Design and Implementation of Electronic Medical Records System for Kogi State College of Education's Clinic Ankpa

Adaji Andrew
Senior Program Officer, New Hope Agency, Ankpa, Kogi State, Nigeria
Elizabeth Onyeje Akpa
Teacher, Department of Computer Science
New Covenant Christian College International, Makurdi, Benue State, Nigeria
Matthew David Femi
Lecturer, Department of Physic, Kogi State College of Education, Ankpa, Kogi State, Nigeria
Aboritori Sunday
Lecturer, Department of Integrated Science, Kogi State College of Education, Ankpa, Kogi State, Nigeria
Idachaba Stephen O.
Lecturer, Department of Integrated Science, Kogi State College of Education, Ankpa, Kogi State, Nigeria

Abstract:
The Electronic Medical Record System was designed for Kogi State College of Education's Clinic Ankpa, to transform the way patient's medical records is being store, search, sort, kept and accessed. It was designed to transform the manual method to electronic method. The goal of the medical record management system is to streamline patient's information and its accessibility for health care providers in the institution. These changes will improve patient care quality and safety over time, and also provide a more accurate, reliable and efficient method of computer based system that will lessen time consuming in the clinic. The programming tools used include Java and Microsoft Access 2003. The software was tested and found effective for the institution. It is recommended for large institute, organization and establishment.

Keywords: Electronic medical record system, network, information technology, information system, records, database management system, structured query language, java programming language.

1. Background

Our world has been radically transformed by digital technology-smart phones, tablets, and web-enabled devices have transformed our daily lives and the way we communicate. Medicine is an information-rich enterprise a greater and more seamless flow of information within an electronic health records (EHRS) can transform the way health care is delivered and compensated. Before now an electronic Medical record contains the standard medical and clinical data gathered in one provider's office.

Research shows that keeping records of clients who visit hospital facilities is one of the most important studies of the hospital irrespective of the capacities, and the nature of activities that takes place in such health facilities. Records provide clinicians, patients or other individuals with knowledge and person-specific information, intelligently filtered or presented at appropriate times to enhance health and better health care. Health facilities who understand the importance of record keeping often takes it very serious; some have integrated their records into electronic formats. Some have created a database for their records. The basic task of the electronic record management system software is to assemble, manage and organize the data of clients, and also staff of the facilities. Problems related to records of the clients can easily be traced and solve using the electronic medical system.

The electronic Medical Record System will consist of an application program that communicates with a database which generates several reports from queries that are issued by the user. It works on the same principle as manual system only that the computer automates the process. So it is fast and more accurate, there is an assurance of accurate and updated information in case the need of accessible of the client's data is required. It would be user friendly with aesthetic user interface design. This ensures that the user or administrator would spend less time learning the system and increase their efficiency.

1.1. Theoretical Framework
Health Care Organizations around the world have developed several methods of keeping their records, paper based records have been in existence for years and are still by far the most common methods of keeping records in health care facilities. Recently though, some Health Care Organization are recognizing the benefit of maintaining electronic medical records for patients with improved quality of service, free flow of information (access at multiple locations), reduced cost of operations resulting in cost efficiencies, better health and efficient utilization of resources. Recognizing these benefits as opportunities, health care providers have or are in the process of migrating from paper-based health care records to electronic medical systems. This transition is not always free from challenges. Some health care provider captures their client's records in form of excel worksheets as the electronic system. Running reports across multiple spreadsheets was difficult, creating a simple report, one that would contain all clients' records was not easy because it involves sorting and filters the data in several spreadsheets, copying and pasting the results to a single worksheet adding and formatting to improve the presentation, these will take several hours. Another problem was data integrity, because all the spreadsheets were maintained manually, data entry errors frequency caused the clients records to become inaccurate.

The world of Information and Communication Technology has gone beyond just using excel for database. A more robust information system is required. It suggests a computer technology to be used in order to provide information to users in an organization. For the purpose of data being transformed into useful information, computer hardware and software are designed and used. A particular case is the Electronic Records Systems development. This kind of system is responsible for storing data of the clients that visits the health facilities and generate reports upon request. It could be integrated with other information systems or modules.

1.2. Statement of the Problem
It has been observed that in Kogi State College of Education, Ankpa, the students, staff and other client's records have been handled manually, i.e. using paper-work, not even excel sheet. This has been observed to be inefficient and cumbersome thereby increasing loss time and reducing productivity. It is the objective of this thesis therefore to seek ways to improve the system and make it more efficient by using the Structured Query Language (SQL) management server as the database and JavaScript programming language to write the code of the electronic medical records been developed.

