MIS (Management Information System), which is supposed to be the first line of approach to developing the Nigerian health care system. Of course, there is a long list of barriers which lie on the pattern of leadership, infrastructures, manpower challenges, clinical training, standardized diagnostic instruments, etc. The reforms and changes made to retain health security seem not to have made positive effect on the health care system. (Health Reform Foundation of Nigeria HERFON, 2014]. Considering the threats of health insecurity, (Health Insurance report, Repositioning the National Health Insurance Scheme (NHIS) for effective take-off, 2014), there is therefore immense need to revitalize the Nigerian health care system and provide specific project design to enhance cooperation and efficiency. To account for the modern day needs of Nigerians, the health care delivery system must adequately meet the following functions:

1. Effectively assess patients' dilapidating state of health
2. Refer patients to specialists for appropriate treatments and supportive services
3. Recognize, treat, or refer co morbid medical and psychiatric conditions for specialists' treatment
4. Perform age, gender, and culturally appropriate disease screening
5. Provide brief interventions to patients with dilapidating state of health
6. Chronic diseases management and prevention

7. Family planning to be included effectively into the health care delivery system

8. Systematically and routinely measure the quality of services provided by the health system

9. Capture mortality data of specific project enrolees to measure the effectiveness of health care provided

10. Carry out health campaigns and awareness

11. Develop effective counselling methods

12. Perform comparative analysis with other countries' experiences in addressing health changes

13. Calculate the economic gain or loss of health care provided

14. Achieve economic distribution of services with adequate capitation rate

15. Verify delivery of health services

16. Provide performance based incentives on a regular basis

17. Develop a strong knowledge base/research culture

The huge problems encountered by the Nigerian health care system could partly be due to the absence of MIS system which holds the key to successful medical leadership, as well as health care delivery.

2.2   Review of Related Works

In healthcare, many data mining techniques have been used to discover knowledge from medical datasets. Balakrishnan *et al*. (2017) proposed a feature selection approach for classification accuracy which can classify type II diabetes records. The feature selection is associated with support vector machine (SVM) ranking for improving classification accuracy. Shakil *et al*. (2017) proposed the global optimization approach to clustering and demonstrated how supervised data classification problem can be solved via clustering. The objective function in this problem is both non smooth and non convex and has a large number of local minimizers. Due to a large number of variables and the complexity of the objective function, general purpose global optimization techniques, as a rule failed to solve such problem. It is very important therefore, to develop optimization algorithm that allow the decision maker to find "deep" local minimizers of the objective function. Such deep mininizers provide a good enough description of the data set under consideration

as far as clustering is concerned. Some automated rule generation methods such as classification and regression trees are available to find rules describing different subsets of the data. When the data sample size is limited, such approaches tend to find very accurate rules that apply to only a small number of patients.

Tsumoto and Hirano (2016) studied trajectory mining techniques in order to analyze laboratory examinations. Multiple trajectories are used and compared one with other trajectory to discover data dynamics. To achieve this they proposed a novel cluster analysis method which was applied on hepatitis dataset and discovered interesting results. Carlos (2016) studied the problem of heart disease prediction. This researcher identified constrained association rules for the purpose. The constraints considered include the appearance of attributes only at one side of rule; attribute segregation into uninterested groups, and restriction on number of attributes. With these constraints the number of discovered rules was reducing making the solution more suitable for the prediction of heart diseases.

Abe *et al*. (2015) proposed data mining environment for integrated time-series for medical data mining. For extracting useful clinical knowledge from medical databases medical time-series data mining is essential. The environment makes use of inputs from medical experts to obtain quality results. Bellaachia and Erhan (2015) analyzed the problem of prediction of survivability of Brest cancer patients. They used three different data mining techniques to discover the survivability probability of breast cancer patients. They include decision tree algorithm such as C4.5, Naïve bayes and back propagation neural network. Out of them they found C4.5 provides better performance. Neelamadhab and Rasmita (2012) describes about the difficulty in prediction of data. Actually no approaches or tools can guarantee to generate the accurate prediction in the organization. They analyzed the different algorithm and prediction technique. Inspite the fact that the least median squares regression is known to produce better results than the classifier linear regression techniques from the given set of attributes. As comparison they found that Linear Regression technique which takes the lesser time as compared to Least Median Square Regression.

Barati (2011) applied data mining techniques on skin diseases. They also explored other diseases. For instance association rule mining was found suitable for cancer diagnosis. They have focused on the skin disease classification with respect to dermatology. They used techniques like Genetic algorithms, fuzzy classification, and neural networks. They found that clustering medical images has very important utility in medical data mining. Heart disease prediction system and heart attack prediction system were presented by Subbalakshmi (2011) and Deepika (2011) respectively. Both the systems work on similar datasets for detecting heart diseases. Yanqing *et al*. (2011) used association in order to learn uncommon casual relationships in Electronic health database. An integrated approach of using Association and Classification techniques also improved the capabilities of data mining. Manaswini and Ranjit (2011) suggested an Artificial Neural Network (ANN) based classification model as one of the powerful method in intelligent field for classifying diabetic patients. The neural network, used in back propagation algorithm, is m-n-1 type network. The GA is used for optimally finding out the number of neurons in the single hidden layered model. For training and testing 10-fold cross validation method was adopted for Pima Indian Diabetes. For Pima dataset the ANN gives the best accuracy with 5 neurons in the hidden layer. Best accuracy being 72% with average accuracy of 72.2%. The designed model was compared with the Functional Link ANN (FLANN) and several classification systems like NN (nearest neighbor), kNN(k-nearest neighbor), BSS(nearest neighbor with backward sequential selection of feature, MFS1(multiple feature subset) , MFS2(multiple feature subset) for Data classification accuracies. It was revealed from the simulation that their suggested model performed better than compared to all of the participating techniques for comparison.

Padmavati (2011) performed a comparative study on WBC dataset for breast cancer prediction using RBF and MLP along with logistic regression. Logistic regression was performed using logistic regression in SPSS package and MLP and RBF were constructed using MATLAB. It was observed that neural networks took slightly higher time than logistic regression but the sensitivity and specificity of both neural network models had a better predictive power over logistic regression. When comparing RBF and MLP neural network models, it was found that RBF had good predictive capabilities and also time taken by RBF was less than MLP.

Abdelaal *et al.* (2010) investigated the capability of the classification SVM with Tree Boost and Tree Forest in analyzing the DDSM dataset for the extraction of the mammographic mass features along with age that discriminates true and false cases. Here, SVM techniques show promising results for increasing diagnostic accuracy of classifying the cases witnessed by the largest area under the ROC curve comparable to values for tree boost and tree forest.

Anunciacao *et al.*(2010) explored the applicability of decision trees for detection of high risk breast cancer groups over the dataset produced by Department of Genetics of faculty of Medical Sciences of Universidade Nova de Lisboa with 164 controls and 94 cases in WEKA machine learning tool. To statistically validate the association found, permutation tests were used. They found a high-risk breast cancer group composed of 13 cases and only 1 control, with a Fisher Exact Test (for validation) value of 9.7*10-6 and a p-value of 0.017. These results showed that it is possible to find statistically significant associations with breast cancer by deriving a decision tree and selecting the best leaf. Sarvestani *et al.* (2010) provided a comparison among the capabilities of various neural networks such as Multilayer Perceptron (MLP), Self Organizing Map(SOM), Radial Basis Function (RBF) and Probabilistic Neural Network(PNN) which are used to classify WBC and NHBCD data. The performance of these neural network structures was investigated for breast cancer diagnosis problem. RBF and PNN were proved as the best classifiers in the training set. But the PNN gave the best classification accuracy when the test set is considered. This work showed that statistical neural networks can be effectively used for breast cancer diagnosis as by applying several neural network structures a diagnostic system was constructed that performed quite well. Gandhi *et al*. (2010) constructed classification rules using the Particle Swarm Optimization Algorithm for breast cancer datasets. In this study to cope with heavy computational efforts, the problem of feature subset selection as a pre-processing step was used which learns fuzzy rules bases using GA implementing the Pittsburgh approach. It was used to produce a smaller fuzzy rule bases system with higher accuracy. The resulted datasets after feature selection were used for classification using particle swarm optimization algorithm. The rules developed were with rate of accuracy defining the underlying attributes effectively.

Soni *et al*. (2010) have used this integrated approach of association and classification for studying health care data. This integrated approach is useful for determining rules in the database and then by using these rules, an effective classifier is raised. The study made experiment on the data of heart patients and generate rules by weighted associative classifier. Thus, Association also has an ample influence in the healthcare field to identify the relationships among various diseases.

Suneetha *et al*. (2010) proposed a tree - base approach to analyze multiple response using classification algorithms compared with a modified decision tree method for classification to overcome the known problems for the Gini-based decision tree method and normalizing the Gini indexes by taking into account information about the splitting status of all attributes. Instead of using the Gini index for attribute selection as usual, they used ratios of Gini indexes and their splitting values in order to reduce the biases. They experimented this approach on medical Heart Diseases dataset and results showed that the modified decision tree method reacted differently with the heart dataset when compared to other known decision tree methods. The modified Gini index method performed well for some data bases. Compared to previous multivariate decision tree methods that have limitations on the type of response and size of data the proposed method can analyze any type of multiple response by using this split formulae.

Elsayad (2010) investigated three different data mining methods; multilayer perceptron neural network, C5.0 decision tree and linear discriminate analysis in order to build an ensemble model to the problem of differential diagnosis of these erythemato-squamous diseases. The dermatology dataset investigated in this study was taken from the University of California at Irvine (UCI) machine learning repository. The proposed ensemble combined the models using a confidence-weighted voting scheme. The classification performance of the proposed system was presented using statistical accuracy, specificity and sensitivity. The performance of MLPNN was enhanced using the scored predictions of C5.0 DT and LDA models in the proposed ensemble arrangement. Kahramanli *et al*. (2009) presented an algorithm for extracting comprehensible classification rules for diagnosis of liver disorders. This algorithm considered all input attributes and extracts rules from the trained neural network with adaptive activation function efficiently. They observed that the neural network trained with adaptive activation function achieved high classification

accuracy. Therefore, Neural network was trained by adaptive activation function in hidden layer and fixed sigmoid activation function in output layer. OptaiNET that is an Artificial Immune Algorithm (AIS) used in extracting rules from the trained neural networks. This approach was applied to BUPA Liver Disorders classification problems. The results of comparison experiments showed that the developed approach generated more accurate rules.

Choi *et al*. (2009) compared the performance of an Artificial Neural Network, a Bayesian Network and a Hybrid Network used to predict breast cancer prognosis. The hybrid Network combined both ANN and Bayesian Network. The Nine variables of SEER data which were clinically accepted were used as inputs for the networks. The accuracy of ANN (88.8%) and Hybrid Network(87.2%) were very similar and they both outperformed the Bayesian Network. They found the proposed Hybrid model can also be useful to take decisions.

Jiquan *et al*. (2008) studied on heterogeneous medical data and proposed a term-mapping framework for improving medical data mining process. Here the miscall data sources are mapped to various medical terminology for simplifying mining process. Tsumoto (2007) presented an approach for multi-stage medical diagnosis through mining of diagnostic rules and diagnostic taxonomy. For grouping medical diseases, they used a measure which has three procedures namely characterization of attributes for decision making, computing similarity between characterization sets, and the concept hierarchy for given classes. Wang and Wang (2007) studied on medical knowledge acquisition through data mining. They explored various data mining algorithms for knowledge discovery. They include classification, clustering, association rule mining, regression analysis, sequence mining, and outlier detection. Chi *et al*. (2007) used the Street's ANN model for Breast Cancer Prognosis on WPBC data and Love data. In their research they used recurrence at five years as a cut point to define the level of risk. The applied models successfully predicted recurrence probability and separated patients with good(>5 yrs) and bad(<5 yrs) prognoses

Seng (2006) studied on medical data mining and sharing of patients' health records securely with respect to telemedicine. They discussed web based data mining techniques for telemedicine. Their methods improved the overall healthcare management. Ghannad *et al*. (2006) presented a new medical data mining approach

based on advanced swam intelligence. As medical data mining techniques, this approach addresses problems of missing values, storage and coding problems. They built an application that is meant for surgery candidate selection in temporal lobe epilepsy. Their method has shown high quality in the results. C4.5 is a well known decision tree induction learning technique which has been used by Bellaachia and Erhan (2006) along with two other techniques that is Naïve Bayes and Back-Propagated Neural Network. They also presented an analysis of the prediction of survivability rate of breast cancer patients using above data mining techniques and used the new version of the SEER Breast Cancer Data. The pre-processed data set consists of 151,886 records, which have all the available 16 fields from the SEER database. They have adopted a different approach in the pre classification process by including three fields: STR(Survival Time Recode), VSR(Vital Status Recode), and COD(Cause Of Death) and used the Weka toolkit to experiment with these three data mining algorithms. Several experiments were conducted using these algorithms. The achieved prediction performances are comparable to existing techniques. However, they found out that model generated by C4.5 algorithm for the given data has a much better performance than the other two techniques. The results obtained in their work differed from the study of Delen *et al*. because they used a newer version of same dataset, a different pre-classification and different toolkit. Their experimental results showed that their approach outperformed the approach used by Delen *et al*. They also proposed that after including the missing data in EOD attribute of used dataset can also increase the performance more.

Leonid *et al*. (2005) demonstrated that both self organizing maps and optimization based clustering algorithms can be used to explore existing classification rules, developed by experts and identify inconsistencies with a patient database.

Bagirov *et al*. (2005) proposed the global optimization approach to clustering and demonstrate how the supervised data classification problem can be solved via clustering. The objective function in this problem is both non smooth and non convex and has a large number of local minimizers. Due to a large number of variables and the complexity of the objective function, general purpose global optimization techniques, as a rule fail to solve such problem. It is very important therefore, to develop optimization algorithm that allow the decision maker to find "deep" local minimizers of the objective function. Such deep mininizers provide a good enough

description of the data set under consideration as far as clustering is concerned. Some automated rule generation methods such as classification and regression trees are available to find rules describing different subsets of the data. When the data sample size is limited, such approaches tend to find very accurate rules that apply to only a small number of patients. Schwarta *et al*. (2005) demonstrated that data mining techniques can play an important role in rule refinement even if the sample size is limited. For that at first stage methodology is used for exploring and identifying inconsistencies in the existing rules, rather than generating a completely new set of rules. K-mean algorithm lies in the improved visualization capabilities resulting from the two dimensional map of the cluster.

Jamarani *et al*. (2005) presented an approach for early breast cancer diagnosis by applying combination of ANN and multiwavelet based sub band image decomposition. The proposed approach was tested using the MIAS mammographic databases and images collected from local hospitals. The best performance was achieved by BiGHM2 multiwavelet with areas ranging around 0.96 under ROC curve. The proposed approach could assist the radiologists in mammogram analysis and diagnostic decision making. Delen *et al*. (2005) compared ANN, decision tree and logistic regression techniques for breast cancer survival analysis . They used the SEER(Surveillance Epidemiology and End Results)data's twenty variables in the prediction models. The decision tree with 93.6% accuracy and ANN with 91.2% were found more superior to logistic regression with 89.2% accuracy.

Müller *et al*. (2001) proposed an intelligent data mining technique. They built a query language by name Knowledge Discovery Question Language (KDQL) that is meant for the discovery of high quality information from medical data sources containing therapeutic and diagnostic measures. Antonie (2001) demonstrated data mining techniques for tumor detection. The experiments are related to digital mammography. The data mining techniques explored to achieve this are association rule mining and neural networks. With the two algorithms they could achieve classification accuracy up to 70%. Chul-Heui *et al*. (2001) proposed a new classification method based on the hierarchical granulation structure using the rough set theory. The hierarchical granulation structure was adopted to find the classification rules effectively. The classification rules had minimal attributes and the knowledge reduction was

accomplished by using the upper and lower approximations of rough sets. A simulation was performed on WBC dataset to show the effectiveness of the proposed method. The simulation result showed that the proposed classification method generated minimal classification rules and made the analysis of information system easy.

Tsumoto (2000) studied on the problems of medical data mining. The problems identified include missing values, data storage issues, coding systems and related problems.

Lundin *et al*. (1999) have applied ANN on 951 instances dataset of Turku University Central Hospital and City Hospital of Turku to evaluate the accuracy of neural networks in predicting 5, 10 and 15 years breast cancer specific survival. The values of ROC curve for 5 years was evaluated as 0.909,for 10 years 0.086 and for 15 years 0.883, these values were used as a measure of accuracy of the prediction model. They compared 82/300 false prediction of logistic regression with 49/300 of ANN for survival estimation and found ANN predicted survival with higher accuracy. Nick Street W. applied ANN classification to Wisconsin Prognostic Breast Cancer and SEER datasets for the analysis of survival. He developed a novel encoding as good and poor prognosis of censored data in an ANN architecture to provide a framework for prognostic prediction.

2.3   Summary of Literature Review and Knowledge Gap

Many researchers in the past have used different data mining techniques for the treatment of different diseases. Summary for the different techniques in medical data mining is presented in Table 2.2

Table 2.2: Summary of data mining techniques used for different diseases (Sheenal and Hardik, 2016)

Author's Name	Disease	Technique used
Doron and Nicholas (1998)	Conventional Pathology Data	Extracting patterns and detecting trends using Neural Networks
Doron and Nicholas (1998) and Yanwei *et al.* (2007)	Coronary heart disease	Prediction models using Decision Tree Algorithms such as ID 3 C4.5, C5, and CART
Gustavo *et al.* (2004) and Hojin *et al.* (2007)	Lymphoma Disease and Lung Cancer	Distinguish disease subtypes using Ensemble approach.
Curiac *et al.* (2009)	Psychiatric Diseases	Predicate the probability of a psychiatric patient on the basis detected symptoms using BBN Bayesian networks.
Ilayaraja and Meyyappan (2013)	Frequent Disease	Identify frequency of diseases in particular geographical area using Apriori algorithm.
Jeong-Yon Shim and Lei Xu (2003)	Liver Diseases	Classification using Bayesian Ying Yang (BYY).
Chang and Chen (2009)	Skin Disease	Categorization of skin disease using integrated tree model with neural network classification methods.
Markus and Wolfgang (2001)	Diabetes	Classification of Medical Data using Genetic Algorithm.
Barnathan *et al.* (2008)	Functional Magnetic Resonance Imaging (fMRI)	Integration of Clustering and Classification of biomedical databases
Er O. *et al.* (2010)	Chest Disease	Constructed a model using Artificial Neural Network
Ping-Hung Tang and, Ming- Tseng (2009)	Diabetes, Cancer	Classification of Disease using k-Nearest Neighbour

Weimin *et al*. (2006)	Coronary Heart Disease	Improving classification accuracy using Naive
Sarojini and Ramaraj (2009)	Diabetes	Disease classification using Support Vector Machine
Syed and Brijesh (2007)	Breast Cancer	Accurate Classification of medical data using K- Self- Organizing Map (SOM) and Naïve Bayes.
Tsang-Hsiang Cheng and Chih-Ping Wei and Vincent S. Tseng (2006)	Cardio Vascular Diseases	Diagnose Cardio Vascular Disease using Classification
Zuoa *et al*. (2013)	Parkinson Disease	Familiarized an adaptive Fuzzy K-NN approach for diagnosing the disease

Healthcare data mining can be limited by the accessibility of data, because the raw inputs for data mining often exist in different settings and systems such as administration, clinics, laboratories and more (Benko and Wilson, 2003). Hence, the data have to be collected and integrated before data mining can be done. Several authors and researchers have suggested that a data warehouse be built before data mining is attempted. That can be costly and time-consuming. Other data problems may arise which include missing, corrupted, inconsistent or non-standardized data such as pieces of information recorded in different formats in different data sources. In particular, the lack of a standard clinical vocabulary is a serious hindrance to data mining applications. There may be ethical, legal and social issues, such as data ownership and privacy issues, related to healthcare data. The successful application of data mining requires knowledge of the domain areas as well as in data mining methodology and tools. Without a sufficient knowledge of data mining, the user may not be aware or be able to avoid the pitfalls of data mining (Salim *et al*., 2013).

This study was done taking all the above limitations into consideration. Association rule technique was used to enable administrators, health care providers and the masses

to uncover hidden data in large data sets. For example one can associate diabetes from the records in the database, the area where it is most prevalent and what caused it to be prevalent in that area. In emergency situations, the patients' fingerprint will be used to retrieve the patient's records from the integrated database. Mobile phone can also be used to access information of patients from the integrated database which helps to retrieve information easily and faster, thereby improving service delivery and saving a lot of lives especially in emergency situations.

CHAPTER THREE

METHODOLOGY AND SYSTEM ANALYSIS

3.1   Methodology Adopted

Object-oriented analysis and design methodology (OOADM) was adopted in this dissertation, and it is a set of standards for system analysis and application design. It uses a formal methodical approach to the analysis and design of information system. Object-oriented design (OOD) elaborates the analysis models to produce implementation specifications.

The OOADM approach is motivated by the kind of system desired to be developed. It is our desire to build a usable and evolvable application. The very nature of the proposed system, in which navigation is combined with the inherent difficulties of dealing with multimedia data, needs an OOADM approach. The interface of Web apps is more complex than in traditional software systems, navigation and functionality should be seamlessly integrated and the navigational structure should be decoupled from the domain model of the app, therefore OOADM was chosen for its functionalities, in that it allows object oriented abstractions for analysis and design of information-intensive web applications. Besides the modeling abstractions, it also provides a methodology which guides a developer through different activities in the web application development.

Unlike Structured System Analysis and Design Methodology (SSADM), the object-oriented approach combines data and processes (termed methods) into single entities termed objects. Object usually corresponds to the real things a system deals with, such as customers, suppliers, contracts and invoices. These models Object-Oriented Analysis and Design Methodology (OOADM) are able to thoroughly represent complex relationships to represent data and data processing with a reliable notation that allows an easier mix of analysis and design in a growth process. The aim of the approach Object-Oriented Analysis and Design Methodology (OOADM) is to make system elements more modular, thus improving system quality and efficiency of systems analysis and design. The focus on this model is tends more towards the behavior of the system and the main feature documented here is the class and object.

This model makes use of six attributes: class, object, state transition, interaction, module, and process. Object Oriented Programming (OOP) enables one to consider a real life entity as an object. Object oriented analysis and design methodology promotes better understanding of requirements, clearer designs and more maintainable systems. An Object Oriented Analysis and Design Methodology (OOADM) can be used to analyze problem requirements, design a solution to the problem and implement a solution in a programming language or database.

The choice of programming language used in this work is My PHP. PHP has a lot of advantages. It does not use a lot of the systems resources so it runs faster and does not tend to slow other processes down. It is typically used as an Apache module, written in C, so it loads and executes quickly. It works well with other software and is quite fast. PHP is also fairly stable and since it is open source, the PHP community works together to fix any bugs. The community offers technical support and continuously updates the code further expanding PHPs capabilities. Also, PHP offers many levels of security to prevent malicious attacks. These security levels can be adjusted in the file.

The primary tasks in object-oriented analysis (OOA) are:

a   Find the objects

b   Organize the objects

c   Describe how the objects interact

d   Define the behaviour of the objects

e   Define the internals of the objects

Common models used in OOA are use cases and object models. Use cases describe scenarios for standard domain functions that the system must accomplish. Object models describe the names, class relations (example Circle is a subclass of Shape), operations, and properties of the main objects.

3.2   Analysis of the Existing System

The current system is partially automated; the patient's admission records are automated. Once a patient obtains the hospital card, the record is entered into the computer which helps to maintain a database of all the patients that visited the hospital for medical treatment. Other departments keep manual records, as every transaction of these units is hand-written. The medical bills of patients are prepared in the same manual form, which will later be transferred to the receptionist who operates a standalone mode of computer processing. So much time is wasted in carrying out these responsibilities on physical recording medium and there is every good reason that some data will be lost on transit. The existing system that is partially automated is not network based. The records reside in the computer at the admin unit. All information required by doctors, nurses, or hospital administrators must be obtained directly from the admin personnel in charge of the system. This means that information is not automatically shared among the users of the system electronically. Information needed concerning the patients must be obtained at a central place where the computer is kept.

In the existing systems, once there is an emergency, the process of treatment usually begins with the patient's relatives being given a form to fill in the hospital in order to get the patient's bio data, which will be documented. Then there will be diagnostic activities in which the patient's blood sample will be taken for test. The result of the test will then be used to determine the treatment to be given to the patient.

The existing system uses the clinical treatment process model as described by J. M. Wehlou (Wehlou, 2014) includes a patient's history assessment, diagnostic activities, actual treatment, and patient's condition follow-up. The patient history assessment has the past and active problems of patients, family history and social history, the diagnosis involves functional assessment, review of systems, laboratory tests, radiology exams, the treatments takes care of conservative and intervention/surgery while follow up involves clinical examinations.

3.2.1 Data Flow Diagram of the Existing System

Figure 3.1 describes the use of a patient's record in a health sector setting that is not fully automated.
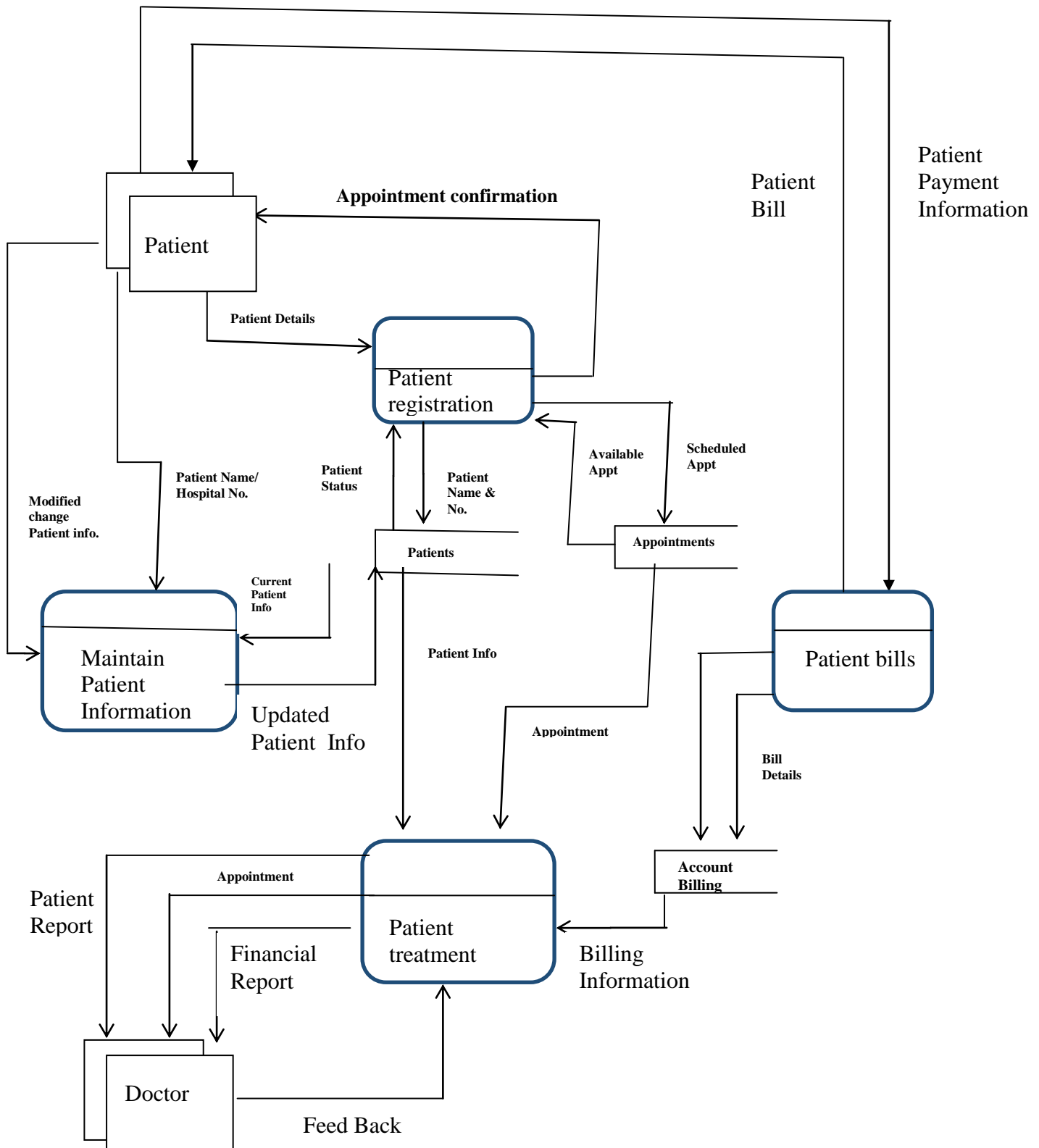
Figure 3.1: Data Flow Diagram of the Existing System

It shows the flow of information from the point of patient's visit till the physician has attended to him/her. The processes are partially automated as some of the computerization makes use of a Stand-alone system.

There are four process management modules of Appointment, Patient information maintenance, Management reports, and Billing management which is executed by the System Administrator. The patient detail or bio-data is captured; appointments determined by the patients' health status are scheduled or modified based on available chances. The patient information management has patient name, hospital number and modified or change of a patient's information which are kept in the patients' data store as updated, which at the same time maintains current information about a patient. To prepare the management reports of consultation, diagnosis, treatment, and drug prescription/ issuance; and finances or service costs, the patient information, appointments, and billing information are required by the Hospital, who equally returns the updated reports back to the process module.

3.2.2   Advantages of the Present System

The existing system has the following advantages:

i   It provides an electronic records of patients which assist physicians to easily retrieve previous medical records of patients within the same hospital

ii   It enables data sharing to some extent among health care team within a given hospital.

3.2.3   Disadvantages of the Present System

This model needs an integrated health database from which to access the past and active problems of patients, family history, social history, then do diagnosis on the assessments and treat the patient but it cannot extract hidden information concerning the patient or the hospital. In case of emergency and in the absence of an integrated health database, the patient will lose his or her life because of delay in the retrieval of the patient's pertinent history and medical records. The existing method has the following challenges:

i   Extraction and retrieval of document freely without involving mobile device lacking thereby resulting in delay in documents retrieval

ii   There is the absence of data integration in the existing system.

iii   The existing system does not have provision for data sharing globally or intra hospitals.

3.3 Analysis of the New System

Data mining aims at discovering novel, interesting and useful knowledge from databases. Nowadays, many organizations including modern hospitals are capable of generating and collecting a huge amount of data. This explosive growth of data requires an automated way to extract useful knowledge. Thus, the development of this system will help in the medical domain. The proposed system model has records in distributed databases from different hospitals, in this research work we made use of records from three different hospitals because of time constraint, which are integrated and stored in an integrated database using SQL server and centralized emergency healthcare provision software with data mining features. The information is now retrieved using the patient's identity number. In the case of emergency, for example when the patient is unconscious the patient's bio data can be retrieved using biometric technology (fingerprint). The association rule technique was used to uncover the relationships among data. This will help to know the type of disease that is most prevalent in a particular state, the diagnosis and the treatment given to the patient before thereby helping the Government, the hospital administration and the masses to know the measures to take to prevent the occurrence of the disease and also help in the efficiency and effectiveness of the hospital administration .This will also help in saving lives of patients and also prevents outbreak of various diseases. Also the use of mobile phone and biometric technology will help to retrieve the information about a patient very fast thereby preventing a lot of delays when attending to a patient during emergency.

During emergency, records of patient previous diagnosis and treatment are taken from three different hospitals, hospital A, B and C. In this research data records were taken from Owerri, Enugu and Nnewi. The data collected from the different hospitals are then pre-processed by eliminating any noisy data, handling of missing data and resolving any inconsistencies in the data record. The various data that has been pre-processed are then integrated to get a unified view of the data and stored in the database. The data is then transformed into forms which are suitable for mining by applying a particular data mining technique. Here the association rule technique was applied to discover and uncover relationships amongst the different data collected

Shared emergency data of patients contained in a local database are taken from each hospital collaborating with others in the Efficient Healthcare Emergency model, pre processed then integrated to form an integrated database which is put to use when an emergency occurs. Any hospital seeking an emergency information passes their request via the patient's identity number to the Efficient Healthcare Emergency System via the data communication network. The Emergency System responds by retrieving the information of the patient from the database, then mine the data using data mining technique. The retrieved information is then communicated back to the source of each request via the data communication network again using the patient's identity number.

3.3.1 Data Flow Diagram of the New System

The data flow of the new system model (Figure 3.2) has records in distributed databases from different hospitals.
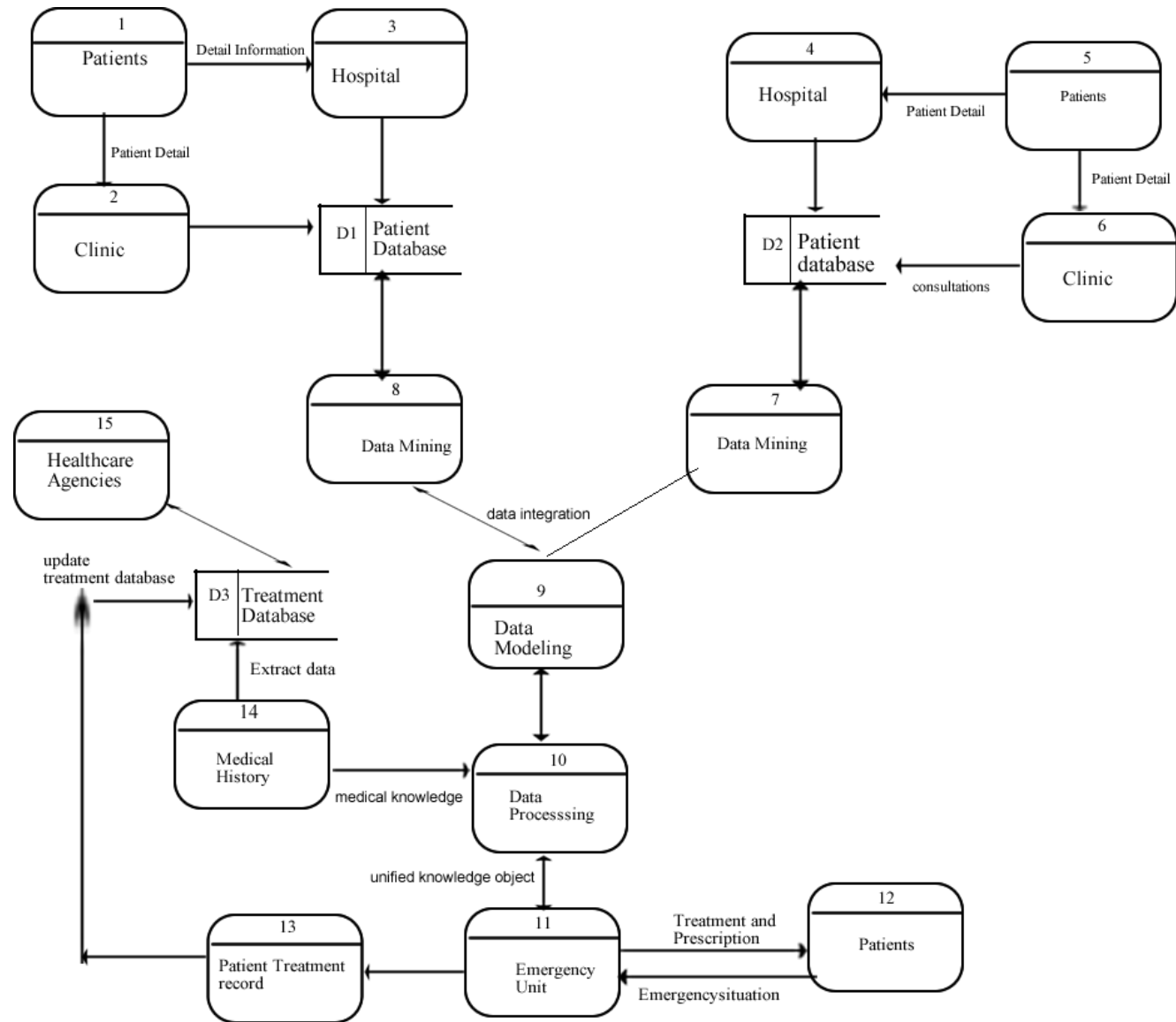
Figure 3.2: Data Flow of the New System

This model made use of records from different hospitals and clinics, which maintains decentralized database using SQL server and centralized emergency healthcare provision software with data mining features that can extract records from different database locations. The information is now retrieved using the patient's identity number or fingerprint. In the case of emergency, for example when the patient is

unconscious the patient's bio data can be retrieved using biometric technology (fingerprint). The association rule technique was used to uncover the relationships among data. From the model developed, it can be seen that each hospital or clinic maintains an electronic record of patient's information. That is to show that a decentralized server is being operated by various health centers with a link to the emergency healthcare system developed. The system is deployed in the emergency unit of various hospitals and clinics. Once an emergency case occurs, they can quickly use the patient's ID or fingerprint to query the system for his/her medical history. The system uses data mining technique to search for related records and integrate the records in order to present a medical report of the patient to the doctors at the emergency unit.

3.3.2   Advantages of the New System

i   The system captures patients' initials at the registration centers that can be used by all departments of the hospital. The registration information shall include his/her fingerprint, blood group, drug allergies, genotype, age and some other medical history.

ii   The system generates patient's identity number automatically.

iii   The system identifies patient's medical history which can be of great assistance in cases of emergency.

iv   The system makes use of biometric technology which can be used in case of emergency for example when a patient is unconscious.

v   The system adopts data mining technique which can be used to retrieve hidden information from the database.

vi   Mobile phone will be used to access information from the database for fast retrieval during emergency using the patient's id number.

3.3.3   Justification of the New System

The new system was introduced to solve problems of the existing manual systems and Electronic Medical Records (EMR). The efficient emergency healthcare management model using integrated database and data mining techniques has many advantages over the manual system and electronic medical record. This can be explained as follow:

i The major benefit of this work is that it will help the staff to accomplish their daily functions more efficiently.

ii Quick access and speed to the required information as it is only one click away.

iii It solves the problem of time consumption, hence patients are treated on time.

iv It will save lots of lives of patients

v It also enhances security as access to the system requires authentication. This means that only authorized users can access that system.

3.4   Use Case Diagram of the New System

The model designed in this dissertation is divided into several modules that needs access restrictions. Different use cases were described in the way they were applicable in the software designed. Use cases are as listed in Figure 3.3 and details provided in Tables 3.1 and 3.2.
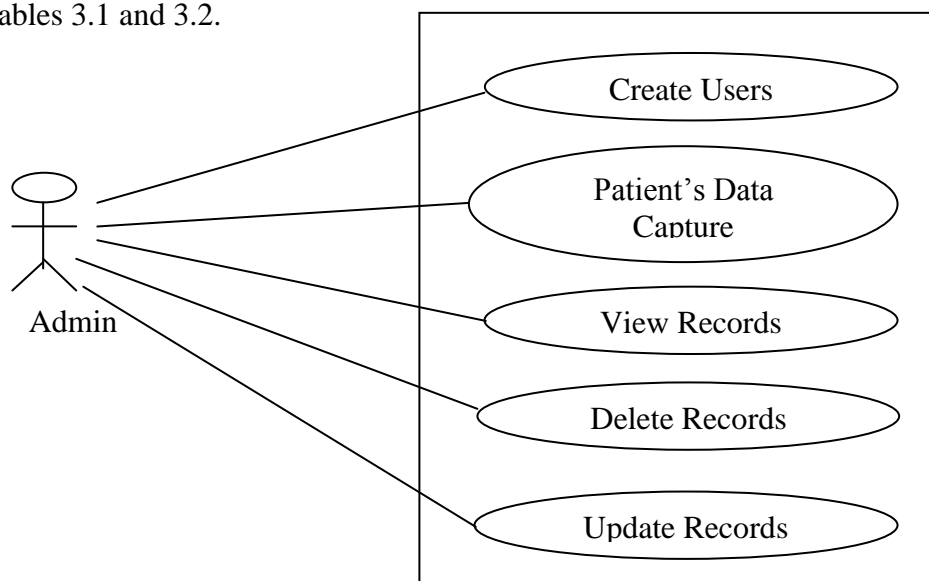
Figure 3.3: Admin use case diagram

Table 3.1 – Administrator Module Actor Description

Actor	Description
Administrator:	This is the system administrator who is super user of the system and is responsible for assigning users to different modules of the system.

Table 3.2 – Administrator Module Use Case Description

Use Case	Description
Create User:	The admin creates user for various hospitals by filling in hospital required details and after which assign roles to the user.
Update Users:	This involves resetting of users and reassigning roles to users.
Delete User:	This involves resetting of users by deactivation of users or removal of user.
Patients Data Capture:	The admin captures the patient data including the picture and biometric.
View Records	The admin views all the records in the database.

Figure 3.4 is the use case diagram for hospitals. Table 3.3 and 3.4 provides details of the use cases.
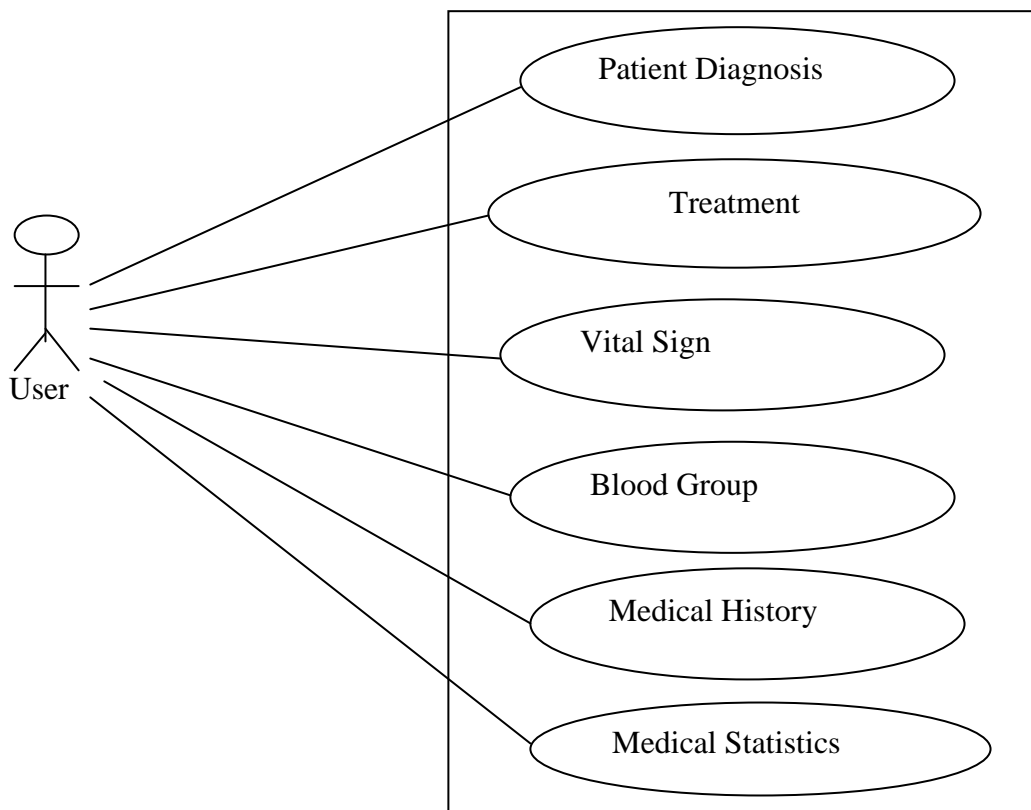
Figure 3.4: Hospital use case diagram

Table 3.3 – User Module Actor Description

Actor	Description
Hospital:	A hospital staff who has the right to use the system and has certain privileges or functions assigned to him by the administrator.

Table 3.4 – User Module Use Case Description

Use Case	Description
Patient Diagnosis:	The user enters the diagnosis result of the patient into the system.
Treatment:	This involves recording patient's treatment in the database.
Vital Sign:	This involves capturing patient's vital signs and record on the system
Blood Group:	The hospital uses this module to match the blood group of the patient
Medical History:	The hospital uses this module to extract the patient's medical records applying data mining
Statistical Report:	The hospital uses this module to group various treatment undertaken in various hospitals

3.5   Main Menu

The main menu controls access to other sub systems in the program design due to the fact that the database has multi access levels. To be very secure, the first page welcomes the user, and then a password is required to log on an authorized user into the site. The Administrator is the only person that has the right to assign user name and password to registered hospitals.

3.6   High Level Model of the New System

The high level model of the proposed system is shown in Figure 3.5 and applied association rule technique for data retrieval. There are two levels of access; the hospitals and the administrator. The high level model shows the sub systems under each of the users.
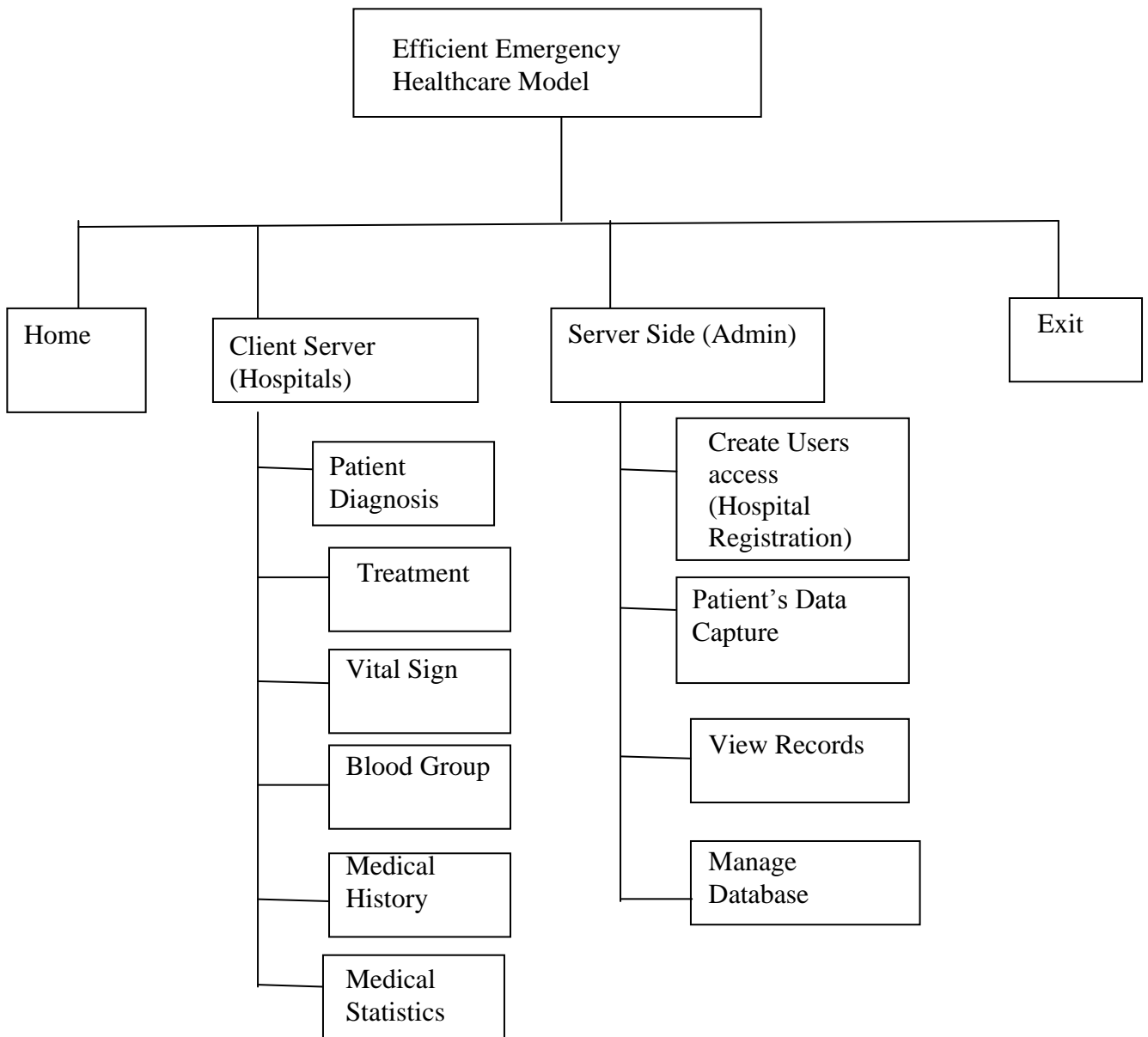
Figure 3.5: High Level Model of the System

CHAPTER FOUR

SYSTEM DESIGN AND IMPLEMENTATION

4.1   Objectives of the Design

The system use modern information technology to create a multi access platform for an integrated healthcare management information system using data mining technique to retrieve patient's medical history from different database. The objectives of the design include:

i   To develop patient registry that consists of the concepts of the domain, the attributes characterizing each patient's data, the allergies, and medical treatments history

ii   To use data mining technique to extract patients medical records in various hospitals

iii   To design a platform for Data Access – Connect to different data sources and make them accessible from a common logical data access point

iv   To enable online verification of patient's username, password and photo by hospital administrators and use it as a key to retrieve his/her past medical records

v   To integrate patients medical records and make it accessible from any healthcare center across Nigeria

4.2   Decomposition and Cohesion of the High Level Model

4.2.1   Control Centre/Main Menu

The main menu (Figure 4.1) contains the server side used by the system administrator, the client side used by hospitals, clinics and health facilities, and also the home page from where access to other subsystems can be granted.

```
                        ┌─────────────────────────┐
                        │        Main Menu        │
                        └─────────────────────────┘
                                     │
          ┌──────────────────────────┼──────────────────────────┐
┌─────────────────────┐   ┌─────────────────────┐   ┌─────────────────────┐
│ Client Side /Hospitals │ │ Server Side / Sys Admin │ │        Home        │
└─────────────────────┘   └─────────────────────┘   └─────────────────────┘
```
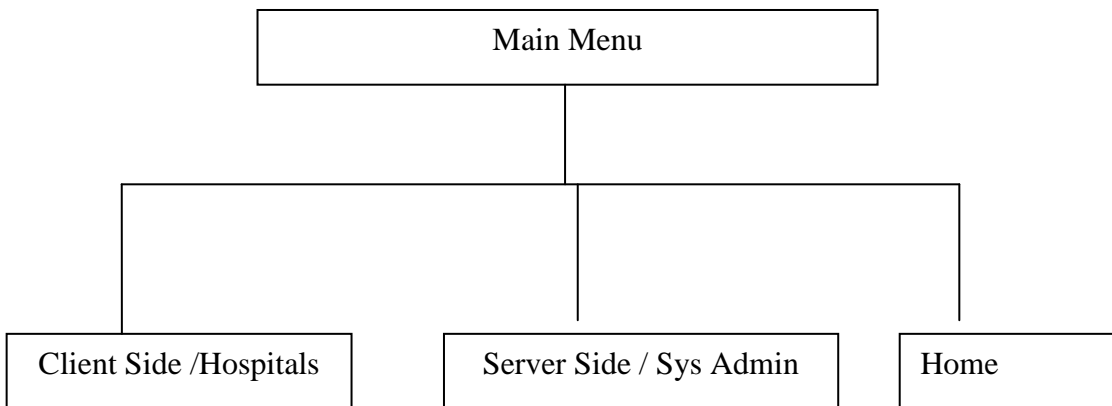
Figure 4.1: Main menu of the new system

4.2.2   The Submenus/Subsystems

Top-Down Approach was applied in the design of the hybrid model for efficient emergency healthcare system. The system is structured in a way that each subsystem is accessed from the main menu and executed independently. The sub menus / sub systems are as follows:

4.2.2.1 Home Sub System

Figure 4.2 shows the content of the home page. It basically contains the login links for different users of the system developed. It has other links like about us which contains information about the software developer and the exit button.

```
                 ┌─────────────────────┐
                 │        Home         │
                 └─────────────────────┘
                           │
                           │   ┌─────────────────────┐
                           ├───│    Admin Login      │
                           │   └─────────────────────┘
                           │
                           │   ┌─────────────────────┐
                           ├───│     Hospital        │
                           │   │     Login           │
                           │   └─────────────────────┘
                           │
                           │   ┌─────────────────────┐
                           ├───│     About us        │
                           │   └─────────────────────┘
                           │
                           │   ┌─────────────────────┐
                           ├───│       Help          │
                           │   └─────────────────────┘
                           │
```
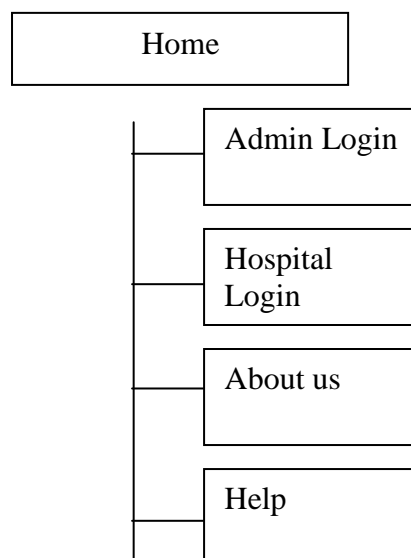
Figure 4.2: Home Sub system

4.2.2.2   Server Side / Admin Sub System

The admin sub system (Figure 4.3) is accessible by system administrator and can perform functions ranging from creating password for various hospitals, deleting and changing passwords, creating patients record, view registered patients from different hospitals, deleting patient's record and managing users access.
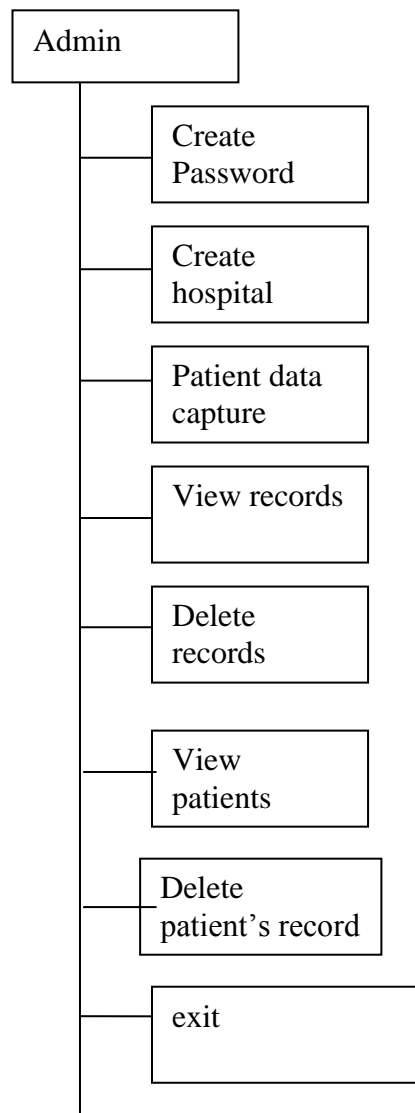
Figure 4.3: Admin sub system

4.2.2.3   Client Side / Hospitals Sub System

The subsystem (Figure 4.4) is used by hospitals, clinics, health centers to manage patient's diagnosis and treatment. They can identify patients, view medical history, treatment patients, send sms alert to patients, and view statistical report.

```
┌──────────────┐
│  Hospitals   │
└──────┬───────┘
       │   ┌──────────────┐
       ├───│  Diagnose    │
       │   │  patient     │
       │   └──────────────┘
       │   ┌──────────────┐
       ├───│  Capture     │
       │   │  Vital Sign  │
       │   └──────────────┘
       │   ┌──────────────┐
       ├───│  Blood group │
       │   │  matching    │
       │   └──────────────┘
       │   ┌──────────────┐
       ├───│  Patient     │
       │   │  treatment   │
       │   └──────────────┘
       │   ┌──────────────┐
       ├───│  Send alert  │
       │   │              │
       │   └──────────────┘
       │   ┌──────────────┐
       ├───│  View        │
       │   │  patients    │
       │   └──────────────┘
       │   ┌──────────────┐
       ├───│  View medical│
       │   │  history     │
       │   └──────────────┘
       │   ┌──────────────┐
       └───│ Statistical  │
           │ report       │
           └──────────────┘
```
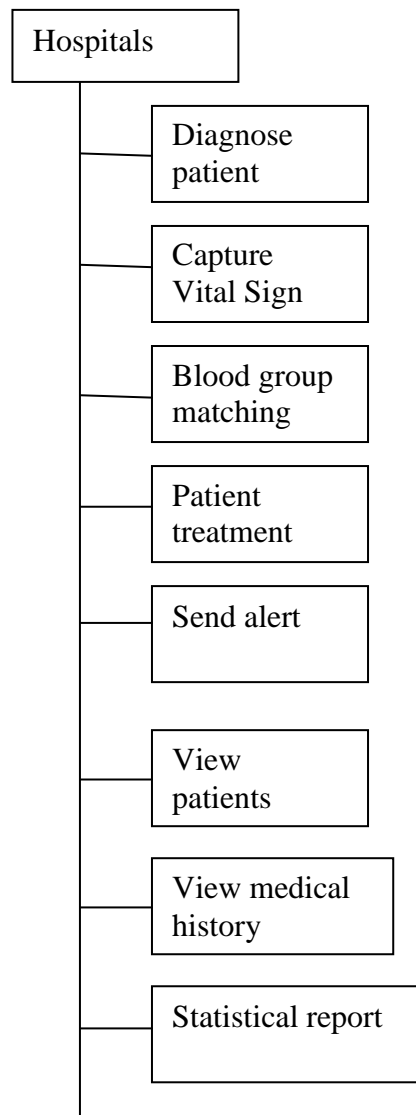
Figure 4.4: Client side / Hospitals sub system

4.3   Specifications

4.3.1 Database Development Tool

A relational database design was used to design the database. A relational database management system (RDBMS) is an excellent tool for organizing large amount of data and defining the relationship between the datasets in a consistent and understandable way. A RDBMS provides a structure which is flexible enough to accommodate almost any kind of data. Relationships between the tables were defined by creating special columns (keys), which contain the same set of values in each table. The tables can be joined in different combinations to extract the needed data. A RDBMS also offered flexibility that enabled redesign and regeneration of reports from the database without need to re-enter the data. Data dictionaries were used to

provide definitions of the data used; these included the final data structures for the various tables and their corresponding data fields, description and sizes. The user application programs and interface were developed using PHP with support of structured query language (SQL) and MySQL Database.