1.3. Aims and Objectives of the Study
The aim of this research work is to design an electronic Medical Record System for Kogi State College of Education, Ankpa. It is expected that on delivery, the proposed electronic Medical record system would improve the record keeping method of the school, which will provide for a quick retrieval and management of client's information and due to the speed of computer, it is expected to provide fast and efficient responses to client information system and data needs.

1.4. Significance of the Study
The revolution of Information and Communication Technology has played a vital role in medical science, including the ways records are kept. This study aims at providing data integrity, avoid redundancy of data and also provide supportive supervision and monitoring of the design and implementation of electronic medical records system software in Kogi State College of Education, Ankpa. It will also help to access and develop ICT skills and managerial needs of staff and management of Kogi State College of Education clinic staff. In general, the research would be of immense benefit to the medical unit of the college.

2. Literature Review
Information is an important and valuable business resource. To survive, business and organizations must have up to data information at the right time and in the right form and in the right place to make management decision. Records management is the systematic control of all records from their creation through their processing, distribution, organization, storage and retrieval to their ultimate disposition (Barklay T. B 2004). Because information is such an important resource to a health care organization, the patients record is take very serious; because it is seen as a guild in providing inform decision by the clinician (international standards organizations ISO 15489 2009)

Recent research on electronic records has produced proposals and models for adding functionality and procedural controls to information system; so that systems care protects the authenticity and integrity of records (Margret Headstream, 2011).

Many organizations in the world after the tragedies of the terrorist attacks on the United States and the well-known corporate scandals which affected the profession of records and information management globally have begun to consider electronic record management as a great option. (Melvin, D. 2001). Electronic technology has greatly expanded the methods of creating editing maintain transmitting and retrieving information most of this electronic information are records because they are used by health care provider's organization to make decision that will guild the clinicians. Though electronic information processing system contains very important information, they do not perform electronic record-keeping functions (Gray D, Aileen Adams and Bary D.K 2002).

Recently, archivist have taken up the change to tame the wild frontier through a variety of research and development projects which have proposed strategies for bringing order integrity to the records of modern information system. Records professionals have been breaking grounds and laboring to solve record-keeping issue on the edge of the electronic frontier (Margret Headstream, (2011).

2.1. Basic Requirement of an Electronic Record-Keeping System
The basic requirements for electronic record-keeping system that manage records are as follows:

2.1.1. Life Cycle Management
    i. The system must manage records throughout their life cycle and be able to:
    ii. Distinguish between record and non-record material
    iii. Match each record to the application record schedule
    iv. Indicate whether the record or the file containing the record is close.
    v. Identify the final disposition date, which is calculated from the date of closure.
    vi. Allow for the separation and removal of temporary records and non-records for destruction and permanent records for transfer to the database.
    vii. Ensure that temporary records authorized for destruction are deleted in accordance with approved records schedules and are not recoverable following their deletion (EPA, 2013).

2.1.2. Metadata
The system must capture metadata about the records it manages and be able to:
    i. Identify each record sufficiently to enable authorized personnel to retrieve, protect, and carry out the disposition of the records in the system.
    ii. Correlate records maintained in the system with related records on paper, microform or other media.
    iii. Preserve transmission and receipt data of any records managed by the system.
    iv. Retain names of addresses on distribution lists for records managed by the system.

2.1.3. Retrieval
The system must retrieve records and be able to:
    i. Permit easy retrieval in a timely fashion.
    ii. Ensure that records are accessible by individuals who have a business need for information in the records.
    iii. Provide a method for all authorized users of the system to retrieve desired documents, such as an indexing or text search system.
    iv. Permit retrieval of both individual records and files or other grouping of related records.

2.1.4. Integrity
The system must ensure the integrity of the records it manages and be able to:
    1. Minimize the risk of unauthorized alteration or ensure of the records.
    2. Allow only authorized personnel access to the records in the system.
    3. Allow only authorized personnel to perform administrative functions such as creating or deleting directories, altering the parameters of metadata fields and assigning access rights.

2.1.5. Security
The system must provide an opiate level of security for the records it manages and be able to comply with appropriate regulatory authority.