SQL is a language used to create, manipulate, examine and manage relational databases. SQL was standardized in 1992 so that a program could communicate with most database systems without having to change the SQL commands. Unfortunately one must connect to the database before sending SQL commands and each database vendor has a different interface as well as different extensions of SQL. Though SQL is well suited for manipulating database, it is unsuitable as a general application language and programmers use it primarily as a means of communicating with databases, another language is needed to feed SQL statements to a database and process results for visual display or report generation. The advantage of PHP is that you can run their programs on any enabled platform without even recompiling the program.

4.3.2   Database Design and Structure

A database consists of collection of tables with data and other objects such as views, indexes, stored procedures and triggers. Creation of a database involves determining the name of the database, and the tables used to store data in that database. In Tables 4.1-4.6, data types, and data sizes were used in the design of the databases using MySQL database. The structure of the tables in the database includes:

a   tbldiagnosis

b   tblhospital

c   tblmembers

d   tblsign

e   tbltreatment

f   tblusers

Table 4.1: Diagnosis Database Structure

Field	Data Type(Size)	Description
Cardno	Varchar(15)	This is card number of patient
Name	varchar(50)	This is name of patient
Diagnosis	varchar(2000)	This is patient's diagnosis
Prescription	varchar(2000)	This is prescription given to the patient
Dateconsulted	Date	This is date of consultation of the patient
Doctor	varchar(50)	This is the doctor in charge
Hospital	varchar(150)	This is name of the hospital
Snum	int(5)	This is the serial number

Table 4.2: Registered Hospitals Database Structure

Field	Data Type(size)	Description
Snum	int(5)	This is the Serial Number
Hospital	varchar(200)	This is the name of hospital
Address	varchar(200)	This is the hospital Address
State	varchar(200)	This is state where the hospital is located
Username	varchar(50)	This is theUser Name
Password	varchar(20)	This is the Password
Datereg	Date	This is the date Registered
Timereg	varchar(20)	Time registered

Table 4.3: Patient's Vital Database Structure

Field	DataType (size)	Description
Cardno	varchar(15)	This is the Card Number of patient
Name	varchar(50)	This is the name of Patient
Dateconsulted	Date	This is date of Consultation
Timeconsulted	varchar(20)	This is time of Consultation
Temperature	varchar(40)	This is the temperature of Patient
Pulse	varchar(40)	This is the pulse of Patient
Bloodpressure	varchar(40)	This is the blood pressure of patient
Respiration	varchar(40)	This is the respiration of patient
Weight	varchar(40)	This is the weight of patient
Takenby	varchar(50)	This is the name of the nurse or doctor that took the vital sign
Hospital	varchar(150)	This is the hospital name
Snum	int(5)	This is the serial number

Table 4.4: Patient's Registration Database Structure

Field	DataType(size)	Description
FirstName	varchar(15)	This is the first name of patient
MiddleName	varchar(15)	This is the middle name of patient
Surname	varchar(15)	This is surname of patient
Designation	varchar(30)	This is the designation of patient
Occupation	varchar(30)	This is the occupation of patient
State	varchar(10)	This is the patient's state of origin
DOB	Date	This is the patient's date of birth
Sex	varchar(8)	This is the patient's sex
Mstatus	varchar(10)	This is the marital status of patient
Age	int(3)	This is patient's Age
BloodGroup	varchar(4)	This is the patient's blood group
NationalID	varchar(15)	This is the patient's national ID number
Phone	varchar(15)	This is the phone number of patient
Address	varchar(150)	This is the address of patient
Gl	varchar(10)	This is the grade level of patient
StP	varchar(10)	This is the step level of patient
Ename	varchar(60)	This is the name of employer
Location	varchar(70)	This is the location of the employer
Pname	varchar(50)	This is the health Provider Name
Genotype	varchar(50)	This is the genotype of Patient
Medical	varchar(100)	This is the medical history of patient
Sname	varchar(30)	This is the name of Spouse
Ssex	varchar(8)	This is the sex of Spouse
SBG	varchar(4)	Spouse Blood group
SDOB	Date	Spouse date of birth

C1Name	varchar(30)	Name of first Child
C1Sex	varchar(8)	This is the sex of the first child
C1BG	varchar(4)	This is the blood group of first child
C1DOB	Date	This is date of birth of first child
C2Name	varchar(30)	This is name of second child
C2Sex	varchar(8)	This is sex of second child
C2BG	varchar(4)	This is blood group of second child
C2DOB	Date	This is date of birth of second child
C3Name	varchar(30)	This is name of third child
C3Sex	varchar(8)	This is sex of third child
C3BG	varchar(4)	This is blood group of third child
C3DOB	Date	This is date of birth of third child
C4Name	varchar(30)	This is the name of fourth child
C4Sex	varchar(8)	This is sex of fourth child
C4BG	varchar(4)	This is blood group of fourth child
C4DOB	Date	This is date of birth of fourth child
Epic	varchar(100)	This is picture of patient
EID	varchar(20)	This is patient's ID number

Table 4.5: Patient's Medical Treatment Database Structure

Field	DataType (size)	Description
Cardno	varchar(15)	This is card number of patient
Name	varchar(50)	This is name of patient
Treatment	varchar(1000)	This is treatment given to the patient
Timeconsulted	varchar(40)	This is time of consultation
Dateconsulted	Date	This is date of consultation
Nurse	varchar(50)	This is nurse in charge
Hospital	varchar(150)	This is name of the hospital
Snum	int(5)	This is the serial number

Table 4.6: Admin User Database Structure

Field	Data Type (size)	Description
Name	varchar(30)	This is the name of the Administrator
Address	varchar(250)	This is the Administrator's Address
Phone	varchar(30)	This is Phone number of Administrator
Email	varchar(100)	This is the Email of Administrator
Username	varchar(30)	This is the User Name
Password	varchar(15)	This is the Password
Userrole	varchar(30)	This is the role of the Administrator
Datereg	Date	This is the date of Registration
Timereg	varchar(20)	This is time of Registration
Snum	int(5)	This is the serial Number

4.3.3   Program Module Specification

The program was designed using Top – Down Approach. It makes use of the fundamental program solving techniques. The software is structured in such a way that each subsystem is selected and executed independently. The task is divided into several modules, which come together to give the solution to the problem. The modules are as follows:

Patient's Registration Module Specification

The patient's registration module form (Figure 4.5) requires capturing the patient's bio data, allergy, genotype, and blood group. The module specification includes:

Patient's Registration Form

Name | Address | ID No | Sex | Date of Birth | Medical History | Allergy | Genotype | Blood group
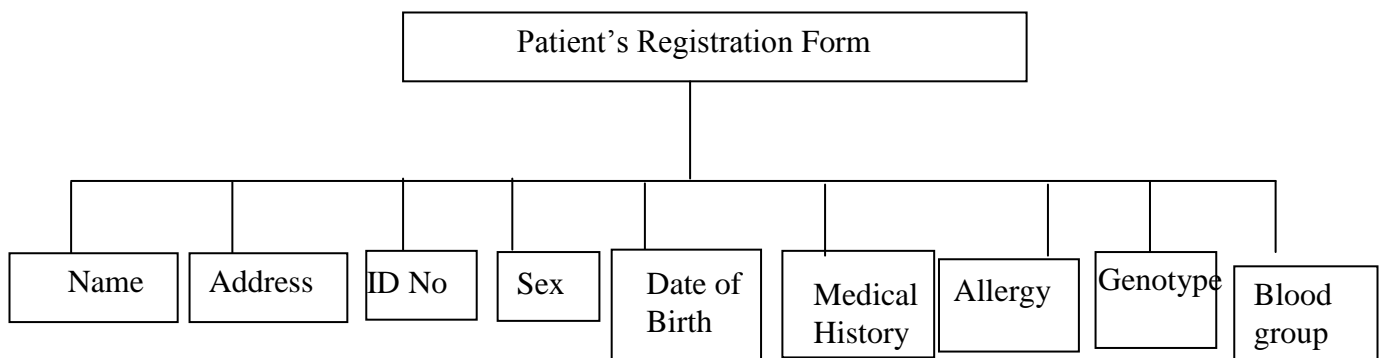
Figure 4.5: Patient Registration form

Hospital Registration Module Specification

The hospital registration module specification(Figure 4.6) captures the hospital a patient registered, the address, state, user name, password, date and time.

Hospital Registration Form

Hospital Name | Address | State | User Name | Password | Date Registered | Time
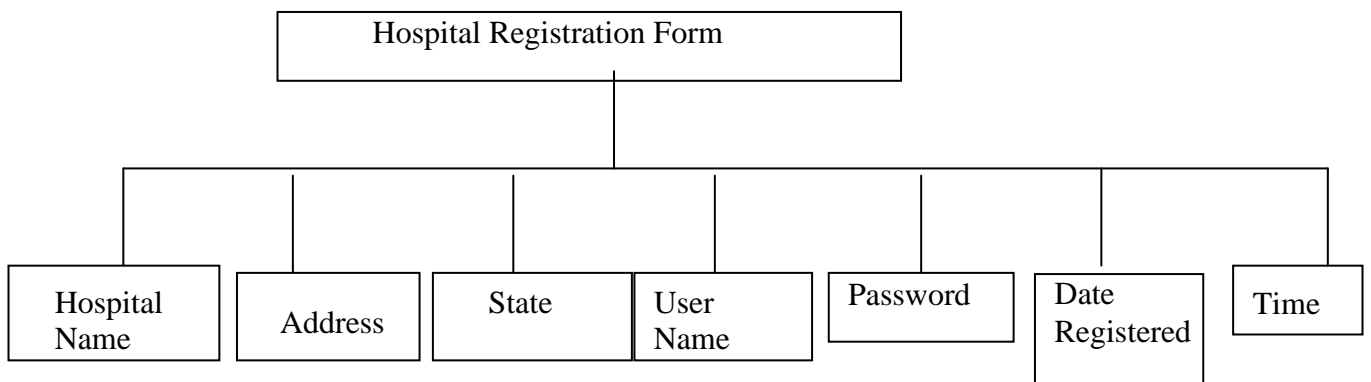
Figure 4.6: Hospital Registration Module Specification

View Patient Module Specification

This module is used to view all the patient's that their data has been captured in the system.

View Hospital Module Specification

The module displays all the registered hospitals.

Patient's Medical Diagnosis Module Specification

This module (Figure 4.7)   is designed to enable doctors enter patient's diagnosis into the system.

```
                    ┌─────────────────────────────┐
                    │  Patient's Medical Diagnosis │
                    └─────────────────────────────┘
```

┌──────────┐ ┌───────────┐ ┌──────────┐ ┌───────────┐ ┌───────────┐ ┌──────────────┐ ┌──────┐
│ Hospital │ │ Doctor in │ │ Name of │ │ Patient ID│ │ Diagnosis │ │ Prescription │ │ Date │
│   │ │ charge   │ │ Patient │ │   │ │   │ │   │ │   │
└──────────┘ └───────────┘ └──────────┘ └───────────┘ └───────────┘ └──────────────┘ └──────┘

Figure 4.7: Patient's Medical Diagnosis Module Specification

Patient's Vital Signs Module Specification

This module (Figure 4.8) is designed to enable doctors enter patient's vital signs into the system.

```
                        ┌──────────────────────────────┐
                        │  Patient's Vital Sign Module  │
                        └──────────────────────────────┘
                                      │
   ┌──────────┬──────────┬──────────┬─┴────────┬──────────────┬──────────┬──────────┐
┌────────┐ ┌─────────┐ ┌─────────┐ ┌────────┐ ┌────────────┐ ┌────────┐ ┌────────┐
│Hospital│ │Doctor in│ │Name of  │ │Patient │ │ Vital Signs│ │  Time  │ │  Date  │
│        │ │charge   │ │Patient  │ │ID      │ └────────────┘ └────────┘ └────────┘
└────────┘ └─────────┘ └─────────┘ └────────┘        │
                                            ┌────────────────┐
                                            │  Temperature   │
                                            └────────────────┘
                                                     │
                                            ┌────────────────┐
                                            │     Pulse      │
                                            └────────────────┘
                                                     │
                                            ┌────────────────┐
                                            │ Blood Pressure │
                                            └────────────────┘
                                                     │
                                            ┌────────────────┐
                                            │  Respiration   │
                                            └────────────────┘
                                                     │
                                            ┌────────────────┐
                                            │    Weight      │
                                            └────────────────┘
```
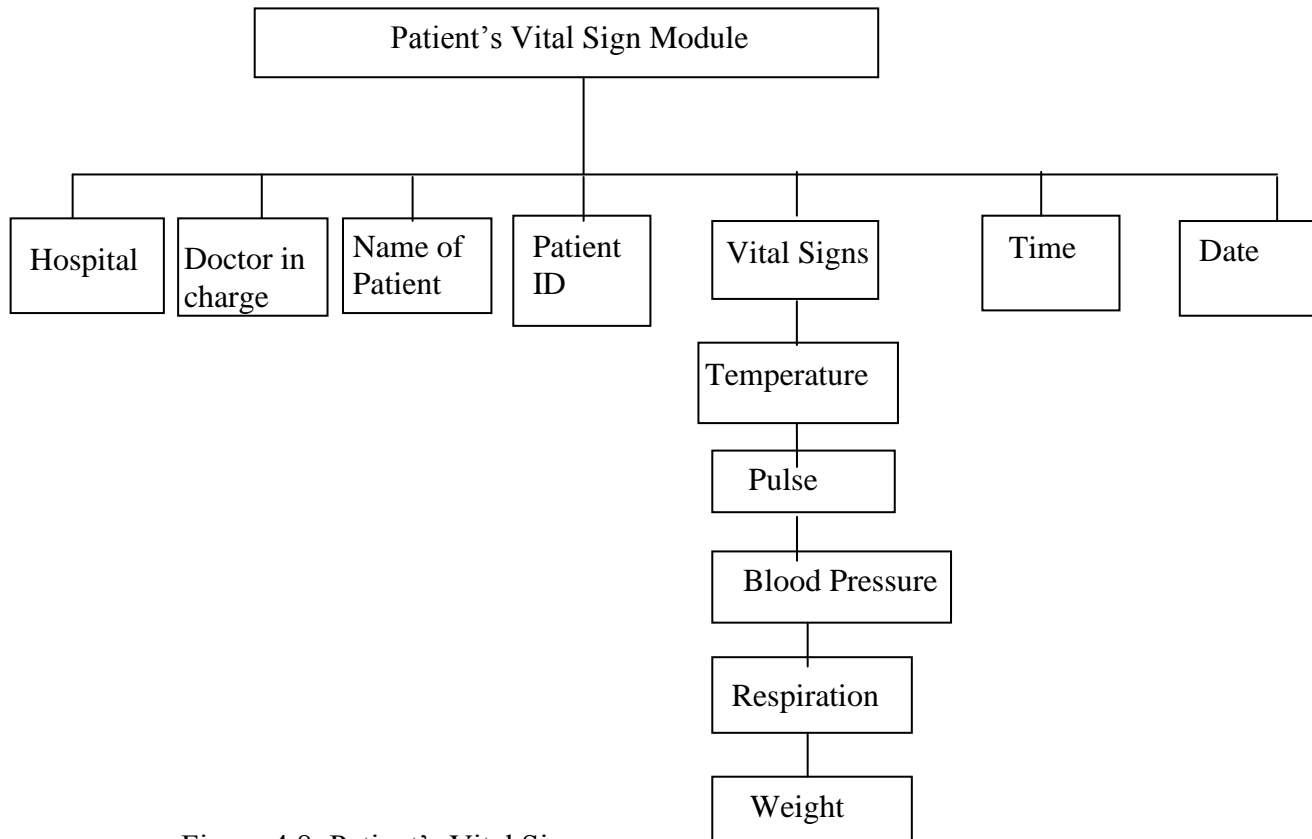
Figure 4.8: Patient's Vital Signs

 Module Specification

Patient Treatment Module Specification

This module (Figure 4.9) is designed to enable nurses enter patient's treatment into the system.

```
                     ┌────────────────────────────┐
                     │   Patient Treatment Module  │
                     └────────────────────────────┘
                                   │
   ┌──────────┬──────────┬─────────┼────────┬───────────┬──────────┬──────────┐
┌────────┐ ┌────────┐ ┌─────────┐ ┌────────┐ ┌──────────┐ ┌──────┐ ┌──────┐
│Hospital│ │Nurse in│ │Name of  │ │Patient │ │Treatment │ │ Time │ │ Date │
│        │ │Charge  │ │Patient  │ │ID      │ └──────────┘ └──────┘ └──────┘
└────────┘ └────────┘ └─────────┘ └────────┘
```

Figure 4.9: Patient Treatment Module Specification

Patient's Blood Group Module Specification

This module (Figure 4.10) is designed to enable hospitals check patient's blood group.
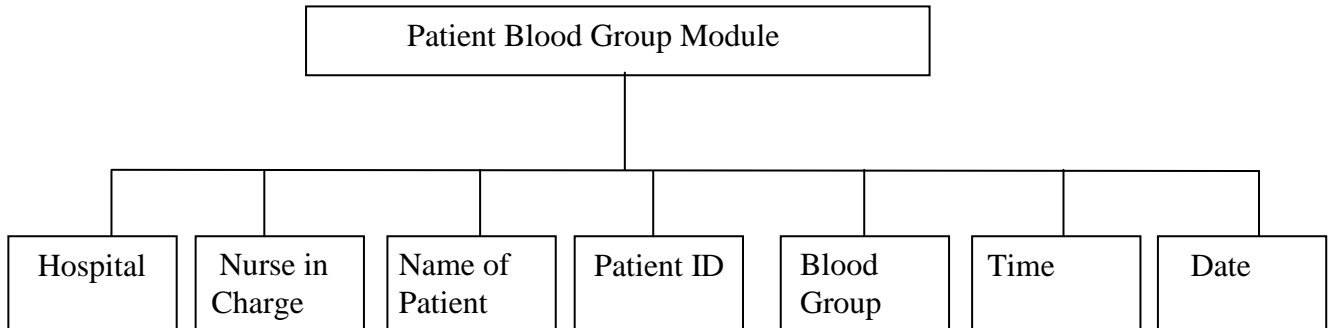
Figure 4.10: Patient's Blood Group Module Specification

Medical History Module Specification

This module makes use of data mining technique to retrieve patient's medical records in various hospitals across the country. The required input is either the patient's ID or Fingerprint.

Data Mining Module Specification

This module makes use of the association rule technique to enable Administrators, Health care providers and the masses to uncover hidden data in large data sets. For example you can associate diabetes, the state where it is most prevalent and what caused it to be prevalent in that area. The findings can help to advise the society on the diet to take to curtail the spread of the disease. Another example is associating cholera and the areas that have the disease, the findings can help the policy makers to provide facilities like pipe borne water to the area to be able to checkmate the spread of the disease. Association rule can also be used to associate the disease, malaria and the treatment that is most effective for patients; this will help to enhance the services of the healthcare providers.

Below is MySQL command that can be used to query the database using association rule data mining technique to extract information about the most prevalent disease and the state it is most prevalent.

SELECT   Disease, State

FROM Diseases, States

WHERE   Disease = (Select Prevalent (Disease) from Diseases)

                    State = (Select Prevalent (State) from States)

Statistics Module Specification

This module makes use of data mining technique to retrieve patient's medical records in various hospitals across the country and displays statistical analysis of the data.

Login Module Specification

This module is used to authenticate the user's password and access level before opening the platform for the user.

Fingerprint Capture Module Specification

This module (Figure 4.11) is used to capture fingerprint of the patient.
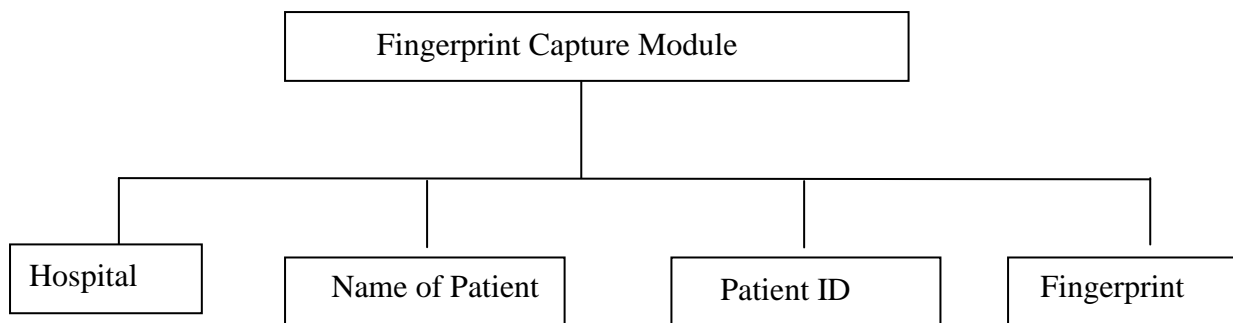
Figure 4.11: Fingerprint Capture Module Specification

Fingerprint Verification Module Specification

The module is used to capture fingerprint of registered Nigerians. The fingerprint captured can then be stored in the database for verification and identification purposes.

4.3.4 Input / Output Format

Hospital Registration Module

This module is used to register all the hospital and clinics to the healthcare management information system platform. Below are some of the required information needed about the hospital.

```
Hospital - - - - - - - - - - - - - -    - - - - - - - - - - - -
Address - - - - - - - - - - - - - -    - - - - - - - - - - - -
State- - - - - - - - - - - - - -    - - - - - - - - - - - -
User Name - - - - - - - - - - - - -    - - - - - - - - - - - -
Password - - - - - - - - - - - - -    - - - - - - - - - - - -
Date Registered - - - - - - - - - - - - -    - - - - - - - - - - - -
Time - - - - - - - - - - - - -    - - - - - - - - - - - -
```
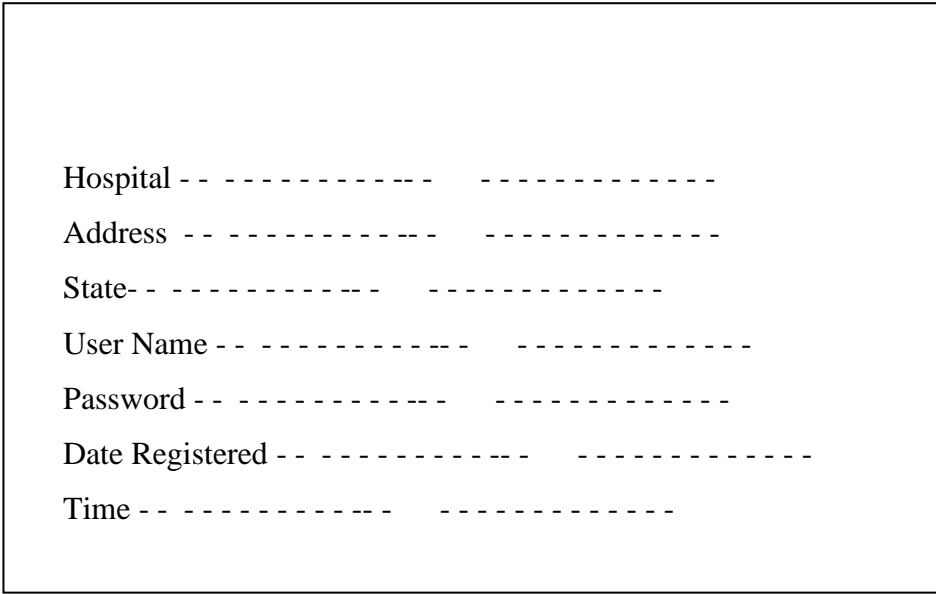
Figure 4.12: Hospital Registration Specifications

Patient's Registration Module

The patient's registration module requires capturing the patient's bio data, allergy, genotype, and blood group

FirstName - - - - - - - - - - - - - -   - - - - - - - - - - - - -

Midle Name - - - - - - - - - - - - - -   - - - - - - - - - - - -

Surname - - - - - - - - - - - - - -   - - - - - - - - - - - -

Designation - - - - - - - - - - - - -   - - - - - - - - - - - -

Occupation - - - - - - - - - - - - -   - - - - - - - - - - - -

State of Origin - - - - - - - - - - - - -   - - - - - - - - - - - -

DOB - - - - - - - - - - - - -   - - - - - - - - - - - -

Sex - - - - - - - - - - - - -   - - - - - - - - - - - -

Marital Status - - - - - - - - - - - - -   - - - - - - - - - - - -

Age - - - - - - - - - - - - -   - - - - - - - - - - - -

Blood Group - - - - - - - - - - - - -   - - - - - - - - - - - -

National ID No - - - - - - - - - - - - -   - - - - - - - - - - - -

Telephone No - - - - - - - - - - - - -   - - - - - - - - - - - -

Residential Address - - - - - - - - - - - - -   - - - - - - - - - - - -

Grade Level - - - - - - - - - - - - -   - - - - - - - - - - - -

Step - - - - - - - - - - - - -   - - - - - - - - - - - -

Employer - - - - - - - - - - - - -   - - - - - - - - - - - -

Healthcare Provider - - - - - - - - - - - - -   - - - - - - - - - - - -

Genotype - - - - - - - - - - - - -   - - - - - - - - - - - -

Medical History (Allergy) - - - - - - - - - - - - -   - - - - - - - - - - - -

Picture - - - - - - - - - - - - -   - - - - - - - - - - - -

Date Registered - - - - - - - - - - - - -   - - - - - - - - - - - -

Time - - - - - - - - - - - - -   - - - - - - - - - - - -

Figure 4.13: Patients Registration Form Specifications

Patient's Medical Diagnosis Module

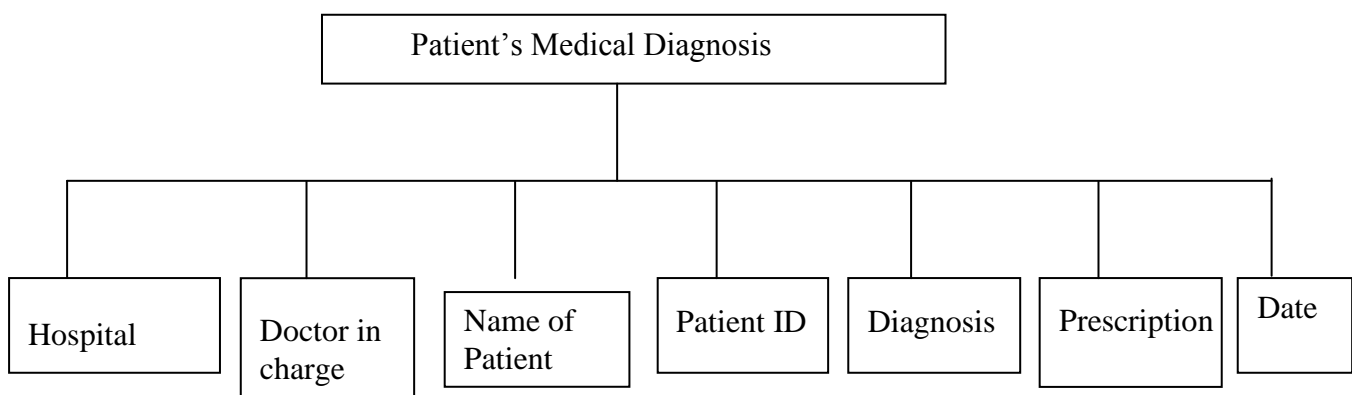This module is designed to enable doctors enter patient's diagnosis into the system.

Patient's Medical Diagnosis

Hospital - - - - - - - - - - - -- -   - - - - - - - - - - - -

Doctor in charge - - - - - - - - - - - -- -   - - - - - - - - - - - -

Name of Patient - - - - - - - - - - - -- -   - - - - - - - - - - - -

Patient ID - - - - - - - - - - - - -- -   - - - - - - - - - - - -

Diagnosis- - - - - - - - - - - - -- -   - - - - - - - - - - - -

Prescriptions - - - - - - - - - - - - -- -   - - - - - - - - - - - -

Date Consulted - - - - - - - - - - - - - --   - - - - - - - - - - - -

Figure 4.14: Patient's Medical Diagnosis Form Specification

Patient Treatment Module

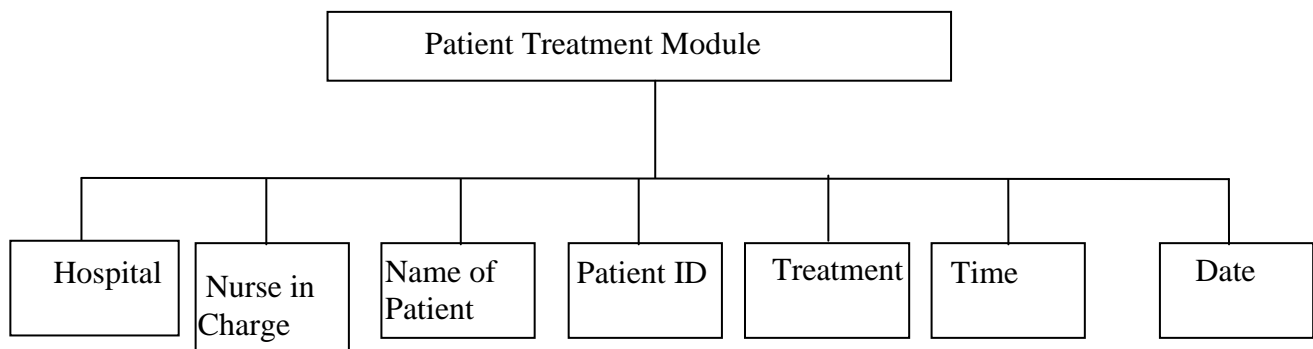This module is designed to enable nurses enter patient's treatment into the system.

Patient Treatment

Hospital - - - - - - - - - - - - -- -   - - - - - - - - - - - -
Nurse - - - - - - - - - - - - -- -   - - - - - - - - - - - -
Name of Patient - - - - - - - - - - - - -- -   - - - - - - - - - - - -
Patient ID - - - - - - - - - - - - - -- -   - - - - - - - - - - - -
Treatment- - - - - - - - - - - - - -- -   - - - - - - - - - - - -
Time - - - - - - - - - - - - - --   - - - - - - - - - - - -
Date Consulted - - - - - - - - - - - - -- -   - - - - - - - - - - - -

Figure 4.15: Patient's Treatment Form Specification

Patient's Vital Signs Module

This module is designed to enable doctors enter patient's vital signs into the system.

Patient's Vital Signs

Hospital - - - - - - - - - - - -- -   - - - - - - - - - - - -

Doctor in charge - - - - - - - - - - - -- -   - - - - - - - - - - - -

Name of Patient - - - - - - - - - - - -- -   - - - - - - - - - - - -

Patient ID - - - - - - - - - - - -- -   - - - - - - - - - - -

Temperature- - - - - - - - - - - - -- -   - - - - - - - - - - - -

Pulse - - - - - - - - - - - - -- -   - - - - - - - - - - - -

Blood Pressure- - - - - - - - - - - - -- -   - - - - - - - - - - - -

Respiration - - - - - - - - - - - - -- -   - - - - - - - - - - - -

Wight - - - - - - - - - - - -- -   - - - - - - - - - - - -

Time - - - - - - - - - - - - -- -   - - - - - - - - - - - -

Date Consulted - - - - - - - - - - - - -- -   - - - - - - - - - - - -

Figure 4.16: Patient's Vital Sign Form Specification

Patient's Blood Group Form Specification

This module is designed to enable hospitals check patients blood group.

Hospital - - - - - - - - - - - -- -   - - - - - - - - - - - -

Nurse - - - - - - - - - - - - -- -   - - - - - - - - - - - -

Name of Patient - - - - - - - - - - - -- -   - - - - - - - - - - - -

Patient ID - - - - - - - - - - - - -- -   - - - - - - - - - - - -

Blood Group- - - - - - - - - - - - -- -   - - - - - - - - - - - -

Time - - - - - - - - - - - - -- -   - - - - - - - - - - - -

Date Consulted - - - - - - - - - - - - -- -   - - - - - - - - - - - -

Fig 4.17: Patient's Blood Group Form

Login Module Design

This module is used to authenticate the user's password and access level before opening the platform for the user.

```
User Name - - - - - - - - - - - - -- -     - - - - - - - - - - - -
Password  - - - - - - - - - - - -- -    - - - - - - - - - - - -
```

Figure 4.18: Login Form Specification

Fingerprint Capture Module Specification

This module is used to capture fingerprint of the patient. The module specification includes:

```
Hospital - - - - - - - - - - - - -- -     - - - - - - - - - - - -
Name of Patient -  - - - - - - - - - - -- -     - - - - - - - - - - - - -
Patient ID - - - - - - - - - - - - -- -     - - - - - - - - - - - -
Fingerprint - - - - - - - - - - - - -- -     - - - - - - - - - - - -
```

Figure 4.19: Fingerprint Enrolment Form Specification

The module is used to capture fingerprint of registered Nigerians. The fingerprint captured can then be stored in the database for verification and identification purposes.

Data mining techniques was adopted in the querying of the database. Below are some of the reports formats designed in the new system.

Table 4.7: Patients Medical Diagnosis Report Module Specification

Patients Name	Hospital	Medical Diagnosis	Treatment	Doctor i/c	Date
Mark Okey	UNTH	Malaria	Lonart DS	Dr Ik	1/2/15
Mark Okey	Parklane	Typhoid	Ampiclus	Dr Uju	2/3/15

This report displays medical diagnosis in various hospitals for a selected patient.

Table 4.8: Patient's vital sign Report Specification

Patients Name	Hospital	Temp	Pulse	BP	Wight	Resp	Date
Mark Okey	UNTH	32.3	92	120/80	78kg	20	1/2/15
Mark Okey	Parklane	30.8	88	122/80	72kk	21	2/3/15

This report displays vital sign in various hospitals for a selected *patient*.

Table 4.9: Medical Treatment Report Specification

Patients Name	Hospital	Treatment	Nurse	Date	Time
Mark Okey	UNTH	Injection	Amaka	1/2/15	4pm
Mark Okey	UNTH	Injection	Mary	2/2/15	4pm

This report displays medical treatment in various hospitals for a selected patient.

Table 4.10: Registered Hospitals Report Specification

ID	Hospital	Address	State
001	UNTH	Ituku Ozalla	Enugu
002	Parklane	GRA	Enugu

Displays all registered hospitals.

Table 4.11: Registered Patients Report Specification

ID	First Name	Surname	Address	Sex	Age
001	Ada	Okeke	1 Ziks Av Enugu	Female	17
002	Henry	Onyia	34 Ogui Rd	Male	23

Displays all registered patients

4.3.5 Algorithm

Traditional *k*-means algorithm

1 MSE = largenumber;

2 Select initial cluster centroids $\{mj\}j$

$K = 1$;

3 Do

4 $OldMSE = MSE$;

5 $MSE1 = 0$;

6 For $j = 1$ to k

7 $mj = 0$; $nj = 0$;

8 endfor

9 For $i = 1$ to n

10 For $j = 1$ to k

11 Compute squared Euclidean distance $d2(xi, mj)$;

12 endfor

13 Find the closest centroid mj to xi;

14 $mj = mj + xi$; $nj = nj+1$;

15 $MSE1 = MSE1 + d2(xi, mj)$;

16 endfor

17 For $j = 1$ to k

18 $nj = \max(nj, 1)$; $mj = mj/nj$;

19 endfor

20 $MSE = MSE1$;

while ($MSE < OldMSE$)

 The New System Algorithm   (4.1)

Table 4.12 contains some of the data variables used in the program design and their full meaning.

Table 4.12: Data Dictionary

Variables	Meaning/Functions
Db	This is the database object used to access the patient's database
DbConn	This is the connection object used by the database object to connect to the physical database
DatRecord	This is the object used to display the Record from dataset
MnuRecord	This is the object used to display program menu
MnuPass	This is the object used to create password of user
MnuUser	This object is used to manage the user of the system
MnuLogin	This is the object that gives access to authorized users of the system
MnuID	This is the object used to display the patients ID number
Mnuhistory	This is the object used to display the patients medical history
Mnutreat	This is the object used to display the treatment given to patient
Mnuname	This is the object used to display the patient's name
MnuExit	This is the object used to exit the application
LoadPicture	This is the object that helps in loading pictures /images from the directories into the program.
Mnuaddress	This is the object used to display patients address
Mnuhospital	This is the object used to display the name of the hospital
Mnustate	This is the object used to display the name of the state
Frmpatient	This is the object used to display the form for patients registration
Frmdatmine	This is the object used to display the result from the data mining operation
Frmalert	This is the object used to display the form for generating patient's reminder alert
FrmVital_Sign	This is the object used to record the vital signs of the patient
FrmPatient_Genotype	This is the object used to retrieve the genotype of the patient

4.4   Program Flowchart

The program flowchart (Figure 4.20) shows the login details and menu for register patients, view patients' records, search for patients' records and edit patients records
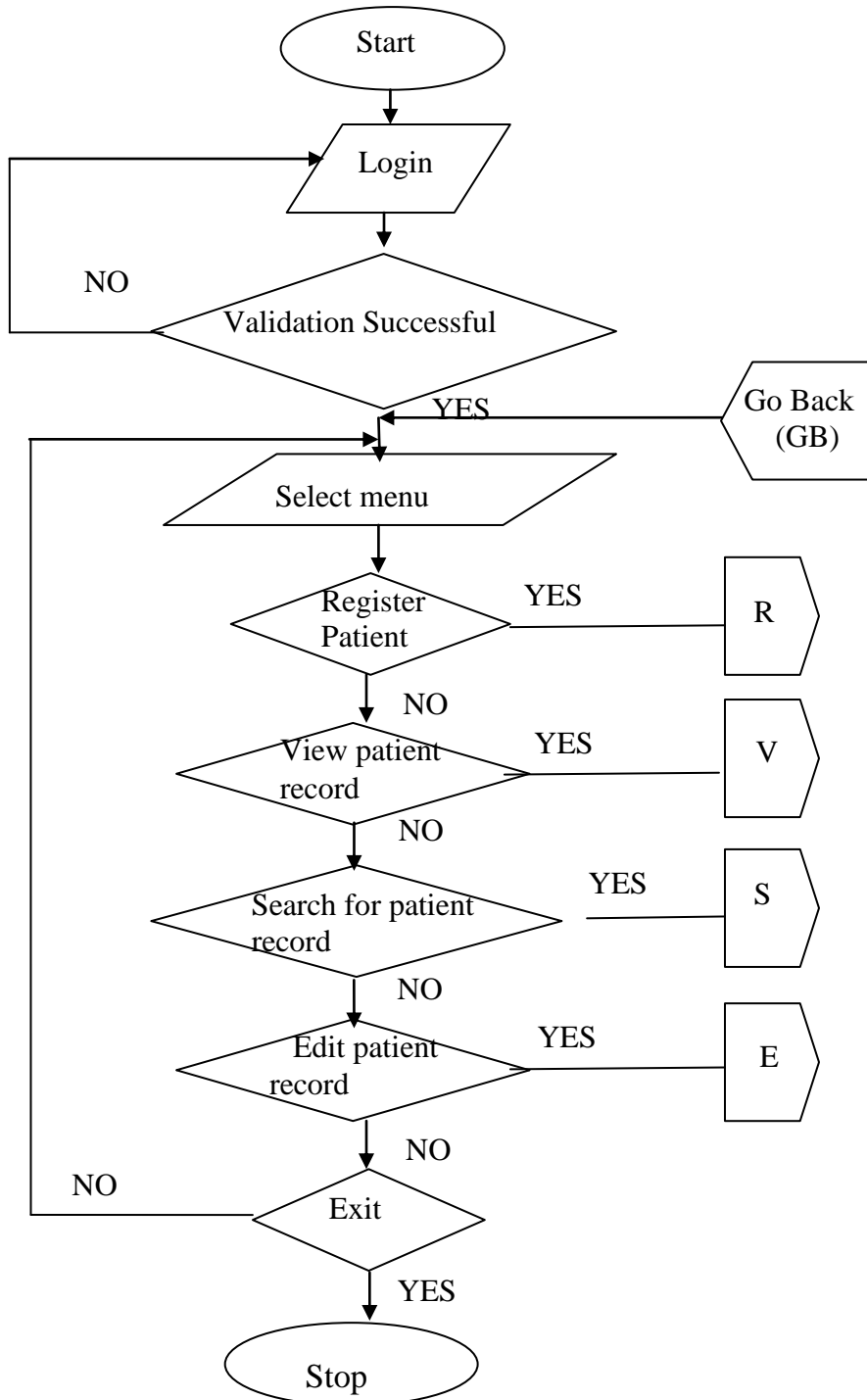
Figure 4.20: Program Flowchart

Healthcare Management Model Register patient Module Flowchart

Figure 4.21 displays the Patients' registration forms

```
            ┌──────────┐
            │    R     │
            └────┬─────┘
                 │
                 ▼
         ╱───────────────╲
        ╱  Enter the      ╲
       ╱   patient's bio   ╲
      ╱    data, blood      ╲
      ╲    group, allergy,  ╱
       ╲   etc             ╱
        ╲─────────┬───────╱
                  │
                  ▼
            ┌──────────┐
            │    GB    │
            └────╲────╱┘
```
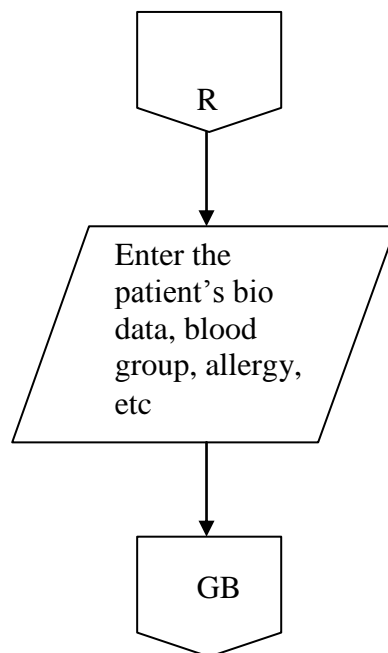
Figure 4.21: Patients' Registration Form Module.

Healthcare Management Model View Patient Record Module Flowchart

Figure 4.22 displays the patients' records

```
            ┌──────────┐
            │    V     │
            └────┬─────┘
                 │
                 ▼
         ╱───────────────╲
        ╱  Displays        ╲
       ╱   patient's bio    ╲
      ╱    data, blood       ╲
      ╲    group, allergy,   ╱
       ╲   etc              ╱
        ╲─────────┬───────╱
                  │
                  ▼
            ┌──────────┐
            │    GB    │
            └────╲────╱┘
```
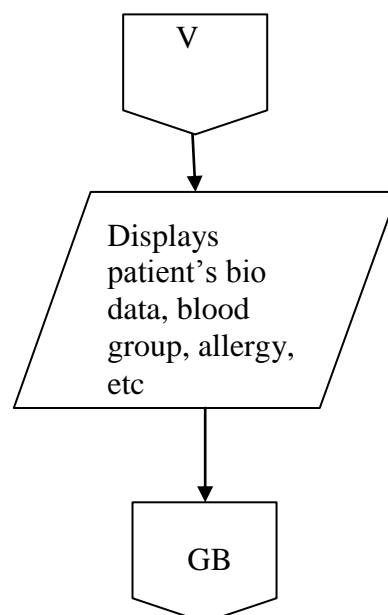
Figure 4.22: View Patients' Records Module Flowchart

Healthcare Management Model Search Patient Record Module Flowchart

Figure 4.23 searches the records of patients in stored in the database
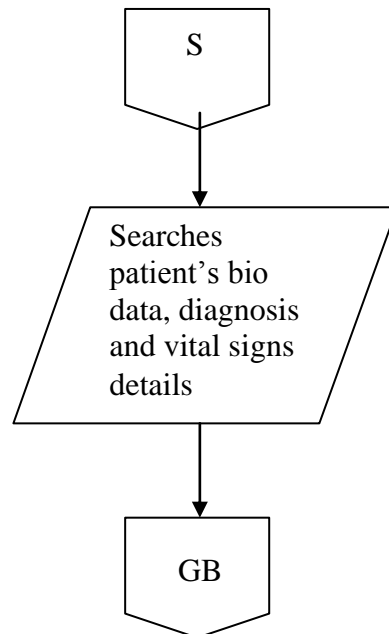
Figure 4.23: Search Patients' Module Flowchart

Healthcare Management Model Edit Patient Record Module Flowchart

Figure 4.24 displays the patients' edit module
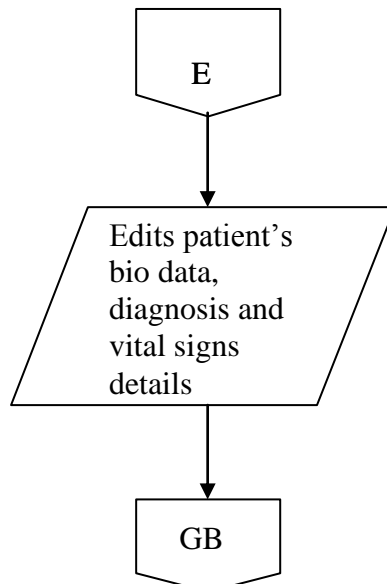
Figure 4.24: Edit Patients' Module Flowchart

4.5   Activity Diagram of the New System

This section presents the Activity Diagrams of the new system.

4.5.1   Login Page

The diagram (Figure 4.25) shows the welcome page at the starting of the application.
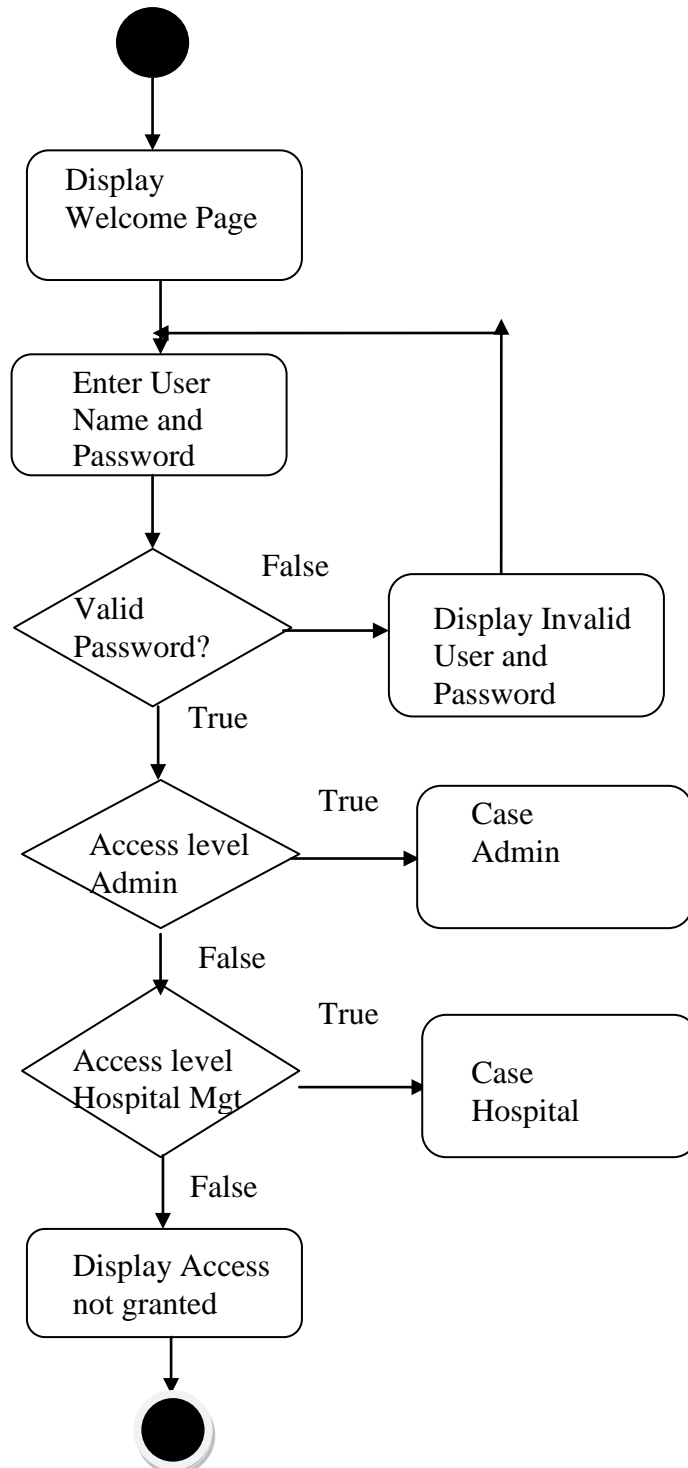
Figure 4.25: Activity Diagram of Welcome Page

4.5.2 Admin Page

The diagram (Figure 4.26) shows the admin page of the application
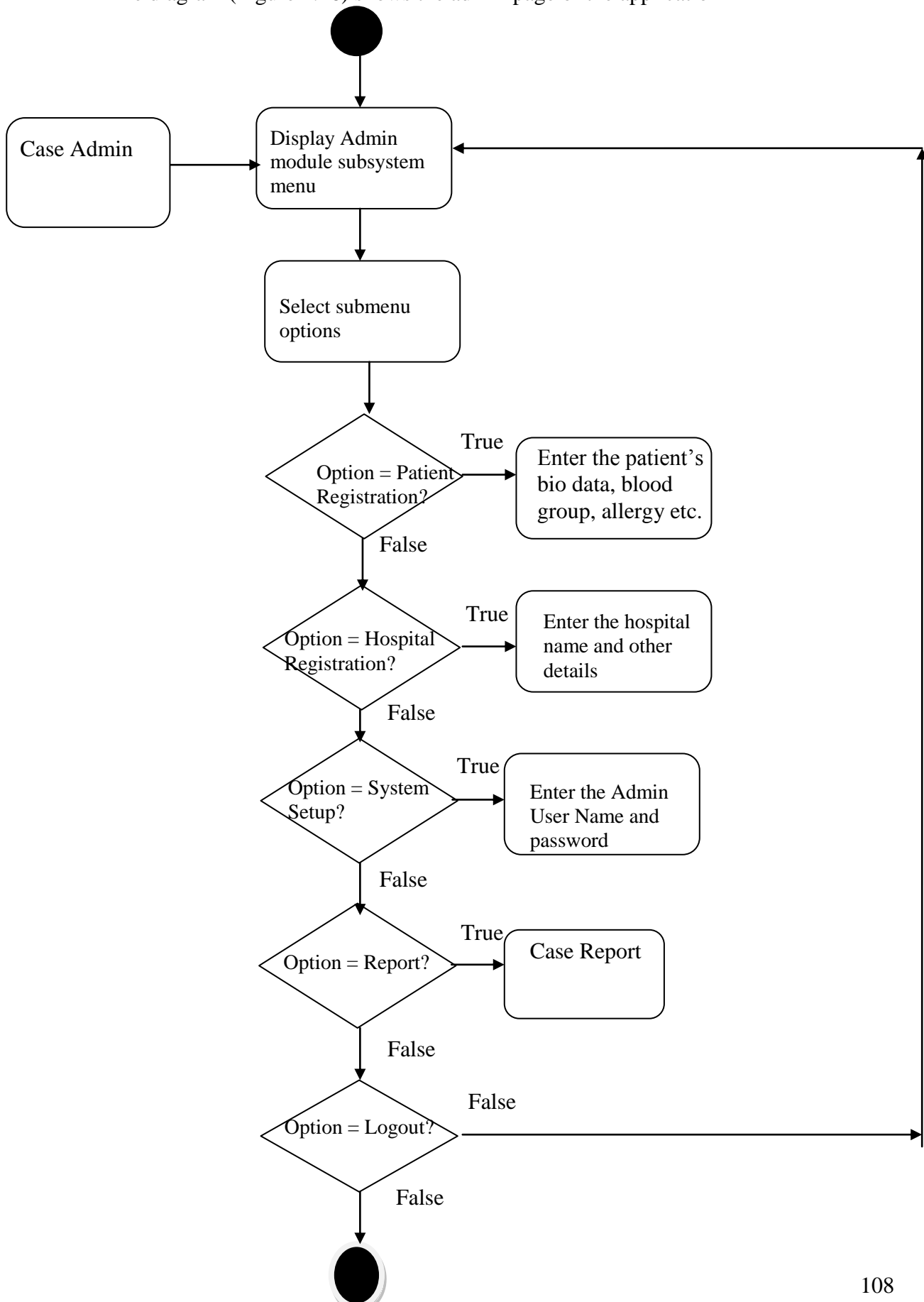
Figure 4.26: Activity Diagram of Admin Page

4.5.3 Diagram of Admin Report Page

The diagram (Figure 4.27) shows the admin report module of the application
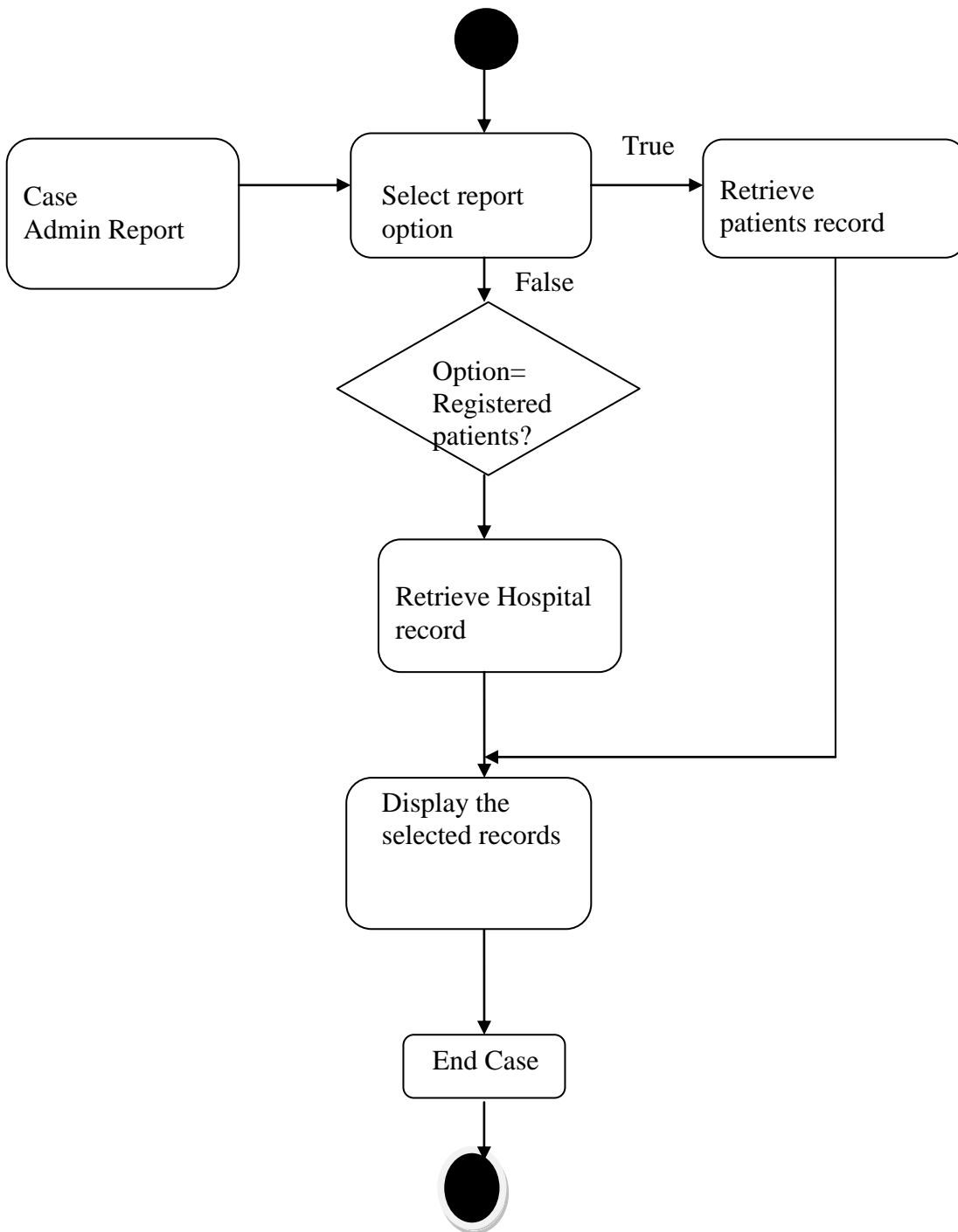
Figure 4.27: Diagram of Admin Report Module. This retrieves and displays the records of registered patients and hospitals

4.5.4   Activity Diagram of Admin Report Page

The diagram (Figure 4.28) shows the hospital module of the application
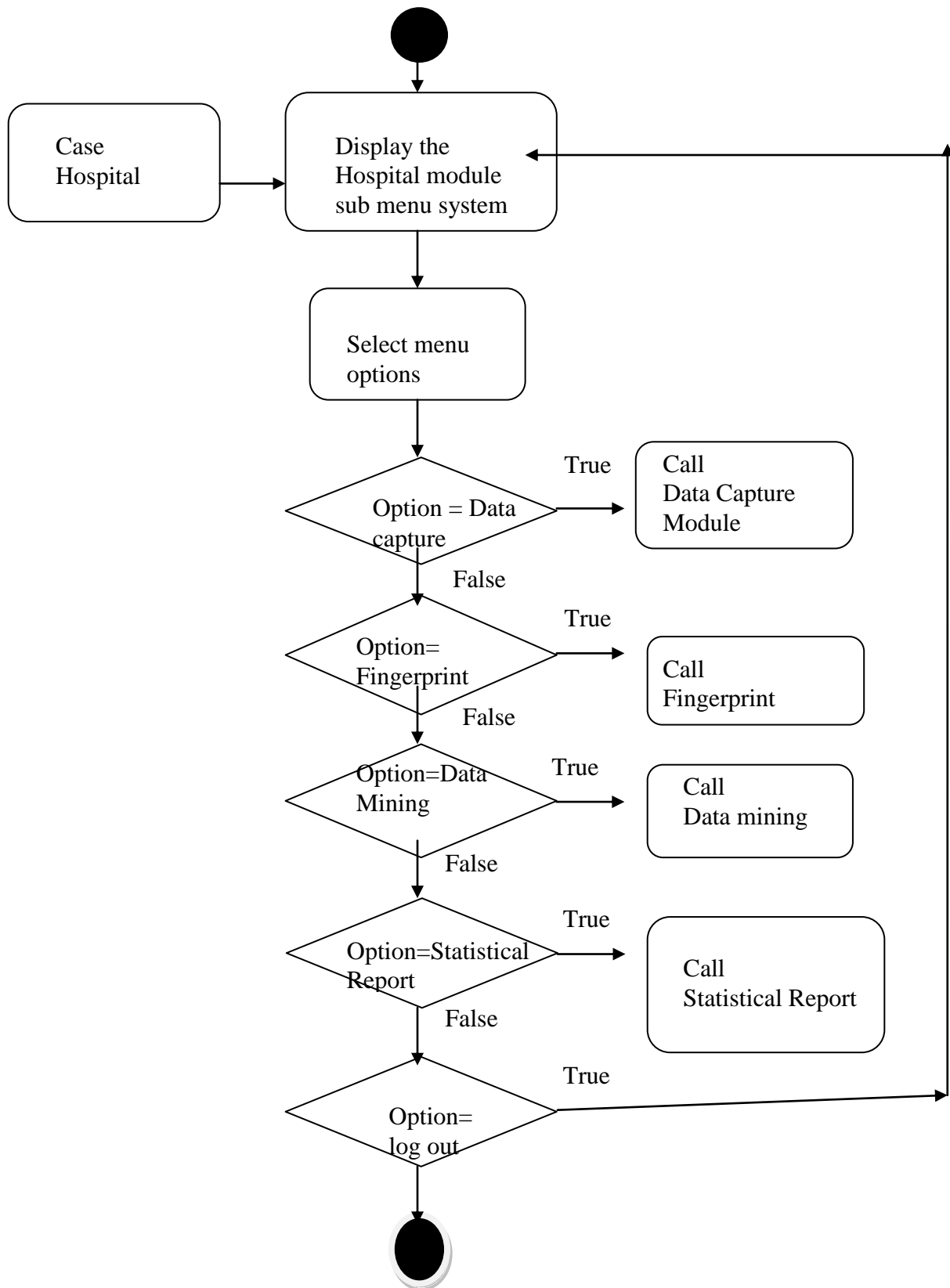
Figure 4.28: Activity Diagram of Hospital Module. This displays the hospital
sub system menu

4.5.5 Activity Diagram of Data Capture

The diagram (Figure 4.29) shows the data capture module of the application
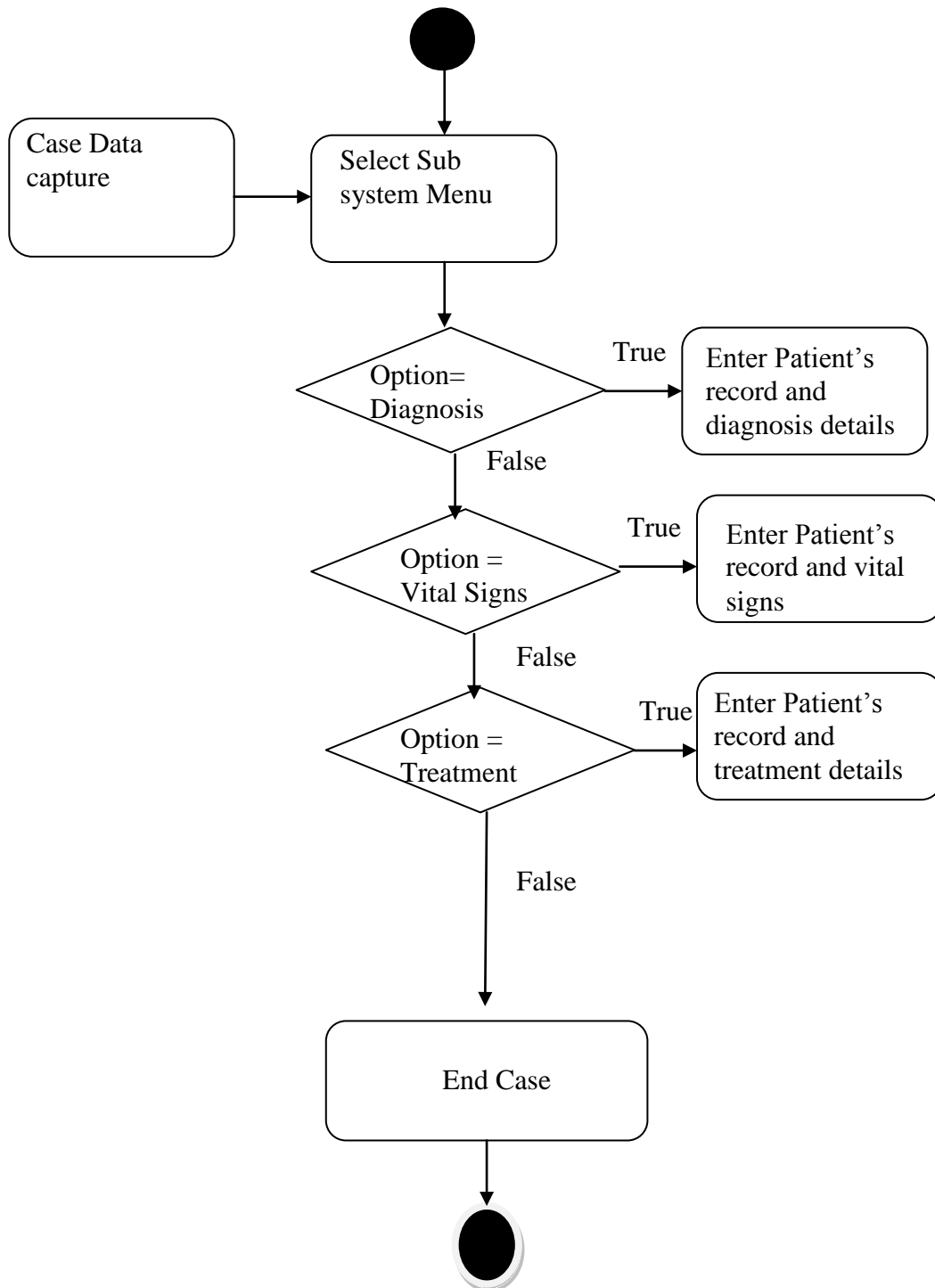
Figure 4.29: Activity Diagram of Data Capture. This contains the records of patients, their diagnosis details and treatment.

4.5.6 Activity Diagram of Fingerprint

The diagram (Figure 4.30) shows the fingerprint module of the application
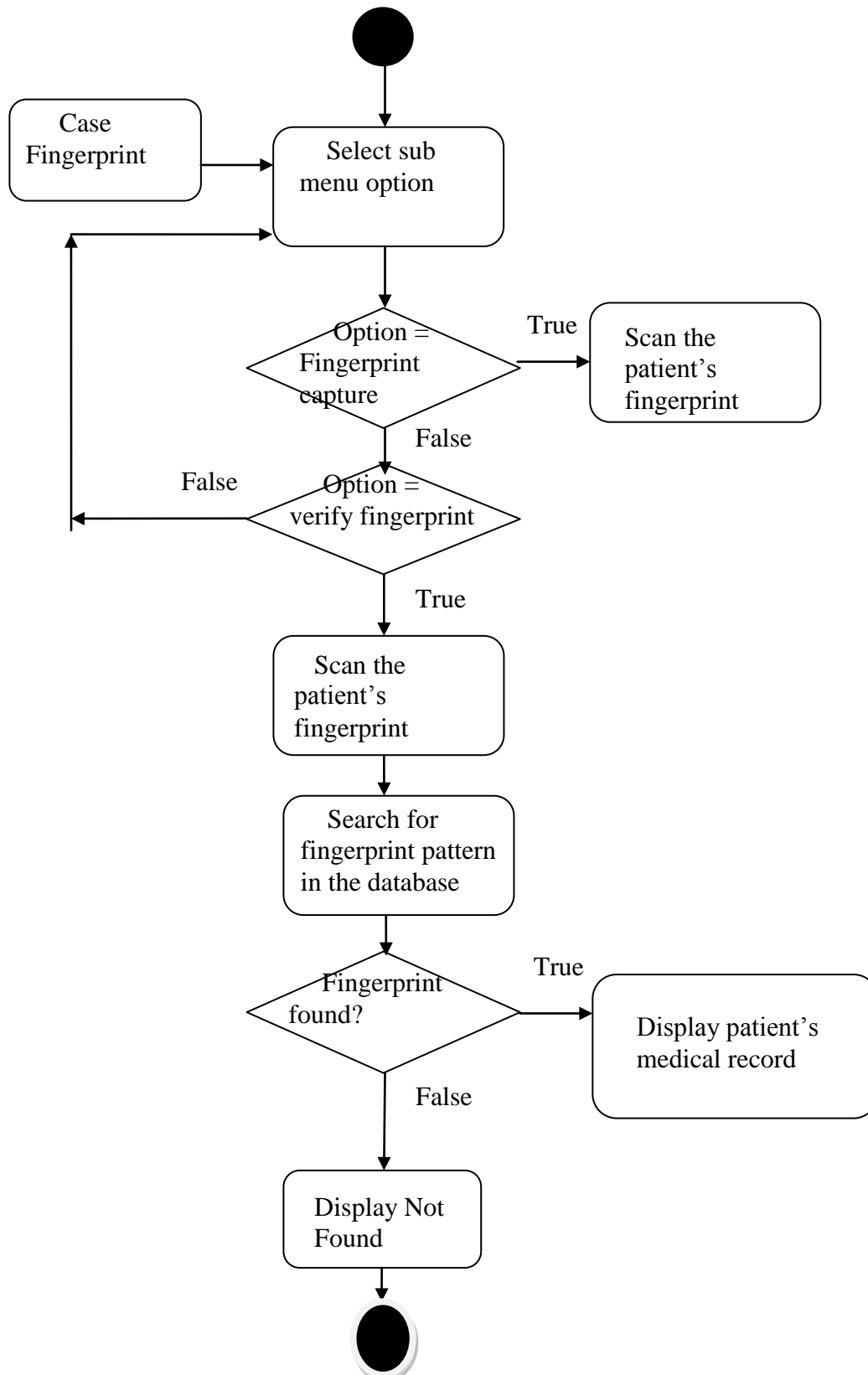
Figure 4.30: Activity Diagram of Fingerprint. This displays, captures and
verifies the fingerprint of a patient.

4.5.7 Activity Diagram of Data mining

The diagram (Figure 4.31) shows the Data mining module of the application
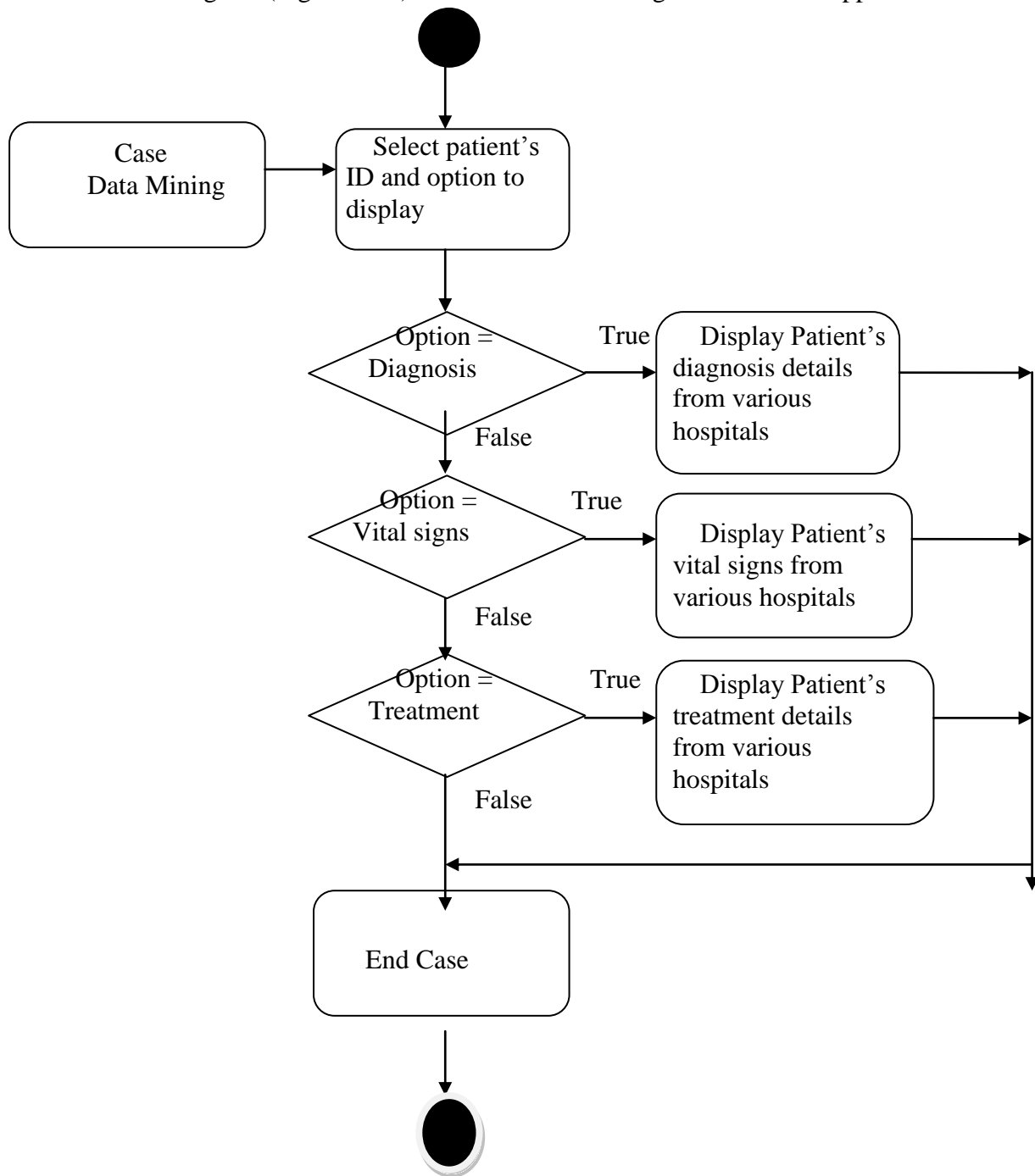
Figure 4.31: Data mining Activity Diagram. This extracts patient's record from various hospitals so as to know the patient's previous diagnosis, vital signs and treatment.

4.5.8 Activity Diagram of Statistical Report

The diagram (Figure 4.32) shows the Statistical Report of the application
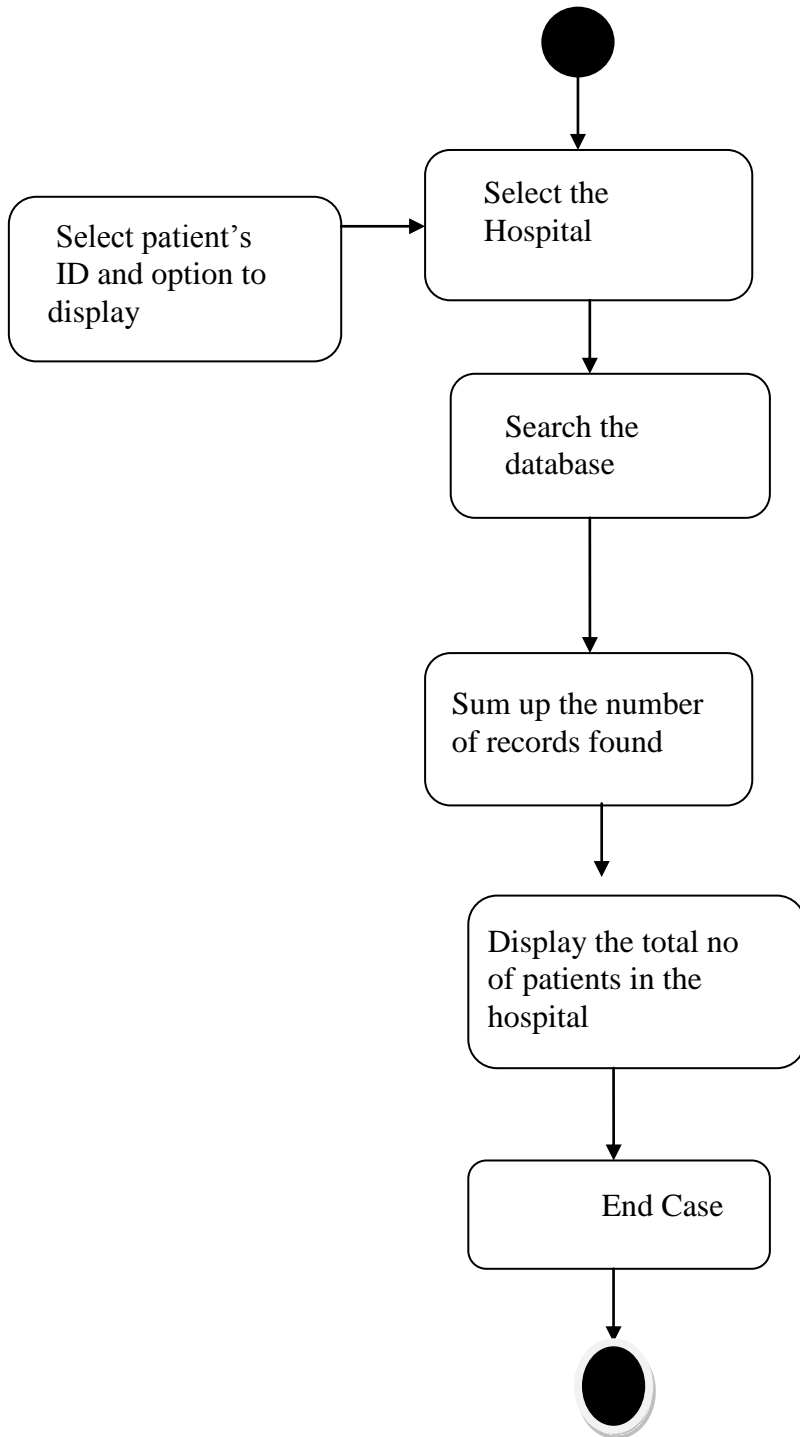
Figure 4.32: Activity diagram of Statistical Report. This displays the total number of patients in a hospital

4.6 Sequence Diagram

The Sequence diagram (Figure 4.33) shows how objects interact with one another and in what order. It depicts the objects and classes involved in the scenario.
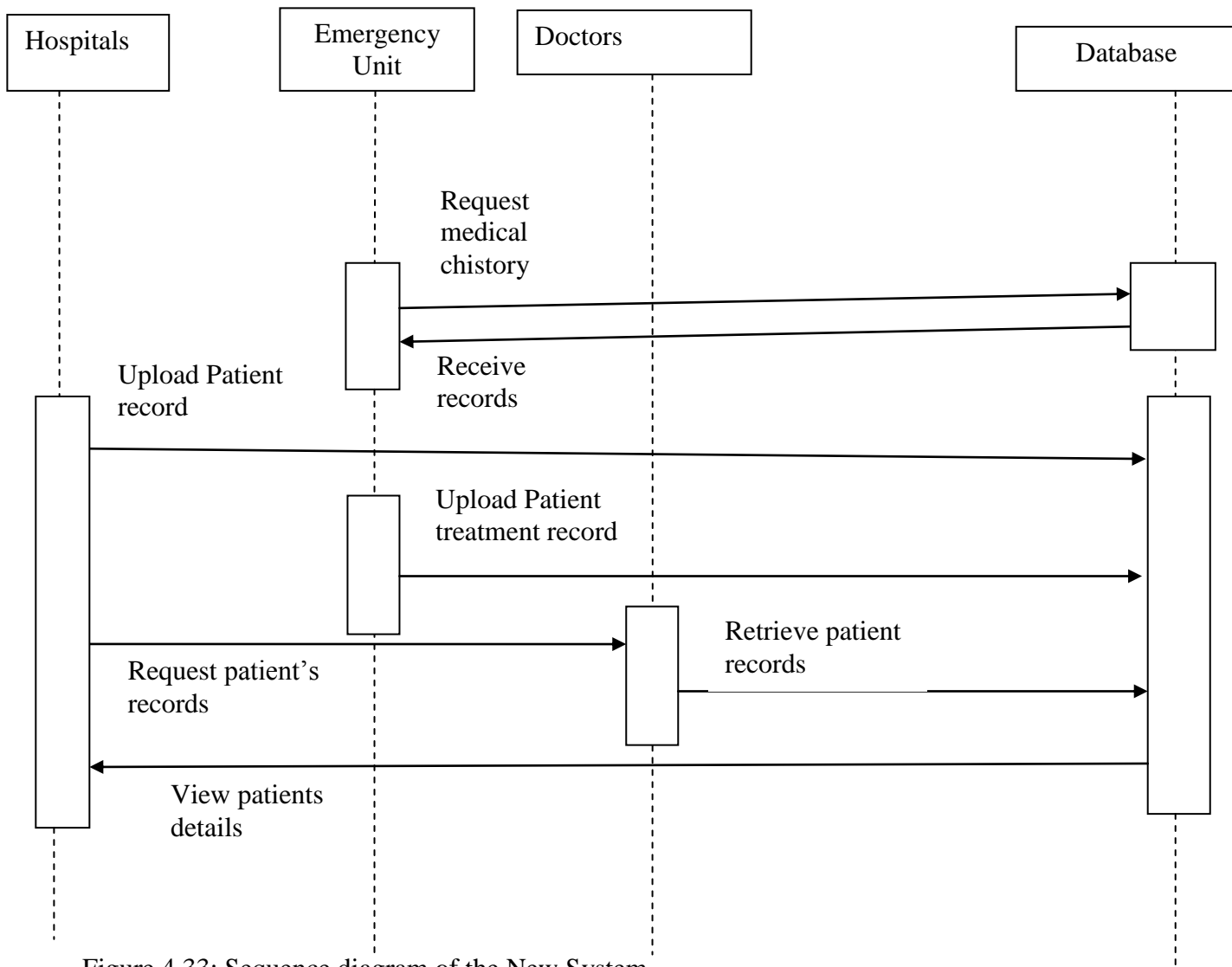
Figure 4.33: Sequence diagram of the New System

4.6.1 Object Diagram

The object diagram (Figure 4.34) stands as dedicated apparatus which demonstrates various relationships that exist among the different entities in a database. The diagram uses symbols, lines or arrows to show various types of information and relationships.
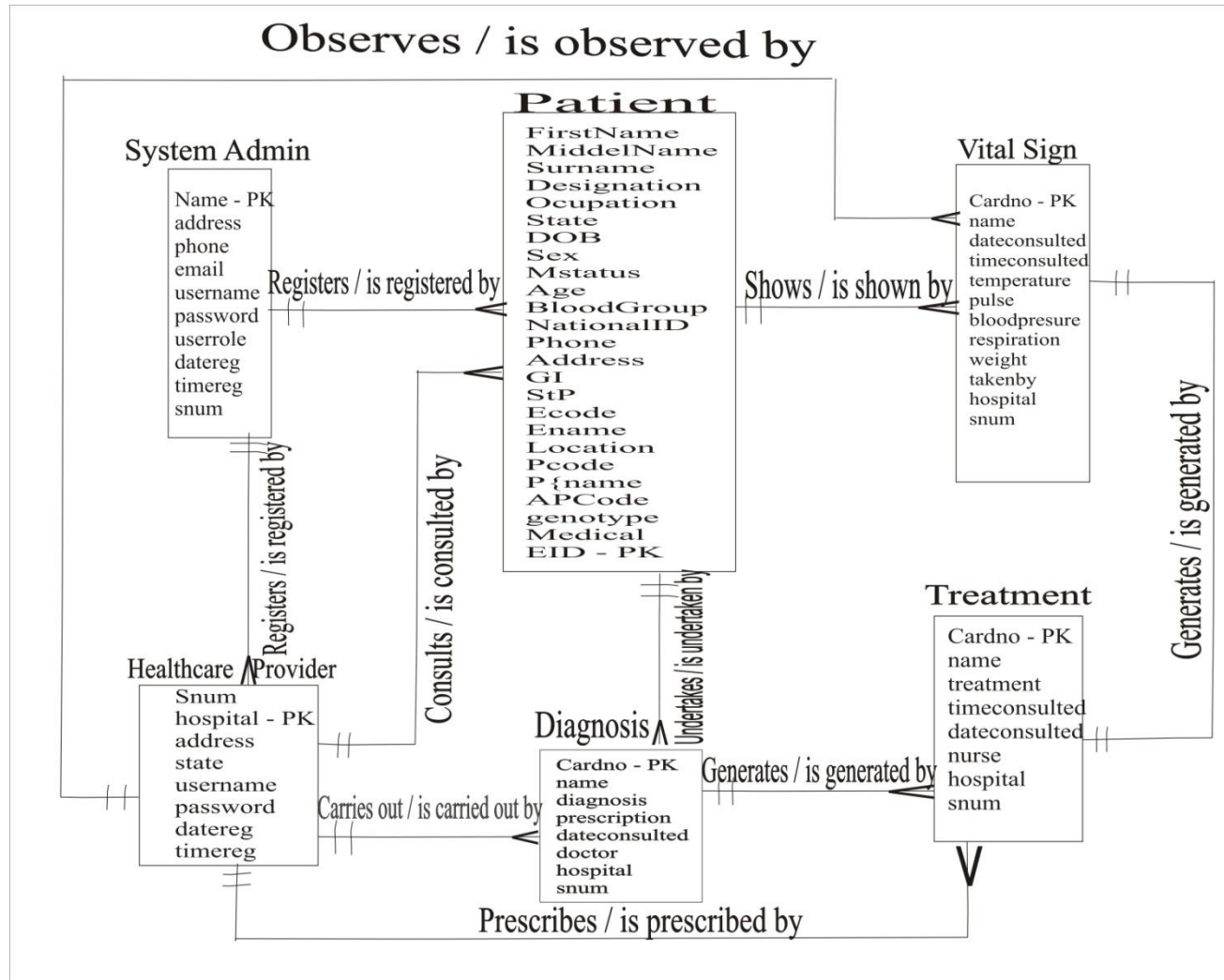
Figure 4.34: Object Diagram of the New System

The diagram expresses the association and level of interaction of the entities in the enhanced healthcare system. The system administrator registers patients and healthcare providers and issues passwords. The patient consults the healthcare provider who prescribes drugs which is issued or released to the patient through the same provider. The patients undergo tests and other diagnosis which report is subject to the attention and study of the healthcare provider. It shows the relationship that exist among the entities and the attributes or instances (cardinalities)

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4.6.3 Class Diagram

Figure 4.35 shows the class diagram of the new system.
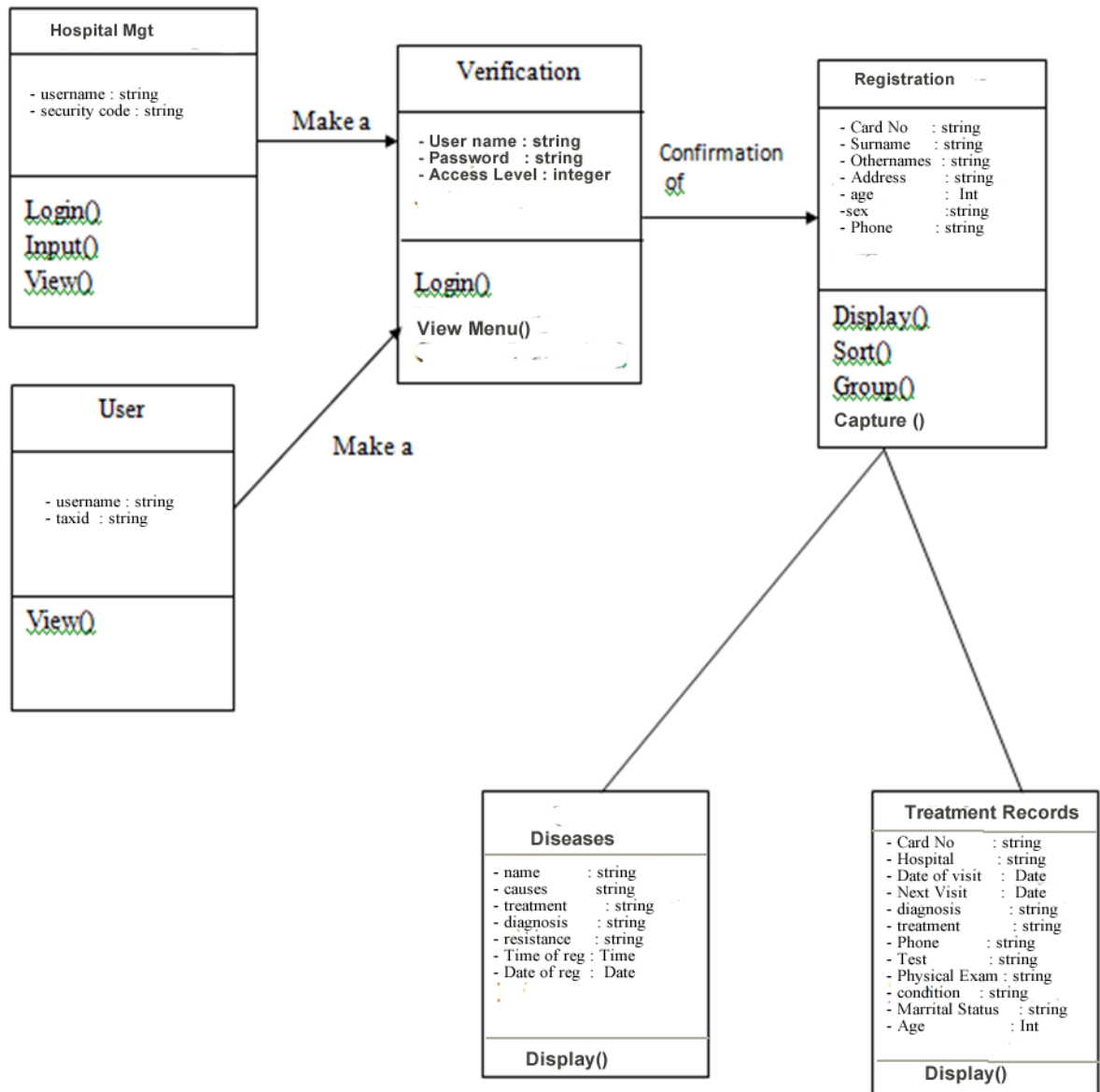
Figure 4.35: Class Diagram of the New System

Class diagrams are one of the most useful types of diagrams in UML as they clearly map out the structure of a particular system by modeling its classes, attributes, operations, and relationships between objects. The standard class diagram is composed of three sections:

a   **Upper section:** Contains the name of the class. This section is always required, whether you are talking about the classifier or an object.

b   **Middle section:** Contains the attributes of the class. Use this section to describe the qualities of the class. This is only required when describing a specific instance of a class.

c   **Bottom section:** Includes class operations (methods). Displayed in list format, each operation takes up its own line. The operations describe how a class interacts with data.

4.7   New System Requirements

4.7.1   Hardware Requirements

For the implementation of the efficient emergency healthcare system, the following hardware is required:

a   2.4 GHZ of processor speed

b   4GB RAM

c   180 GB Hard disk

d   Internet Modem

e   Coloured Monitor

f   Printer

4.7.2   Software Requirements

The following software has to be installed on the computer system to run the new system developed.

a   window 7, Window 8 or windows 10

b   Microsoft Dream Weaver 8

c   Wamp Server

d   JQuery

e   Fireworks

f   PHP- MySQL

g   Java Virtual Machine

4.8   Program Development

4.8.1   Choice of Programming Environment

PHP-MySQL programming language and Java Script was used during the program development. It consists of all necessary tools required to build main stream server Applications. The features of PHP-MySQL and Java Script are as follows:-

i.   GUI Interface

ii.   Modularization

iii.   Object Oriented

iv.   Debugging

v.   MySQL Data access feature

vi.   Scripting

4.8.2   Language Justification

The above programming language was chosen because the programming language has the advantage of easy development, flexibility and it has the ability of providing the developer with possible hints and it produces a graphical user interface. Moreover, PHP-MySQL is very user friendly and enables the design of an interface that can be modified programmatically.

4.9   System Testing

Testing was done after the system was put in place. This was done in two ways: Implementation and Unit testing was carried out on individual modules of the system to ensure that they are fully functional units. The researcher did this by examining each unit which we checked to ensure that it functions as required and that it adds patient's data and other details and also ensured that this data is sent to the database. The success of each individual unit gave the researcher the go ahead to carryout integration testing. All identified errors were dealt with.

The researcher carried out integration and system testing after different modules had been put together to make a complete system. Integration was aimed at ensuring that modules are compatible and they can be integrated to form a complete working system. For example we tested to ensure that when a user is logged in, he/she is linked to the appropriate page, and could at the same time access the database. As one of the final specific objectives of this study, validation of the system was very important.

Validation of the system was done by comparing it to the questions asked by the users at the hospital. Most of their answers matched what the system can do.

4.9.1   Test Plan

We have three basic testing method that shall be adopted viz.

(i)   Module Testing

(ii)   Intergrated Testing and

(iii) System Testing

4.9.1.1   Integration and System Test

So far, the various modules have been tested and each has proved efficient as an entity.

The essence of this intergrations and system test is to check how these modules when they are intergrated into subsystem stand as main system.

Therefore, the test that will be carried out here is to ascertain that those modules do not loose their efficiency and reliability (which has been proved in the module testing above) due to this intergration into subsystem and system.

4.9.2   Test Data

Test data (Table 4.13) was collected from patient's forms.

Table 4.13 Test Result

Module	Expected Test Result	Actual Test Result
The Patient Registration Form	Expected to see the patients, bio data, allergy, genotype and blood group.	The patient Registration records appeared whenever requested.
Hospital Registration Form	The expected result was to see all the hospitals information.	When clicked on log in, the hospital records will be shown.
Patient's Diagnosis form	When clicked on the system, it is expected to display the form for entering patients record	When clicked on the button, the system displays the patient's diagnosis form.
Patient's Medical History Form	Expected to see all the records of patients and their medical History.	The patient medical history will show with the input of the patient's ID or fingerprint.
Report	In this module, it is expected to be used to view patient's report	When you go to this module, patient's report was displayed

4.9.3   Software Performance Evaluation

A performance metrics can be derived from the confusion matrix as show in Table 4.14 and equation 4.2, which show the accuracy (AC) of the emergency healthcare system in classifying patient's data.

Table 4.14: Confusion Matrix

		Observed	
		True	**False**
	True	TP	FP
Predicted	**False**	FN	TN

$$AC = \frac{a+b}{a+b+c+d}$$ (4.2)

a	=	True Positive
b	=	False Positive
c	=	False Negative
d	=	True Negative

Table 4.15 show the results for classification techniques applied on hospital dataset in WEKA. On the basis of comparison done over accuracy and error rates; the classification algorithm with highest accuracy are obtained for this dataset in given different data mining tools.

Table 4.15: Confusion matrix of a model applied to test hospital dataset using K-nearest neighbor classification algorithm

		Observed	
		Correctly classified instances	**Incorrectly classified instance**
Predicted	**Correctly classified instances**	46	37
	Incorrectly classified instance	6	11

Substituting the values we have

AC	=	(46+37) / (46+6+11+37)
AC	=	0.83 i.e. 83% accuracy in classification

Table 4.16: **Confusion matrix of a model applied to test hospital dataset using Apriori classification algorithm**

		Observed	
		Correctly classified instances	Incorrectly classified instance
Predicted	**Correctly classified instances**	50	31
	Incorrectly classified instance	7	12

Substituting the values we have

AC   =   (50+31) / (50+7+12+31)

AC   =   0.81   i.e. 81% accuracy in classification

Table 4.17: **Confusion matrix of a model applied to test hospital dataset using K-Mean classification algorithm**

		Observed	
		Correctly classified instances	Incorrectly classified instance
Predicted	**Correctly classified instances**	56	37
	Incorrectly classified instance	3	2

Substituting the values we have

AC   =   (56+37) / (56+3+2+37)

AC   =   0.93   i.e. 93% accuracy in classification

Table 4.18: Comparison of Classification Results Obtained

Technique Applied	Accuracy Rate	Error Rate
Apriori	81	19
k-nearest neighbor	83	17
K-Mean	93	7

Figure 4.36 shows comparison between the best classification techniques applied on this dataset.
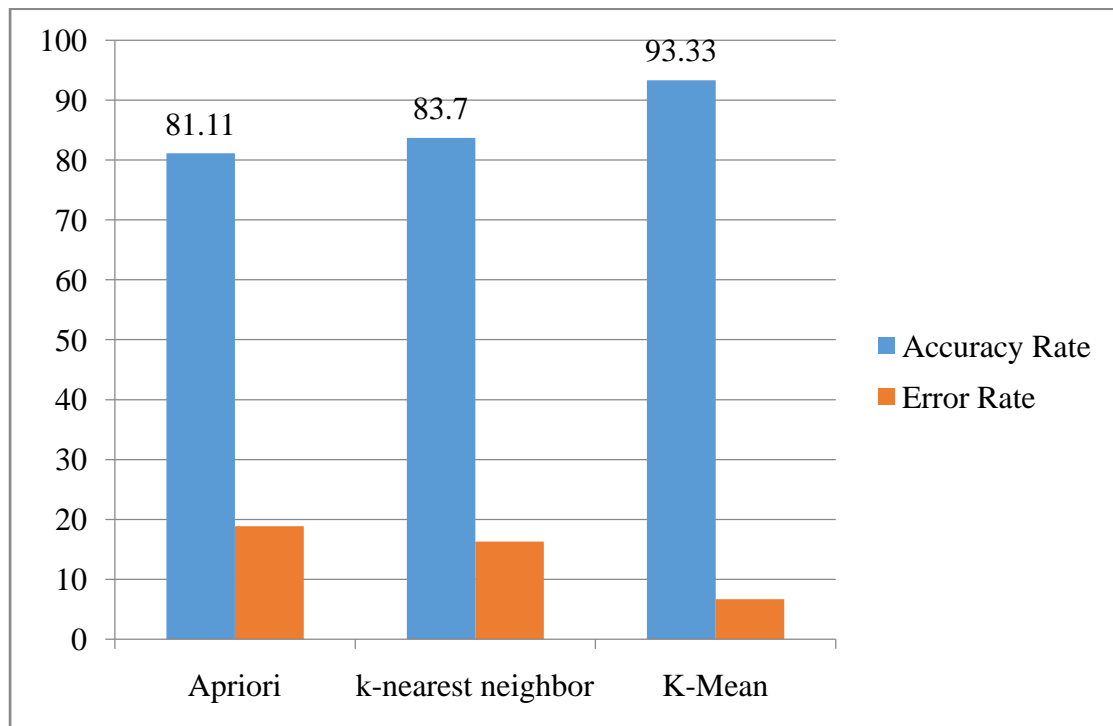
Figure 4.36: Comparison between best classification algorithms

From Figure 4.36 it is observed that K-Mean classification algorithm applied in thesis for this dataset is best among all other participating techniques applied in other tools.

4.10 System Conversion

File conversion is a major part of the system development and involves fact-finding, data capturing, clerical procedure design, form design and even program specification. It is an often-expensive part of the systems implementation and usually means the conversion of existing manual records into a medium used by the computer. This itself, may involve the transcription of records, or part of them, onto specially designed forms before they are keyed onto the appropriate computer medium. Once the file has been created, extensive checking for accuracy is essential; otherwise considerable problems may arise when the system becomes operational.

4.10.1 Changeover Procedures

Although there are numerous change over methods, the one recommended for this system is a parallel run implementation in which both the old and new system are

operated concurrently for a period of time until the new system is certified okay. This approach is low risk. If the new system fails, the organization can just switch to the old system to keep going. This method, however, is expensive as it keeps people and equipment active to manage the two systems.

4.11   System Security

The system was pass-worded and also the use of biometric technology (fingerprint) to prevent unauthorized users from gaining access to the files The files in the system were also backed up.

4.12   Training and Retraining of Staff

For the new system to function effectively and efficiently, educating and training of staff is necessary. Training is conducted for the staff selected to do the job of keying in data and running of the system. The members of staff selected are trained for a period of time on how to manipulate and operate the system so as to be acquainted with the computer and the system designed. The staff members are also given procedural manuals to assist them in operating the system.

They are also educated on how to safeguard files in the system to avoid unauthorized user from gaining access to the system files.

4.13   Documentation

The records in the system were documented using the hardware and software of the system. The Software was stored in a CD. To install it on the system to run from the hard disk, follow the procedure below.

i.   Click Start Button on the desktop

ii.   Select program

iii.   Click Windows explorer

iv.   Click Drive D:

v.   Select the folder "**healthcare"**

vi.   Click Edit

vii.   Click Copy

viii. Select drive C:

ix.   Select Wamp

x.   Select www

xi.   Click paste to Copy the Folder "**healthcare**" from drive D: to Drive C:

xii.   The folder contains the entire sub program that makes up the software developed.

xiii.   Open internet explorer

xiv.   Type http://localhost/healthcare/index.php

Maintenance Details

To ensure safety of the software, the following maintenance procedures are recommended.

1.   Provision of Uninterrupted Power Supply (UPS) to avoid power failures

2.   Installation of Anti Virus in the system

3.   Provision of Air conditioner in the environment.

4.   Backing up of files using external hard disk drives or CDs.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1   Summary

As discussed in the previous chapters the main problem that was addressed was dealing with patient medical records. It is this situation that led to the development of this Efficient Emergency Healthcare Management Model using integrated database and data mining techniques for use in Nigerian Hospitals to enable them handle details on patient's medical history and treatment efficiently and effectively. The project has implemented most of the objectives stipulated in earlier chapters. The patient record management system offers a number of benefits to the user and can capture data, store, view, add and delete the records entered, the data can also be posted to the database. The new system also integrates biometric technology in tracking patient's medical history. Patient's fingerprint is captured and stored in a centralized database to be accessed by various hospitals. The system developed is user friendly, robust database, and accessibility of data is guaranteed.

5.2   Conclusions

The core reason for the establishment of Efficient Emergency Healthcare Management Model using Integrated Database and Data mining Technique is to enable the hospital administrators to work in a convenient, fair and timely manner and discharge their duties effectively. Therefore the information technology used supports the core objective of the system to enable it remain relevant to the hospital. A lot still needs to be done in the hospital administrative department in order to make the available technology effective. This involves training of the staff on how to enter data in the right way and to maintain relevant data in the system. The management should also keep updating the hardware and software requirements of the system. Information technology and computer systems need to be upgraded as more and more information technology facilities and software are introduced in today's information technology market.

5.3 Recommendations

Training of all the members of staff in the hospitals across the country to get accustomed to the system is a priority. This being a new system, some members of hospital management will get threatened that the computerized healthcare management model will replace their jobs. The researcher recommends that management of the hospitals educate the staff on how this system will operate and how it will supplement but not replace their efforts. For the efficiency of the hospital, users of the system need to be thoroughly educated about the use of the password and staff name and how to safeguard them. They should be kept confidential. Access to the server room should be physically guarded against unauthorized persons; the server room should be dust free, fully protected and should have an air conditioner to prevent the server from overheating. Backup media like CDs, and Flash disks can be used for backups and storage of data.

5.3.1 Areas of Application of Work

This work can be applied in hospitals, healthcare centres, Ministry of Health and any other Healthcare parastatal.

5.3.2 Suggestions for Further Work

a   It is obvious that data mining is very important for healthcare and it can improve the situation from health centers to customers, we recommend that the system be made cloud based instead of server based.

b   The researcher acknowledges the fact that this system does not handle all patients' information like bills and financial status. The researcher therefore suggests that further research be done on the most cost effective way of handling all bills and financial reports of various hospitals all over the country regardless of the location.

5.4 Contribution to Knowledge

In this work, the major contribution to knowledge is that readers will be exposed to application of data mining in health sectors for easy access to medical information of patients in emergency situations. This makes it possible to retrieve the patients' record very fast thereby saving lives.

Other contribution to knowledge of this research effort include:

a   The development of a national Healthcare Management Model backed with an integrated database that supports Data Mining Techniques for efficient health information retrieval and knowledge discovery. This is necessary because there is no national database for healthcare delivery that is in existence in Nigeria as of now.

b   The use of mobile phone to access and retrieve patients' records from the database. This will help in faster retrieval of information thereby saving a lot of time and lives.

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User Login Codes

```php
<?php
 $user="amen";
$password= "city00005";
$database="amen_amendata";
mysql_connect(localhost,$user, $password);

/*$user="root";
$database="amendata";
mysql_connect(localhost,$user);*/
@mysql_select_db($database) or die( "Unable to select database");
$username = $_POST['username'];
$password = $_POST['password'];

$select = "select * from admin_login where username = '$username' and password =
'$password'";
$login = mysql_query($select) ;//or die(mysql_error());
if (mysql_num_rows($login)!=1)
{
  header("Location: loginerror.php");
echo 'Invalid Password <br />';
}
else
{
$update = "update  admin_login2 set  username = '$username', password =
'$password'";
        mysql_query($update) or die(mysql_error());
 header("Location: loginok.php");
}



?>
```

```html
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1" />
<title></title>
</head>

<body>
<table width="600" border="0">
  <tr>
   <td><form id="userForm" name="userForm" method="post" action="">
            <input name="username" type="hidden" id="username" value="<?php
echo $username ?>" />
            <input name="password" type="hidden" id="password" value="<?php
echo $password ?>" />
          </form></td>
  </tr>
</table>
</body>
</html>
```

Administrative Login Codes

```php
<?php
$user="root";
$database="healthcare";
mysql_connect(localhost,$user);

@mysql_select_db($database) or die( "Unable to select database");

$username = $_POST['username'];
$password = $_POST['password'];

$tm = date("y-m-d h:i:s");
```

```php
$select = "select * from tblusers where username = '$username' and password =
'$password' and userrole='Admin'";
$login = mysql_query($select) ;//or die(mysql_error());
if (mysql_num_rows($login)!=1)
{

  header("Location: loginerror.php");
echo 'Invalid Password <br />';
}
else
{

$welcome = "Welcome ".$username;
}
?>
```

```html
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1" />
<title> Efficient Healthcare Management Model Using Integrated Database and Data
Mining Techniques</title>
<link href="skb.css" rel="stylesheet" type="text/css" />
<script type="text/javascript" src="jQuery.js"></script>
<script type="text/javascript" src="js.js"></script>
<script language="javascript" src="mootools/mootools.svn.js"
type="text/javascript"></script>
<style type="text/css">
<!--
body {
        background-color: #FFFFFF;
}
.style15 {font-size: 24px}
-->
```

```
</style>
</head>


<body>
<table width="600" border="0">
 <tr>
  <td><form id="userForm" name="userForm" method="post" action="">
            <input name="username" type="hidden" id="username" value="<?php
echo $username ?>" />
            <input name="password" type="hidden" id="password" value="<?php
echo $password ?>" />
  </form></td>
 </tr>
</table>
<table width="800" border="0" align="center" cellpadding="0" cellspacing="0"
id="wrapper">
 <tr>
   <td><table width="800" border="0" cellspacing="0" cellpadding="0">
    <tr>
     <td><img src="images/name.gif" width="800" height="100" /></td>
    </tr>
    <tr>
     <td><img src="images/spacer.gif" alt="5" width="1" height="5" /></td>
    </tr>
    <tr>
     <td id="navbar"><ul id="nav">
            <li><a href="#"
onclick="adminTransfer('adminhead.php');">HOME</a></li>
      <li><a href="#" onclick="adminTransfer('userreg.php');">PATIENT'S
REGISTRATION</a></li>
            <li><a href="#"
onclick="adminTransfer('hostreg.php');">HOSPITAL REGISTRATION</a></li>
      <li><a href="#" onclick="adminTransfer('setpass.php');">SETUP
PASSWORD</a></li>
```

```
    <li><a href="#" onclick="adminTransfer('members.php');">VIEW
PATIENTS</a></li>
    <li><a href="#" onclick="adminTransfer('viewhost.php');">VIEW
HOSPITAL</a></li>

    <li><a href="#" onclick="adminTransfer('index.php');">LOG OUT</a></li>
    <li></li>
  </ul></td>
</tr>
<tr>
  <td><img src="images/r2.gif" alt="5" width="800" height="5" /></td>
</tr>
<tr>
  <td valign="top"><table width="800" border="0" cellspacing="0"
cellpadding="0">
    <tr>
      <td><img src="images/spacer.gif" alt="7" width="1" height="5" /></td>
    </tr>
    <tr>
      <td valign="top"><table width="800" border="0" cellspacing="0"
cellpadding="0">
        <tr>
          <td width="800" height="215" align="left" valign="top" class="bdr"><div
align="center">
            <table width="800" height="180" border="0">
              <tr>
                <td valign="top"><div align="left">
                  <p><strong><br />
                  </strong></p>
                </div>                <table width="180" border="0">
                  </table>
                <div align="center"></div>
                <div align="center"><img src="images/33.JPG" width="360"
height="270" /></div></td>
```

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```
          </tr>
        </table>
      </div></td>
      <td><img src="images/spacer.gif" alt="4" width="1" height="5" /></td>
    </tr>
    <tr>
      <td colspan="2" valign="top" class="t4"><div align="center"
class="style15">Welcome to Administrative Control Panel </div></td>
    </tr>
    <tr>
      <td width="327" align="left" valign="top" class="t4"><?php echo
$welcome;?></td>
      <td align="left" valign="top"> </td>
    </tr>
    <tr>
      <td align="left"><div align="center"></div></td>
      <td align="left" valign="top"><b><a href="gallery.php"></a></b></td>
    </tr>
    <tr>
      <td height="25" colspan="2" class="divider"> </td>
    </tr>
                  <tr>
    <td id="navbar"><ul id="nav">

    <li><a href="#" onclick="adminTransfer('index.php');">LOG OUT</a></li>
     <li></li>
    </ul></td>
  </tr>
      </table></td>
     </tr>
    </table></td>
   </tr>
  </table></td>
 </tr>
```

```php
</table>
<p align="center"> </p>
</body>
</html>
```

Patient Registration Codes

```php
<?php
$user="root";
$database="healthcare";
mysql_connect(localhost,$user);
@mysql_select_db($database) or die( "Unable to select database");
if(!($_POST['username2']))
{
$username = $_POST['username'];
$password = $_POST['password'];
}
else
{
$username = $_POST['username2'];
$password = $_POST['password2'];
}
$select = "select * from tblusers where username = '$username' and password =
'$password' and userrole='Admin'";
$login = mysql_query($select) ;//or die(mysql_error());
if (mysql_num_rows($login)<1)
{
  header("Location: loginerror.php");
echo 'Invalid Password <br />';
}
else

{

$welcome = "Welcome ".$username;
$txtfname = $_POST['textfield'];
```

```php
$txtmname = $_POST['textfield2'];
$txtlname = $_POST['textfield3'];


$txtde = $_POST['textfield4'];
$txtoc = $_POST['textfield5'];
$txtst = $_POST['select17'];
$txtdob = $_POST['textfield7'];
$sex =$_POST['select'];
$ms =$_POST['select2'];
$txtag = $_POST['textfield82'];
$bg=$_POST['select3'];
$txtnid = $_POST['textfield9'];
$txtph= $_POST['textfield10'];
$txtadd = $_POST['textfield11'];
$txtgl = $_POST['textfield12'];
$txtstp = $_POST['textfield13'];
$ecode="-";
$ename= $_POST['select4'];;
$eloc="-";
$pc="-";
$pname =$_POST['select5'];
$apc="-";
$apn=$_POST['select6'];
$txtmed = $_POST['textfield14'];
$txtsna = $_POST['textfield15'];
$ss=$_POST['select7'];
$sbg=$_POST['select8'];
$txtsdb = $_POST['textfield16'];
$txtc1na = $_POST['textfield17'];
$c1s=$_POST['select9'];
$c1bg=$_POST['select10'];
$txtc1db = $_POST['textfield18'];
$txtc2na = $_POST['textfield19'];
$c2s=$_POST['select11'];
```

```php
$c2bg=$_POST['select12'];
$txtc2db = $_POST['textfield20'];
$txtc3na = $_POST['textfield21'];
$c3s=$_POST['select13'];
$c3bg=$_POST['select14'];
$txtc3db = $_POST['textfield22'];
$txtc4na = $_POST['textfield23'];
$c4s=$_POST['select15'];
$c4bg=$_POST['select16'];
$txtc4db = $_POST['textfield24'];

if ($txtfname !="")
{
$pin = rand(40000,99000);


$picImage=$_FILES['file']['name'];


$uploaddir = './pic_view/';
$dt =    date('dmy');
$tm = strftime('%H%M%S');
$new_file = $dt . $tm . $_FILES['file']['name'];
//print $new_file;
$fileName = $uploaddir . basename($_FILES['file']['name']);
if (move_uploaded_file($_FILES['file']['tmp_name'], $fileName))
{
        $imgUrl = $uploaddir . $new_file;
        $res = @rename($fileName , $imgUrl);
}
$query = "INSERT INTO tblmembers (
FirstName,MidilleName,Surname,Designation,Occupation,State,DOB,Sex,MStatus,Age,BloodGroup,
NationalID,Phone,Address,Gl, Stp,
Ecode,Ename,Location,Pcode,Pname,APCode,genotype,Medical,Sname,SSex,SBG,
```

```
SDOB,C1Name,C1Sex,C1BG,C1DOB,C2Name,C2Sex,C2BG,C2DOB,C3Name,C3S
ex,C3BG,C3DOB,C4Name,
C4Sex,C4BG,C4DOB,EPic,EID)
 VALUES ('$txtfname' , '$txtmname', '$txtlname', '$txtde', '$txtoc', '$txtst',
 '$txtdob', '$sex', '$ms', '$txtag', '$bg', '$txtnid', '$txtph', '$txtadd', '$txtgl',
 '$txtstp', '$ecode', '$ename', '$eloc', '$pc', '$pname', '$apc', '$apn', '$txtmed',
 '$txtsna', '$ss', '$sbg', '$txtsdb', '$txtc1na', '$c1s',
 '$c1bg', '$txtc1db', '$txtc2na', '$c2s', '$c2bg', '$txtc2db', '$txtc3na', '$c3s', '$c3bg',
'$txtc3db', '$txtc4na', '$c4s', '$c4bg', '$txtc4db','$imgUrl', '$pin' )";
mysql_query($query)
 or die(mysql_error());


}
}
?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1" />
<title>Efficient Healthcare Management Model Using Integrated Database and Data
Mining Techniques</title>
<link href="skb.css" rel="stylesheet" type="text/css" />
<script type="text/javascript" src="jQuery.js"></script>
<script type="text/javascript" src="js.js"></script>
<script language="javascript" src="mootools/mootools.svn.js"
type="text/javascript"></script>
<style type="text/css">
<!--
body {
        background-color: #FFFFFF;
}
.style15 {
        font-size: 20px;
```

```
              color: #660000;
}
.style16 {font-size: 14px}
.style18 {color: #0000FF; font-weight: bold; }
.style8 {color: #FF0000}
.style9 {color: #FFFFFF}
.style22 {color: #0000FF; font-weight: bold; font-size: 14px; }
-->
</style>
</head>

<body>
<table width="600" border="0">
  <tr>
   <td><form id="userForm" name="userForm" method="post" action="">
           <input name="username" type="hidden" id="username" value="<?php
echo $username ?>" />
           <input name="password" type="hidden" id="password" value="<?php
echo $password ?>" />
  </form></td>
  </tr>
</table>
<table width="800" border="0" align="center" cellpadding="0" cellspacing="0"
id="wrapper">
  <tr>
   <td><table width="800" border="0" cellspacing="0" cellpadding="0">
    <tr>
     <td><img src="images/name.GIF" width="800" height="100" /></td>
    </tr>
    <tr>
     <td><img src="images/spacer.gif" alt="5" width="1" height="5" /></td>
    </tr>
    <tr>
     <td id="navbar"><ul id="nav">
```

```html
        <li><a href="#"
onclick="adminTransfer('adminhead.php');">HOME</a></li>
      <li><a href="#" onclick="adminTransfer('userreg.php');">PATIENT'S
REGISTRATION</a></li>
              <li><a href="#"
onclick="adminTransfer('hostreg.php');">HOSPITAL REGISTRATION</a></li>
      <li><a href="#" onclick="adminTransfer('setpass.php');">SETUP
PASSWORD</a></li>
      <li><a href="#" onclick="adminTransfer('members.php');">VIEW
PATIENTS</a></li>
      <li><a href="#" onclick="adminTransfer('viewhost.php');">VIEW
HOSPITAL</a></li>

      <li><a href="#" onclick="adminTransfer('index.php');">LOG OUT</a></li>
      <li></li>
     </ul></td>
    </tr>
    <tr>
     <td><img src="images/r2.gif" alt="5" width="800" height="5" /></td>
    </tr>
    <tr>
     <td valign="top"><table width="800" border="0" cellspacing="0"
cellpadding="0">
      <tr>
       <td><img src="images/spacer.gif" alt="7" width="1" height="5" /></td>
      </tr>
      <tr>
       <td valign="top"><table width="800" border="0" cellspacing="0"
cellpadding="0">
        <tr>
         <td width="800" height="215" align="left" valign="top" class="bdr"><div
align="center">
          <table width="800" height="180" border="0">
           <tr>
```

```html
<td width="300" valign="top"><div align="left">
 <p align="center"><strong><img src="images/6.JPG" width="360"
height="270" /><br />
 </strong></p>
</div></td>
<td valign="top"><table width="180" border="0">
</table>


                              <form action="" method="post"
enctype="multipart/form-data" name="form1" id="form1">


        <table width="500" border="0" align="center">
         <tr>
          <td height="30" colspan="2"><div align="center"
class="style15">Patient's Registration Form </div></td>
         </tr>


         <tr>
          <td colspan="2"><table width="500" border="0" align="center">
           <tr>
            <td width="150"><div align="right" class="style18
style16">FirstName </div></td>
            <td><label> </label>
             <label>
             <div align="left">
              <input name="textfield" type="text" id="textfield" />
             </div>
             </label>                </td>
           </tr>
           <tr>
            <td><div align="right" class="style22">Midle Name
</div></td>
            <td><label> </label>
             <label>
```

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```html
          <div align="left">
            <input type="text" name="textfield2" />
          </div>
        </label>                              </td>
    </tr>
    <tr>
      <td><div align="right" class="style22">Surname</div></td>
      <td><label></label>
          <label>
          <div align="left">
            <input type="text" name="textfield3" />
          </div>
        </label>                        </td>
    </tr>
    <tr>
      <td><div align="right" class="style22">Designation</div></td>
      <td><label> </label>
          <label>
          <div align="left">
            <input type="text" name="textfield4" />
          </div>
        </label>                        </td>
    </tr>
    <tr>
      <td><div align="right" class="style22">Occupation</div></td>
      <td><label> </label>
          <label>
          <div align="left">
            <input type="text" name="textfield5" />
          </div>
        </label>                        </td>
    </tr>
    <tr>
```

```html
                    <td><div align="right" class="style22">State of Origin
</div></td>
                    <td><label> </label>
                      <label>
                      <div align="left">
                        <select name="select17">
                          <option>Anambra</option>
                          <option>Imo</option>
                          <option>Enugu</option>
                          <option>Abia</option>
                          <option>Ebonyi</option>
                          <option>Rivers</option>
                          <option>Akwa-Ibom</option>
                          <option>Cross River</option>
                          <option>Delta</option>
                          <option>Lagos</option>
                          <option>Abuja</option>
                          <option>Kano</option>
                          <option>Kaduna</option>
                          <option>Benue</option>
                          <option>Ogun</option>
                          <option>Kogi</option>
                          <option>Taraba</option>
                          <option>Niger</option>
                          <option>Zamfara</option>
                          <option>Sokoto</option>
                          <option>Kastina</option>
                          <option>Kebbi</option>
                          <option>Taraba</option>
                          <option>Platue</option>
                          <option>Bayesa</option>
                        </select>
                      </div>
                      </label>                                    </td>
```

```html
        </tr>
        <tr>
          <td><div align="right" class="style22">DOB</div></td>
          <td><label> </label>
            <label>
            <div align="left">
              <input type="text" name="textfield7" />
              (yy-mm-dd)                          </div>
            </label>                          </td>
        </tr>
        <tr>
          <td><div align="right" class="style22">Sex</div></td>
          <td><label> </label>


              <div align="left">
                <select name="select">
                  <option>Male</option>
                  <option>Female</option>
                </select>
              </div></td>
        </tr>
        <tr>
          <td><div align="right" class="style22">Marital Status

</div></td>
          <td><label> </label>
            <label>
            <div align="left">
              <select name="select2">
                <option>Single</option>
                <option>Married</option>
                <option>Divorced</option>
              </select>
            </div>
            </label>                          </td>
```
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```html
        </tr>
        <tr>
         <td><div align="right" class="style22">Age</div></td>
         <td><label> </label>
            <label>
            <div align="left">
              <input type="text" name="textfield82" />
            </div>
            </label>                        </td>
        </tr>
        <tr>
         <td><div align="right" class="style22">Blood Group
</div></td>
         <td><label> </label>
            <label>
            <div align="left">
              <select name="select3">
               <option>AB</option>
               <option>AB-</option>
               <option>A+</option>
               <option>A-</option>
               <option>B+</option>
               <option>B-</option>
               <option>O+</option>
               <option>O-</option>
              </select>
            </div>
            </label>                    </td>
        </tr>
        <tr>
         <td><div align="right" class="style22">National ID No
</div></td>
         <td><label> </label>
            <label>
```

```html
                              <div align="left">
                               <input type="text" name="textfield92" />
                              </div>
                             </label>                          </td>
                        </tr>
                        <tr>
                          <td><div align="right" class="style22">Telephone No
</div></td>
                          <td><label> </label>
                            <label>
                            <div align="left">
                             <input type="text" name="textfield10" />
                            </div>
                            </label>                        </td>
                        </tr>
                        <tr>
                          <td><div align="right" class="style22">Residential Address
</div></td>
                          <td><label> </label>
                            <label>
                            <div align="left">
                             <input type="text" name="textfield11" />
                            </div>
                            </label>                       </td>
                        </tr>
                        <tr>
                          <td><div align="right" class="style22">Grade Level
</div></td>
                          <td><label>
                            <label></label>
                            </label>
                            <label>
                            <div align="left">
                             <input type="text" name="textfield12" />
```

```
                          </div>
                      </label></td>
              </tr>
              <tr>
                <td><div align="right" class="style22">Step </div></td>
                <td><label> </label>
                    <label>
                    <div align="left">
                      <input type="text" name="textfield13" />
                    </div>
                    </label>                        </td>
              </tr>
              <tr>
                <td><div align="right" class="style22">Employer </div></td>
                <td><label> </label>
                    <label>
                    <div align="left">
                      <input name="select4" type="text" id="select4" />
                    </div>
                    </label>                        </td>
              </tr>
              <tr>
                <td><div align="right" class="style22">Healthcare Provider
</div></td>
                <td><label> </label>
                    <label>
                    <div align="left">
                      <select name="select5">
                       <?php
$user="root";
$database="healthcare";
mysql_connect(localhost,$user);
@mysql_select_db($database) or die( "Unable to select database");
```

```php
$result="SELECT * FROM tblhospital";
$query=mysql_query($result);
$num=mysql_numrows($query);


$sn=1;
while ($display = mysql_fetch_object($query))


                {


$pr= "$display->hospital";

 ?>
                        <option><?php echo $pr; ?></option>
                        <?php
                $sn++;
                }
                ?>
                    </select>
                  </div>
                </label>                    </td>
              </tr>
              <tr>
                <td><div align="right" class="style22">Genotype </div></td>
                <td><label> </label>
                  <label>
                  <div align="left">
                    <select name="select6">
                      <option>AA</option>
                      <option>AS</option>
                      <option>SS</option>
                    </select>
                  </div>
                  </label>                    </td>
              </tr>
```

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```
                              <tr>
                                <td><div align="right" class="style22">Medical History

(Alergy) </div></td>
                                <td><label> </label>
                                  <label>
                                  <div align="left">
                                    <input type="text" name="textfield14" />
                                  </div>
                                  </label>                              </td>
                              </tr>
                              <tr>
                                <td colspan="2"><div align="right" class="style18">
                                    <div align="center"><span class="style9">One Spouse and

Four Biological Children</span> </div>
                                  </div>
                                    <label>
                                    <div align="center">
                                      <table width="500" border="1">
                                        <tr>
                                          <td width="100"> </td>
                                          <td width="100"><span class="style8">First

Name</span></td>
                                          <td width="100"><span class="style8">Sex</span></td>
                                          <td width="100"><span class="style8">Blood Group

</span></td>
                                          <td width="90"><span class="style8">DOB</span></td>
                                        </tr>
                                        <tr>
                                          <td><span class="style8">Spouse</span></td>
                                          <td><label>
                                            <input type="text" name="textfield15" />
                                          </label></td>
                                          <td><label>
                                            <select name="select7">
```

```html
          <option>Male</option>
          <option>Female</option>
        </select>
      </label></td>
      <td><label>
        <select name="select8">
          <option>AB</option>
          <option>AB-</option>
          <option>A+</option>
          <option>A-</option>
          <option>B+</option>
          <option>B-</option>
          <option>O+</option>
          <option>O-</option>
        </select>
      </label></td>
      <td><label>
        <input name="textfield16" type="text" size="9" />
      </label></td>
    </tr>
    <tr>
      <td><span class="style8">Child 1 </span></td>
      <td><label>
        <input type="text" name="textfield17" />
      </label></td>
      <td><label>
        <select name="select9">
          <option>Male</option>
          <option>Female</option>
        </select>
      </label></td>
      <td><label>
        <select name="select10">
          <option>AB</option>
```

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```html
      <option>AB-</option>
      <option>A+</option>
      <option>A-</option>
      <option>B+</option>
      <option>B-</option>
      <option>O+</option>
      <option>O-</option>
     </select>
    </label></td>
    <td><label>
     <input name="textfield18" type="text" size="9" />
    </label></td>
   </tr>
   <tr>
    <td><span class="style8">Child 2 </span></td>
    <td><label>
     <input type="text" name="textfield19" />
    </label></td>
    <td><label>
     <select name="select11">
      <option>Male</option>
      <option>Female</option>
     </select>
    </label></td>
    <td><label>
     <select name="select12">
      <option>AB</option>
      <option>AB-</option>
      <option>A+</option>
      <option>A-</option>
      <option>B+</option>
      <option>B-</option>
      <option>O+</option>
      <option>O-</option>
```

```
    </select>
   </label></td>
   <td><label>
    <input name="textfield20" type="text" size="9" />
   </label></td>
  </tr>
  <tr>
   <td><span class="style8">Child 3 </span></td>
   <td><label>
    <input type="text" name="textfield21" />
   </label></td>
   <td><label>
    <select name="select13">
     <option>Male</option>
     <option>Female</option>
    </select>
   </label></td>
   <td><label>
    <select name="select14">
     <option>AB</option>
     <option>AB-</option>
     <option>A+</option>
     <option>A-</option>
     <option>B+</option>
     <option>B-</option>
     <option>O+</option>
     <option>O-</option>
    </select>
   </label></td>
   <td><label>
    <input name="textfield22" type="text" size="9" />
   </label></td>
  </tr>
  <tr>
```

```html
<td><span class="style8">Child 4 </span></td>
<td><label>
  <input type="text" name="textfield23" />
</label></td>
<td><label>
  <select name="select15">
    <option>Male</option>
    <option>Female</option>
  </select>
</label></td>
<td><label>
  <select name="select16">
    <option>AB</option>
    <option>AB-</option>
    <option>A+</option>
    <option>A-</option>
    <option>B+</option>
    <option>B-</option>
    <option>O+</option>
    <option>O-</option>
  </select>
</label></td>
<td><label>
  <input name="textfield24" type="text" size="9" />
</label></td>
</tr>
<tr>
  <td> </td>
  <td> </td>
  <td> </td>
  <td> </td>
  <td> </td>
</tr>
</table>
```

```
                            </div>
                          </label></td>
                        </tr>
                        <tr>
                          <td class="style18"><div align="right"> Picture </div></td>
                          <td><label>
                            <div align="left">
                              <input type="file" name="file" />
                            </div>
                          </label></td>
                        </tr>

                      </table></td>
                    </tr>
                  <tr>
                    <td width="200"><div align="right" class="style18"></div></td>
                    <td width="300"><label>
                      <div align="left">
                        <input name="username2" type="hidden" id="username2"
value="<?php echo $username ?>" />
                        <input name="password2" type="hidden" id="password2"
value="<?php echo $password?>" />
                      </div>
                    </label></td>
                  </tr>

                  <tr>
                    <td class="style16"><div align="right" class="style18">Date
Registered </div></td>
                    <td><div align="left">
                     <label>
                     <input name="textfield8" type="text" value="<?php echo
date("y-m-d");?>" />
                     </label>
```
169

```
</div></td>
                </tr>
                <tr>
                 <td class="style16"><div align="right"
class="style18">Time</div></td>
                 <td><div align="left">
                  <label>
                  <input name="textfield9" type="text" value="<?php echo
date("H:i A");?>" />
                  </label>
</div></td>
                </tr>
                <tr>
                 <td> </td>
                 <td><label>
                  <div align="left">
                   <input name="Submit2" type="submit" class="btn"
id="Submit2" value="Submit" />
                  </div>
                 </label></td>
                </tr>
               </table>
                </form>
            </td>
           </tr>
          </table>
         </div></td>
         <td><img src="images/spacer.gif" alt="4" width="1" height="5" /></td>
        </tr>
        <tr>
         <td colspan="2" valign="top" class="t4"> </td>
        </tr>
        <tr>
```

```html
            <td width="327" align="left" valign="top" class="t4"><?php echo
$welcome;?></td>
            <td align="left" valign="top"> </td>
          </tr>
          <tr>
            <td align="left"><div align="center"></div></td>
            <td align="left" valign="top"><b><a href="gallery.php"></a></b></td>
          </tr>
          <tr>
            <td height="25" colspan="2" class="divider"> </td>
          </tr>
        </table></td>
      </tr>
    </table></td>
  </tr>
</table>
<p align="center"> </p>
</body>
</html>
```

Treament, Diagnosis and Vital Sign Codes

```php
<?php
$user="root";
$database="healthcare";
mysql_connect(localhost,$user);
@mysql_select_db($database) or die( "Unable to select database");
$username = $_POST['username'];
$password = $_POST['password'];
$id = $_POST['id'];
$select = "select * from tblhospital where username = '$username' and password =
'$password'";
$login = mysql_query($select) ;//or die(mysql_error());
```

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```php
if (mysql_num_rows($login)!=1)
{
 header("Location: userloginerror.php");
echo 'Invalid Password <br />';
}
else


{


$welcome = "Welcome ".$username;


$select2 = "select * from tbldiagnosis where cardno='$id'";
$result = mysql_query($select2) ;
}
?>
```

```html
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1" />
<title>Efficient Healthcare Management Model Using Integrated Database and Data
Mining Techniques</title>
<link href="skb.css" rel="stylesheet" type="text/css" />
<script type="text/javascript" src="jQuery.js"></script>
<script type="text/javascript" src="js.js"></script>
<script language="javascript" src="mootools/mootools.svn.js"
type="text/javascript"></script>
<style type="text/css">
<!--
body {
        background-color: #FFFFFF;
}
.style2 {
        font-size: 18px;
```

```
        color: #FF0000;
}
.style5 {font-size: 12; font-weight: bold; }
.style7 {color: #FFFFFF; }
-->
</style>
<script type="text/javascript">

function view(user,pass,id,url)

{
document.userForm.action=url;
$("#username").val(user);
$("#password").val(pass);
$("#id").val(id);
$("#userForm").submit();
}
</script>
</head>

<body>
<table width="600" border="0">
  <tr>
  <td><form id="userForm" name="userForm" method="post" action="">
          <input name="username" type="hidden" id="username" value="<?php
echo $username ?>" />
          <input name="password" type="hidden" id="password" value="<?php
echo $password ?>" />
          <input name="id" type="hidden" id="id" />
  </form></td>
  </tr>
</table>
<table width="800" border="0" align="center" cellpadding="0" cellspacing="0"
id="wrapper">
```

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```html
<tr>
  <td><table width="800" border="0" cellspacing="0" cellpadding="0">
    <tr>
      <td><img src="images/name.gif" width="800" height="100" /></td>
    </tr>
    <tr>
      <td><img src="images/spacer.gif" alt="5" width="1" height="5" /></td>
    </tr>
    <tr>
      <td id="navbar"><ul id="nav">
              <li><a href="#"
onclick="adminTransfer('userhead.php');">HOME</a></li>
                              <li><a href="#"
onclick="adminTransfer('diag.php');">DIAGNOSIS</a></li>
              <li><a href="#" onclick="adminTransfer('vital.php');">VITAL
SIGNS</a></li>
              <li><a href="#"
onclick="adminTransfer('treat.php');">TREATMENT</a></li>
<li><a href="#" onclick="adminTransfer('blood.php');">BLOOD GROUP</a></li>
              <li><a href="#"
onclick="adminTransfer('finger.php');">FINGERPRINT</a></li>
    <li><a href="#" onclick="adminTransfer('medical.php');">MEDICAL
HISTORY</a></li>
              <li><a href="#"
onclick="adminTransfer('stat.php');">STATISTICS</a></li>
    <li><a href="#" onclick="adminTransfer('index.php');">LOG OUT</a></li>
     <li></li>
    </ul></td>
    </tr>
    <tr>
      <td><img src="images/r2.gif" alt="5" width="800" height="5" /></td>
    </tr>
    <tr>
```

```html
    <td valign="top"><table width="800" border="0" cellspacing="0"
cellpadding="0">
    <tr>
     <td><img src="images/spacer.gif" alt="7" width="1" height="5" /></td>
    </tr>
    <tr>
     <td valign="top"><table width="800" border="0" cellspacing="0"
cellpadding="0">
      <tr>
       <td width="800" height="215" align="left" valign="top" class="bdr"><div
align="center">
        <table width="800" height="180" border="0">
         <tr>
          <td valign="top"><div align="left">
           <p align="center" class="style2">Patient's   Medical Diagnosis Report
</p>
            <table width="800" border="0">
             <tr>
              <td width="150" bgcolor="#0000FF"><div align="center"
class="style7"><span class="style5">Name</span></div></td>
                                              <td width="150"
bgcolor="#0000FF"><div align="center" class="style7"><span
class="style5">Hospital</span></div></td>
              <td width="200" bgcolor="#0000FF"><div align="center"
class="style7"><span class="style5">Diagnosis </span></div></td>
              <td width="150" bgcolor="#0000FF"><div align="center"
class="style7"><span class="style5">Prescription </span></div></td>
              <td width="80" bgcolor="#0000FF"><div align="center"
class="style7"><span class="style5">Doctor </span></div></td>
              <td width="70" bgcolor="#0000FF"><div align="center"
class="style7"><span class="style5">Date</span></div></td>

             </tr>
                                <?php
```

```php
        $sn=1;


        while ($display = mysql_fetch_object($result))


        {
        ?>
        <tr>
          <td><?php echo "$display->name"; ?></td>
              <td><?php echo "$display->hospital"; ?></td>
          <td><?php echo "$display->diagnosis"; ?></td>
        <td><?php echo "$display->prescription"; ?></td>
        <td><?php echo "$display->doctor"; ?></td>
          <td><?php echo "$display->dateconsulted"; ?></td>


        </tr>
                                    <?php
                                     $sn++;
        }
                                    ?>
      </table>
      <p align="center">  </p>
    </div>
     </td>
    </tr>
  </table>
 </div></td>
 <td><img src="images/spacer.gif" alt="4" width="1" height="5" /></td>
</tr>
<tr>
 <td colspan="2" valign="top" class="t4"> </td>
</tr>
<tr>
```

```html
        <td width="327" align="left" valign="top" class="t4"><?php echo
$welcome;?></td>
        <td align="left" valign="top"> </td>
      </tr>
      <tr>
        <td align="left"><div align="center"></div></td>
        <td align="left" valign="top"><b><a href="gallery.php"></a></b></td>
      </tr>
      <tr>
        <td height="25" colspan="2" class="divider"> </td>
      </tr>
     </table></td>
    </tr>
   </table></td>
  </tr>
 </table></td>
 </tr>
</table>
<p align="center"> </p>
</body>
</html>
```

Medical History Codes

```php
<?php
$user="root";
$database="healthcare";
mysql_connect(localhost,$user);
@mysql_select_db($database) or die( "Unable to select database");
$username = $_POST['username'];
$password = $_POST['password'];

$select = "select * from tblhospital where username = '$username' and password =
'$password'";
$login = mysql_query($select) ;//or die(mysql_error());
```

```php
if (mysql_num_rows($login)!=1)
{
 header("Location: userloginerror.php");
echo 'Invalid Password <br />';
}
else


{


$welcome = "Welcome ".$username;


$select2 = "select * from tblmembers";
$result = mysql_query($select2) ;
}


?>
```

```html
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1" />
<title>Efficient Healthcare Management Model Using Integrated Database and Data
Mining Techniques</title>
<link href="skb.css" rel="stylesheet" type="text/css" />
<script type="text/javascript" src="jQuery.js"></script>
<script type="text/javascript" src="js.js"></script>
<script language="javascript" src="mootools/mootools.svn.js"
type="text/javascript"></script>
<style type="text/css">
<!--
body {
        background-color: #FFFFFF;
}
```

```
.style2 {
        font-size: 18px;
        color: #FF0000;
}
.style5 {font-size: 12; font-weight: bold; }
.style7 {color: #FFFFFF; }
-->
</style>
<script type="text/javascript">

function view(user,pass,id,url)

{
document.userForm.action=url;
$("#username").val(user);
$("#password").val(pass);
$("#id").val(id);
$("#userForm").submit();
}
</script>
</head>

<body>
<table width="600" border="0">
  <tr>
  <td><form id="userForm" name="userForm" method="post" action="">
          <input name="username" type="hidden" id="username" value="<?php
echo $username ?>" />
          <input name="password" type="hidden" id="password" value="<?php
echo $password ?>" />
          <input name="id" type="hidden" id="id" />
  </form></td>
  </tr>
</table>
```

```
<table width="800" border="0" align="center" cellpadding="0" cellspacing="0"
id="wrapper">
 <tr>
   <td><table width="800" border="0" cellspacing="0" cellpadding="0">
    <tr>
     <td><img src="images/name.gif" width="800" height="100" /></td>
    </tr>
    <tr>
     <td><img src="images/spacer.gif" alt="5" width="1" height="5" /></td>
    </tr>
    <tr>
     <td id="navbar"><ul id="nav">
              <li><a href="#"
onclick="adminTransfer('userhead.php');">HOME</a></li>
                            <li><a href="#"
onclick="adminTransfer('diag.php');">DIAGNOSIS</a></li>
              <li><a href="#" onclick="adminTransfer('vital.php');">VITAL
SIGNS</a></li>
              <li><a href="#"
onclick="adminTransfer('treat.php');">TREATMENT</a></li>
<li><a href="#" onclick="adminTransfer('blood.php');">BLOOD GROUP</a></li>
                <li><a href="#"
onclick="adminTransfer('finger.php');">FINGERPRINT</a></li>
     <li><a href="#" onclick="adminTransfer('medical.php');">MEDICAL
HISTORY</a></li>
              <li><a href="#"
onclick="adminTransfer('stat.php');">STATISTICS</a></li>
     <li><a href="#" onclick="adminTransfer('index.php');">LOG OUT</a></li>
      <li></li>
     </ul></td>
    </tr>
    <tr>
     <td><img src="images/r2.gif" alt="5" width="800" height="5" /></td>
    </tr>
```

```html
    <tr>
      <td valign="top"><table width="800" border="0" cellspacing="0"
cellpadding="0">
        <tr>
          <td><img src="images/spacer.gif" alt="7" width="1" height="5" /></td>
        </tr>
        <tr>
          <td valign="top"><table width="800" border="0" cellspacing="0"
cellpadding="0">
            <tr>
              <td width="800" height="215" align="left" valign="top" class="bdr"><div
align="center">
                <table width="800" height="180" border="0">
                  <tr>
                    <td valign="top"><div align="left">
                      <p align="center" class="style2">Patient's   Medical Report</p>
                      <table width="800" border="0">
                        <tr>
                          <td width="100" bgcolor="#0000FF"><div align="center"
class="style7"><span class="style5">First Name</span></div></td>
                                                    <td width="100"
bgcolor="#0000FF"><div align="center" class="style7"><span
class="style5">Surname</span></div></td>
                          <td width="200" bgcolor="#0000FF"><div align="center"
class="style7"><span class="style5">Address </span></div></td>
                          <td width="100" bgcolor="#0000FF"><div align="center"
class="style7"><span class="style5">ID </span></div></td>
                          <td width="100" bgcolor="#0000FF"><div align="center"
class="style7"><span class="style5">Diagnosis </span></div></td>
                          <td width="100" bgcolor="#0000FF"><div align="center"
class="style7"><span class="style5">Vital Sign</span></div></td>
                                                    <td width="100"
bgcolor="#0000FF"><div align="center" class="style7"><span
class="style5">Treatment</span></div></td>
```

```php
            </tr>
                            <?php
        $sn=1;

        while ($display = mysql_fetch_object($result))

        {

     $id = "$display->EID";


    $vi = '<a href="#"
onclick=view("'.$username.'","'.$password.'","'.$id.'","vitald.php")>View</a>';
    $tr = '<a href="#"
onclick=view("'.$username.'","'.$password.'","'.$id.'","treatd.php")>View</a>';


    $dg = '<a href="#"
onclick=view("'.$username.'","'.$password.'","'.$id.'","diagd.php")>View</a>';


            ?>
            <tr>
             <td><?php echo "$display->FirstName"; ?></td>
                                    <td><?php echo "$display->Surname"; ?></td>
             <td><?php echo "$display->Address"; ?></td>
             <td><?php echo "$display->EID"; ?></td>
            <td><div align="center"><?php echo $dg; ?></div></td>


             <td><div align="center"><?php echo $vi; ?></div></td>


             <td><div align="center"><?php echo $tr; ?></div></td>
            </tr>
                            <?php
                             $sn++;
        }
```
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```
                                          ?>
              </table>
              <p align="center">  </p>
            </div>
             </td>
            </tr>
          </table>
        </div></td>
        <td><img src="images/spacer.gif" alt="4" width="1" height="5" /></td>
       </tr>
       <tr>
        <td colspan="2" valign="top" class="t4"> </td>
       </tr>
       <tr>
        <td width="327" align="left" valign="top" class="t4"><?php echo
$welcome;?></td>
        <td align="left" valign="top"> </td>
       </tr>
       <tr>
        <td align="left"><div align="center"></div></td>
        <td align="left" valign="top"><b><a href="gallery.php"></a></b></td>
       </tr>
       <tr>
        <td height="25" colspan="2" class="divider"> </td>
       </tr>
      </table></td>
     </tr>
    </table></td>
   </tr>
 </table></td>
 </tr>
</table>
<p align="center"> </p>
</body>
```

</html>

Hospital Registration Codes

```php
<?php
$user="root";
$database="healthcare";
mysql_connect(localhost,$user);
@mysql_select_db($database) or die( "Unable to select database");
if(!($_POST['username2']))
{
$username = $_POST['username'];
$password = $_POST['password'];
}
else
{
$username = $_POST['username2'];
$password = $_POST['password2'];
}
$select = "select * from tblusers where username = '$username' and password =
'$password' and userrole='Admin'";
$login = mysql_query($select) ;//or die(mysql_error());
if (mysql_num_rows($login)<1)
{
  header("Location: loginerror.php");
echo 'Invalid Password <br />';
}
else
{
$welcome = "Welcome ".$username;
$txtuser=$_POST['textfield3'];
$txtna=$_POST['textfield4'];
$txtad=$_POST['textfield5'];
$txtst=$_POST['textfield6'];
$txtpsw=$_POST['textfield'];
$txtdt=$_POST['textfield8'];
```

```php
$txttm=$_POST['textfield9'];


if ($txtna)
{
$query = "INSERT INTO tblhospital (hospital, address, state, username, password,
datereg, timereg)
 VALUES ( '$txtna','$txtad','$txtst','$txtuser','$txtpsw','$txtdt','$txttm')";


mysql_query($query)
 or die(mysql_error());
}


}


?>


<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1" />
<title>Efficient Healthcare Management Model Using Integrated Database and Data
Mining Techniques</title>
<link href="skb.css" rel="stylesheet" type="text/css" />
<script type="text/javascript" src="jQuery.js"></script>
<script type="text/javascript" src="js.js"></script>
<script language="javascript" src="mootools/mootools.svn.js"
type="text/javascript"></script>
<style type="text/css">
<!--
body {
        background-color: #FFFFFF;
}
.style15 {
```

```
        font-size: 20px;
        color: #660000;
}
.style16 {font-size: 14px}
.style18 {color: #0000FF; font-weight: bold; }
-->
</style>


</head>


<body>
<table width="600" border="0">
 <tr>
  <td><form id="userForm" name="userForm" method="post" action="">
          <input name="username" type="hidden" id="username" value="<?php
echo $username ?>" />
          <input name="password" type="hidden" id="password" value="<?php
echo $password ?>" />
  </form></td>
 </tr>
</table>
<table width="800" border="0" align="center" cellpadding="0" cellspacing="0"
id="wrapper">
 <tr>
   <td><table width="800" border="0" cellspacing="0" cellpadding="0">
    <tr>
     <td><img src="images/name.GIF" width="800" height="100" /></td>
    </tr>
    <tr>
     <td><img src="images/spacer.gif" alt="5" width="1" height="5" /></td>
    </tr>
    <tr>
     <td id="navbar"><ul id="nav">
```

```
        <li><a href="#"
onclick="adminTransfer('adminhead.php');">HOME</a></li>
      <li><a href="#" onclick="adminTransfer('userreg.php');">PATIENT'S
REGISTRATION</a></li>
              <li><a href="#"
onclick="adminTransfer('hostreg.php');">HOSPITAL REGISTRATION</a></li>
      <li><a href="#" onclick="adminTransfer('setpass.php');">SETUP
PASSWORD</a></li>
      <li><a href="#" onclick="adminTransfer('members.php');">VIEW
PATIENTS</a></li>
      <li><a href="#" onclick="adminTransfer('viewhost.php');">VIEW
HOSPITAL</a></li>

      <li><a href="#" onclick="adminTransfer('index.php');">LOG OUT</a></li>
      <li></li>
     </ul></td>
    </tr>
    <tr>
     <td><img src="images/r2.gif" alt="5" width="800" height="5" /></td>
    </tr>
    <tr>
     <td valign="top"><table width="800" border="0" cellspacing="0"
cellpadding="0">
       <tr>
        <td><img src="images/spacer.gif" alt="7" width="1" height="5" /></td>
       </tr>
       <tr>
        <td valign="top"><table width="800" border="0" cellspacing="0"
cellpadding="0">
          <tr>
           <td width="800" height="215" align="left" valign="top" class="bdr"><div
align="center">
             <table width="800" height="180" border="0">
              <tr>
```

```html
            <td width="300" valign="top"><div align="left">
             <p align="center"><strong><img src="images/6.JPG" width="360"
height="270" /><br />
             </strong></p>
           </div></td>
           <td valign="top"><table width="180" border="0">
           </table>



                              <form action="" method="post"
enctype="multipart/form-data" name="form1" id="form1">


               <table width="500" border="0" align="center">
                <tr>
                  <td colspan="2"><div align="center" class="style15">Hospital
Registration Form </div></td>
                </tr>
                <tr>
                  <td width="200" class="style16"><div align="right"
class="style18">User Name </div></td>
                  <td width="300"><div align="left">
                    <label>
                    <input type="text" name="textfield3" />
                    </label>
</div></td>
                </tr>
                <tr>
                  <td class="style16"><div align="right" class="style18">Hospital
Name </div></td>
                  <td><div align="left">
                    <label>
                    <input type="text" name="textfield4" />
                    </label>
</div></td>
                </tr>
```

```
                        <tr>
                          <td class="style16"><div align="right"
class="style18">Address</div></td>
                          <td><div align="left">
                            <label>
                            <input type="text" name="textfield5" />
                            </label>
</div></td>
                          </tr>
                          <tr>
                            <td class="style16"><div align="right" class="style18">State
</div></td>
                            <td><div align="left">
                              <label>
                              <select name="textfield6" id="textfield6">
                                <option>Anambra</option>
                    <option>Imo</option>
                    <option>Enugu</option>
                    <option>Abia</option>
                    <option>Ebonyi</option>
                    <option>Rivers</option>
                    <option>Akwa-Ibom</option>
                    <option>Cross River</option>
                    <option>Delta</option>
                    <option>Lagos</option>
                    <option>Abuja</option>
                    <option>Kano</option>
                    <option>Kaduna</option>
                    <option>Benue</option>
                    <option>Ogun</option>
                    <option>Kogi</option>
                    <option>Taraba</option>
                    <option>Niger</option>
                    <option>Zamfara</option>
```

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```html
            <option>Sokoto</option>
            <option>Kastina</option>
            <option>Kebbi</option>
            <option>Taraba</option>
            <option>Platue</option>
            <option>Bayesa</option>
                </select>
                </label>
</div></td>
                </tr>


                <tr>
                 <td><div align="right" class="style18"><span
class="style16">Password  </span></div></td>
                 <td><label>
                  <div align="left">
                    <input type="password" name="textfield" />
                    <input name="username2" type="hidden" id="username2"
value="<?php echo $username ?>" />
                    <input name="password2" type="hidden" id="password2"
value="<?php echo $password?>" />
                  </div>
                 </label></td>
                </tr>


                <tr>
                 <td class="style16"><div align="right" class="style18">Date
Registered </div></td>
                 <td><div align="left">
                  <label>
                  <input name="textfield8" type="text" value="<?php echo
date("y-m-d");?>" />
                  </label>
</div></td>
```

```html
          </tr>
          <tr>
            <td class="style16"><div align="right"
class="style18">Time</div></td>
            <td><div align="left">
              <label>
              <input name="textfield9" type="text" value="<?php echo
date("H:i A");?>" />
              </label>
</div></td>
          </tr>
          <tr>
            <td> </td>
            <td><label>
              <div align="left">
                <input name="Submit2" type="submit" class="btn"
id="Submit2" value="Submit" />
              </div>
            </label></td>
          </tr>
        </table>
          </form>
        </td>
      </tr>
    </table>
    </div></td>
    <td><img src="images/spacer.gif" alt="4" width="1" height="5" /></td>
  </tr>
  <tr>
    <td colspan="2" valign="top" class="t4"> </td>
  </tr>
  <tr>
    <td width="327" align="left" valign="top" class="t4"><?php echo
$welcome;?></td>
```

```html
        <td align="left" valign="top"> </td>
      </tr>
      <tr>
       <td align="left"><div align="center"></div></td>
       <td align="left" valign="top"><b><a href="gallery.php"></a></b></td>
      </tr>
      <tr>
       <td height="25" colspan="2" class="divider"> </td>
      </tr>
     </table></td>
    </tr>
   </table></td>
  </tr>
 </table></td>
</tr>
</table>
<p align="center"> </p>
</body>
</html>
```

Fingerprint Codes

```php
<?php
$user="root";
$database="healthcare";
mysql_connect(localhost,$user);


@mysql_select_db($database) or die( "Unable to select database");


$username = $_POST['username'];
$password = $_POST['password'];
$hid = $_POST['select'];
$tm = date("y-m-d h:i:s");
$select = "select * from tblhospital where username = '$username' and password =
'$password'";
$login = mysql_query($select) ;//or die(mysql_error());
```

```php
if (mysql_num_rows($login)!=1)

{

 header("Location: userloginerror.php");

echo 'Invalid Password <br />';

}

else

{

$welcome = "Welcome ".$username;

$cmp= mysql_fetch_object($login);

$hsp = "$cmp->hospital";

}


?>
```

```html
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"

"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">

<html xmlns="http://www.w3.org/1999/xhtml">

<head>

<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1" />

<title>Efficient Healthcare Management Model Using Integrated Database and Data
Mining Techniques</title>

<link href="skb.css" rel="stylesheet" type="text/css" />

<script type="text/javascript" src="jQuery.js"></script>

<script type="text/javascript" src="js.js"></script>

<script language="javascript" src="mootools/mootools.svn.js"

type="text/javascript"></script>

<style type="text/css">

<!--

body {

        background-color: #FFFFFF;

}

.style15 {font-size: 24px}

-->

</style>
```

```html
</head>

<body>
<table width="600" border="0">
 <tr>
  <td><form id="userForm" name="userForm" method="post" action="">
          <input name="username" type="hidden" id="username" value="<?php
echo $username ?>" />
          <input name="password" type="hidden" id="password" value="<?php
echo $password ?>" />
  </form></td>
 </tr>
</table>
<table width="800" border="0" align="center" cellpadding="0" cellspacing="0"
id="wrapper">
 <tr>
   <td><table width="800" border="0" cellspacing="0" cellpadding="0">
    <tr>
     <td><img src="images/name.gif" width="800" height="100" /></td>
    </tr>
    <tr>
     <td><img src="images/spacer.gif" alt="5" width="1" height="5" /></td>
    </tr>
    <tr>
     <td id="navbar"><ul id="nav">
              <li><a href="#"
onclick="adminTransfer('userhead.php');">HOME</a></li>
                         <li><a href="#"
onclick="adminTransfer('diag.php');">DIAGNOSIS</a></li>
              <li><a href="#" onclick="adminTransfer('vital.php');">VITAL
SIGNS</a></li>
              <li><a href="#"
onclick="adminTransfer('treat.php');">TREATMENT</a></li>
<li><a href="#" onclick="adminTransfer('blood.php');">BLOOD GROUP</a></li>
```
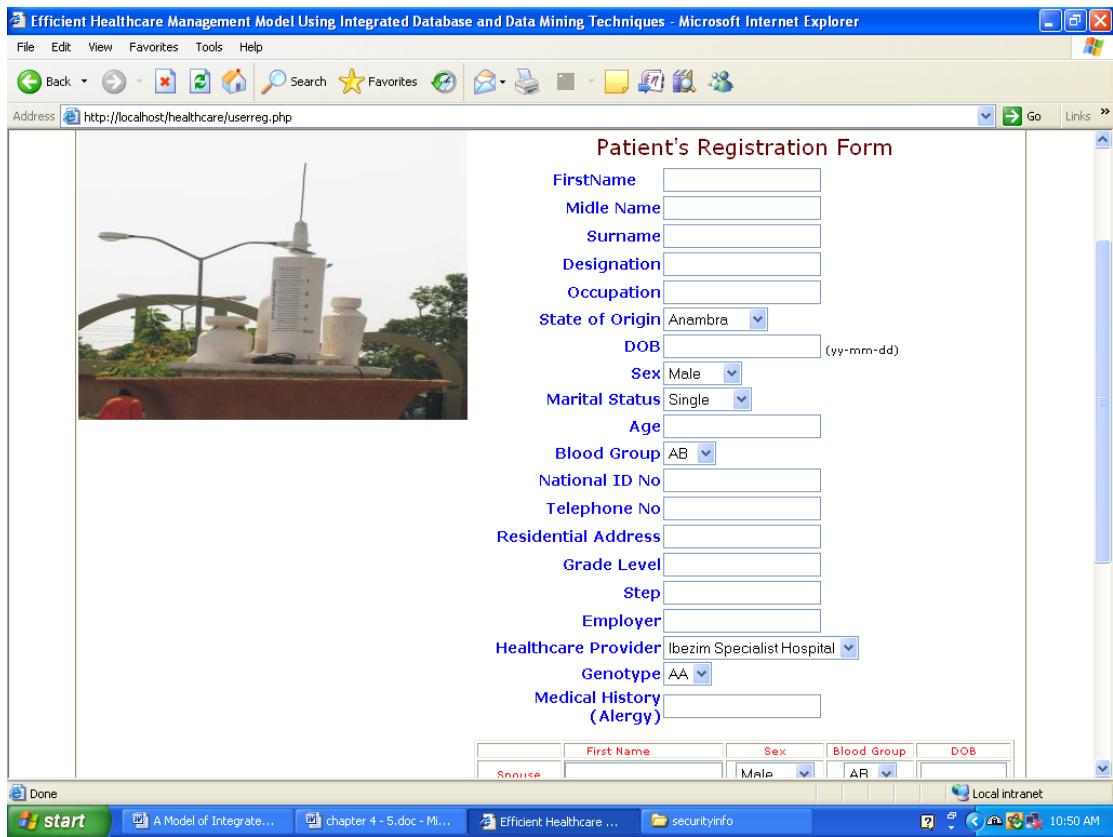
```html
            <li><a href="#"
onclick="adminTransfer('finger.php');">FINGERPRINT</a></li>
    <li><a href="#" onclick="adminTransfer('medical.php');">MEDICAL
HISTORY</a></li>
              <li><a href="#"
onclick="adminTransfer('stat.php');">STATISTICS</a></li>
     <li><a href="#" onclick="adminTransfer('index.php');">LOG OUT</a></li>
      <li></li>
     </ul></td>
    </tr>
    <tr>
     <td><img src="images/r2.gif" alt="5" width="800" height="5" /></td>
    </tr>
    <tr>
     <td valign="top"><table width="800" border="0" cellspacing="0"
cellpadding="0">
       <tr>
        <td><img src="images/spacer.gif" alt="7" width="1" height="5" /></td>
       </tr>
       <tr>
        <td valign="top"><table width="800" border="0" cellspacing="0"
cellpadding="0">
         <tr>
          <td width="800" height="215" align="left" valign="top" class="bdr"><div
align="center">
            <table width="800" height="180" border="0">
             <tr>
              <td valign="top"><div align="left">
               <p align="center"><strong><br class="titletxt" /><?php echo $hsp;?>
                </strong></p>
              </div>                <table width="180" border="0">
                </table>
              <div align="center"></div>
              <div align="center">
```
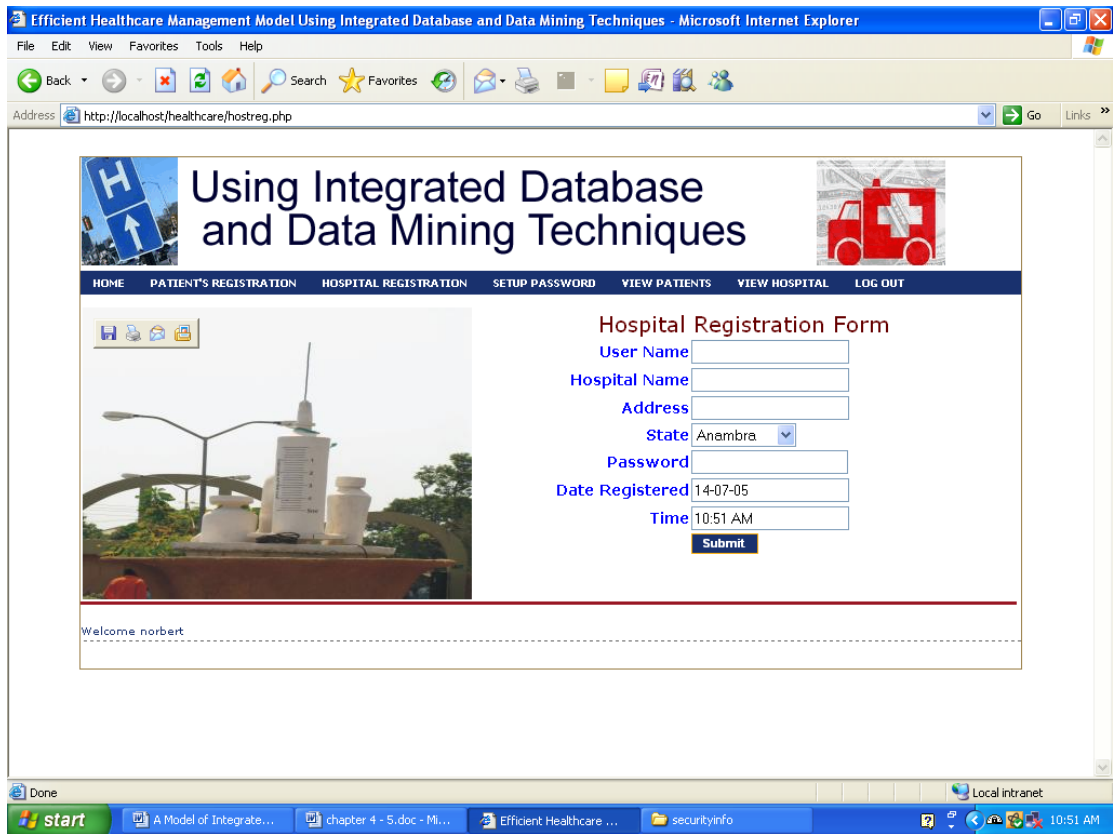
```html
          <p><img src="images/gabon_non_connected_reader1.jpg"
width="150" height="244" /></p>
              <p><a href="finger/FingerCapture.exe">Verify Fingerprint</a></p>
              <p> </p>
            </div></td>
            </tr>
          </table>
         </div></td>
         <td><img src="images/spacer.gif" alt="4" width="1" height="5" /></td>
        </tr>
        <tr>
         <td colspan="2" valign="top" class="t4"><div align="center"
class="style15">
             <p>Welcome, Login Successful.  </p>
             <p> </p>
           </div></td>
         </tr>
         <tr>
          <td width="327" align="left" valign="top" class="t4"><?php echo
$welcome;?></td>
          <td align="left" valign="top"> </td>
         </tr>
         <tr>
          <td align="left"><div align="center"></div></td>
          <td align="left" valign="top"><b><a href="gallery.php"></a></b></td>
         </tr>
         <tr>
          <td height="25" colspan="2" class="divider"> </td>
         </tr>
        </table></td>
       </tr>
      </table></td>
     </tr>
    </table></td>
```
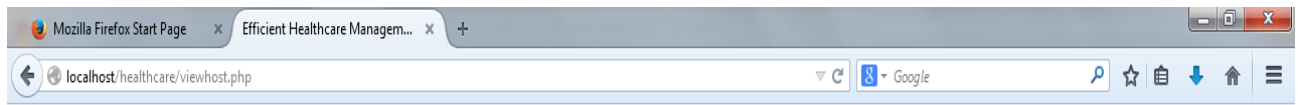
```html
  </tr>
</table>
<p align="center"> </p>
</body>
</html>
```

APPENDIX B
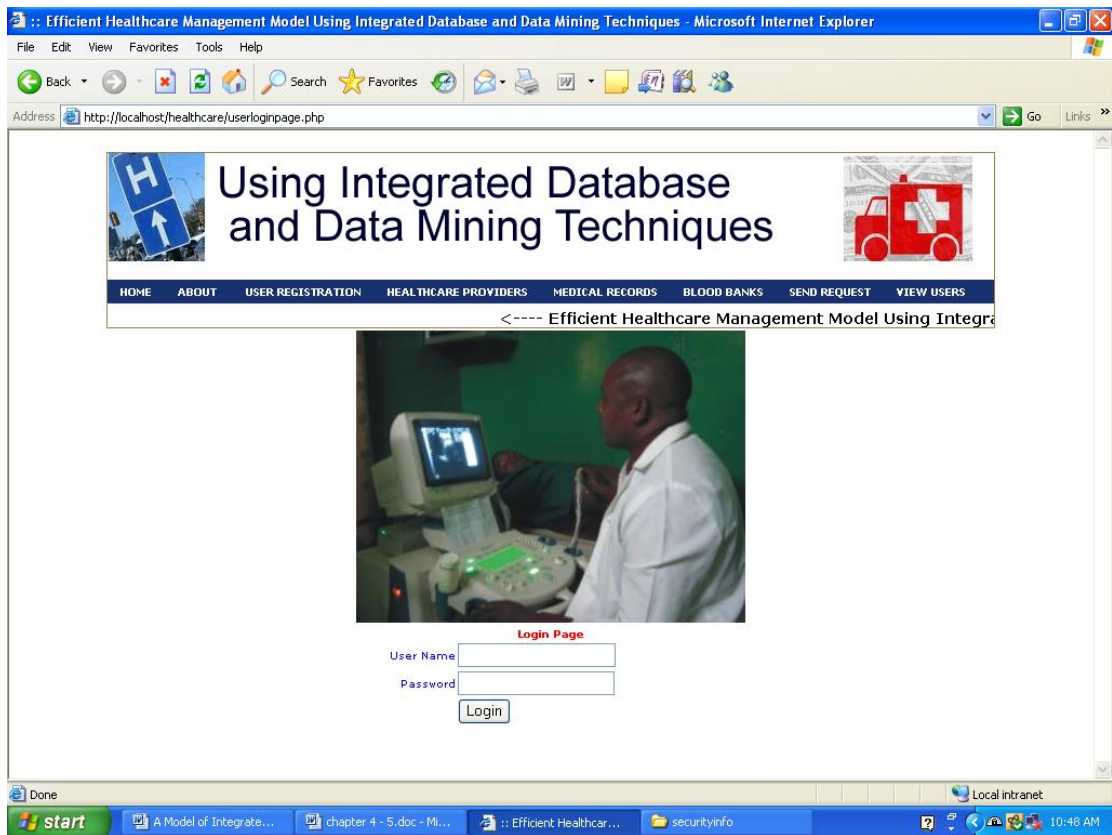
The Login Form
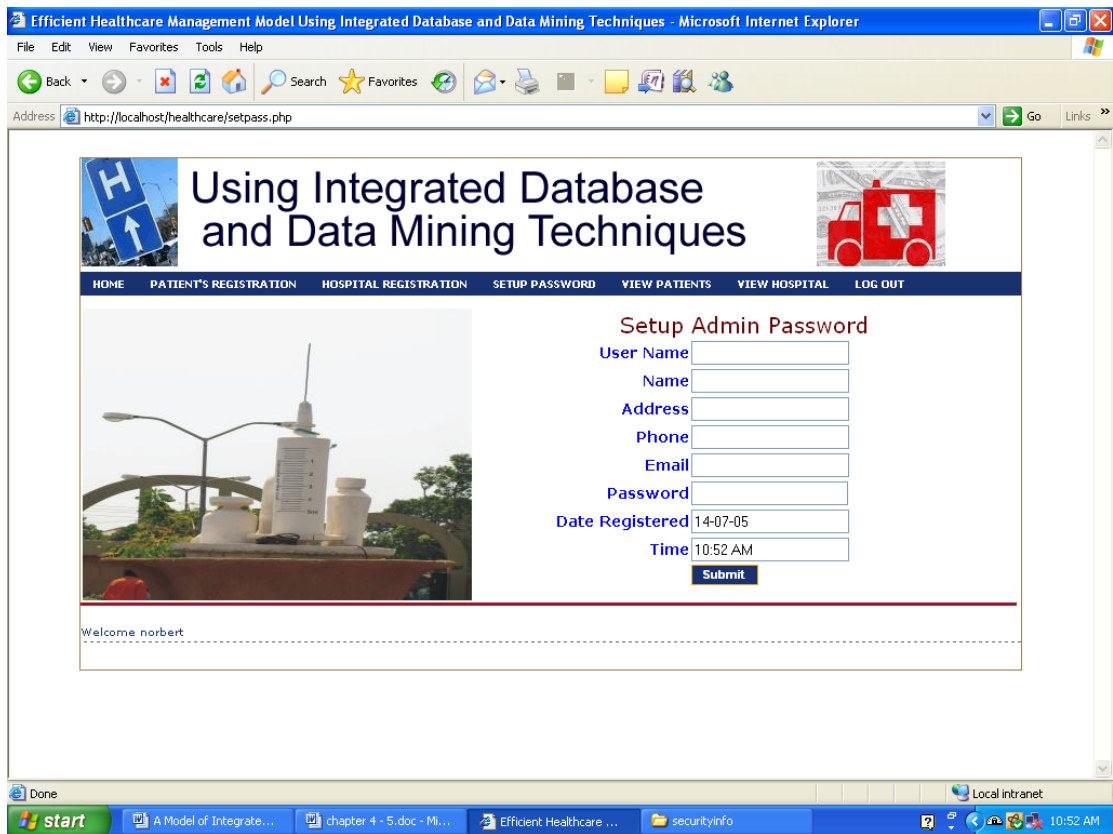
Administrative Password Form

Patient's Medical History Report

Registered Patient's Report

Patient's Registration Form

Hospital Registration Form

Patient's Record Details

Hospital Report