2.1.6. Backup
The system must be allowed for records to be backed up to protect against information loss and be able to:
    i. Be backed up on a regular basis to safeguard against the loss of information due to equipment malfunctions or human error.
    ii. Provide for recovery of the records that have been copied during the backup.
    iii. Allow duplicate copes of permanent or unscheduled records to be maintained in storage areas separate from the location of the records that have been copied CPA (2013): Basic requirement of an electronic record-keeping system.

2.1.7. Migration
The system must allow records to be migrated and be able to:
    i. Retain the records in a usable format for their required retention period and until authorized disposition date.
    ii. Ensure that information is not lost because of changing technology or deterioration.
    iii. Allow for the conversion of storage media to provide compatibility with current hardware and software.
    iv. Maintain a link between records and their metadata through conversion or migration.

3.1. System Analysis and Design

3.1.1. Operation Requirement
The current method of managing both patients and staff information was studied in order to have better understanding of both functional and non-functional requirements necessary for its operation. In the course of study, the researcher interacted with the staff of Kogi State College of Education clinic and also the administrative staff. Documents were reviewed and operation procedures were also formed and these formed a major part of system elicitation.

3.1.2. Functional Requirements
These requirements involved factors that make a give system to performed effectively and efficiently according to its desired functions. It captures the intended behaviors of the system, the behavior may express as task, services or functions the system is required to perform. System must exhibit software quality attributes such as accuracy, performance, security and modification. Functional requirements present a systematic and grammatical approach to building quality into the system. Functional requirement is a well-defined database which manages and store data for the effective running of the system.

3.2. Object – Oriented Analysis
The main purpose of an object-oriented analysis (OOA) is to describe what the new system will do; it has three steps.
    i.   Use – case modeling
   ii.   Class modeling
  iii.   Dynamic modeling

3.2.1. Use – Case Modeling
A use – case is a set of scenarios that describes an interaction between a user and a system. A use-case diagram displays the relationship among actors and use cases. The two main components of use case diagram are use cases and actors.
For the purpose of this design the following were identified;

3.2.2. Actors
     1. Nurses
     2. Clerical staff
     3. Pharmacy

3.2.3. Use Cases
     1. Patient personal data entry
     2. Patient treatment data entry
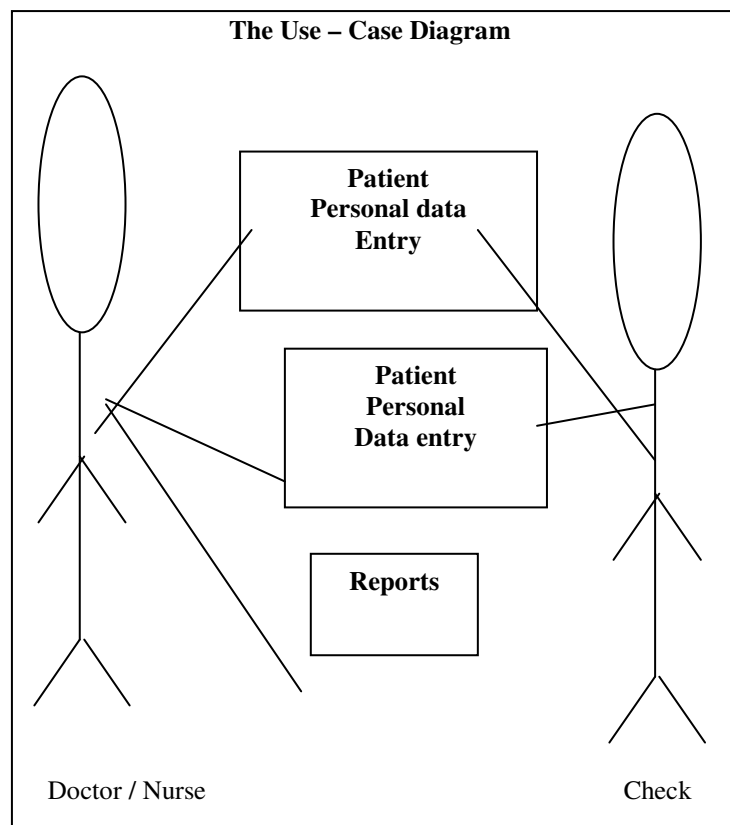   3. Staff data entry
     4. Reports.

Figure 1: use – case diagram for KSCOE clinic Application

3.1.4. Class Modeling

Class Modeling diagram are wisely used to describe the types of object in a system and their relationships. Class diagram model, class structure and content uses design elements such as classes, packages and objects.
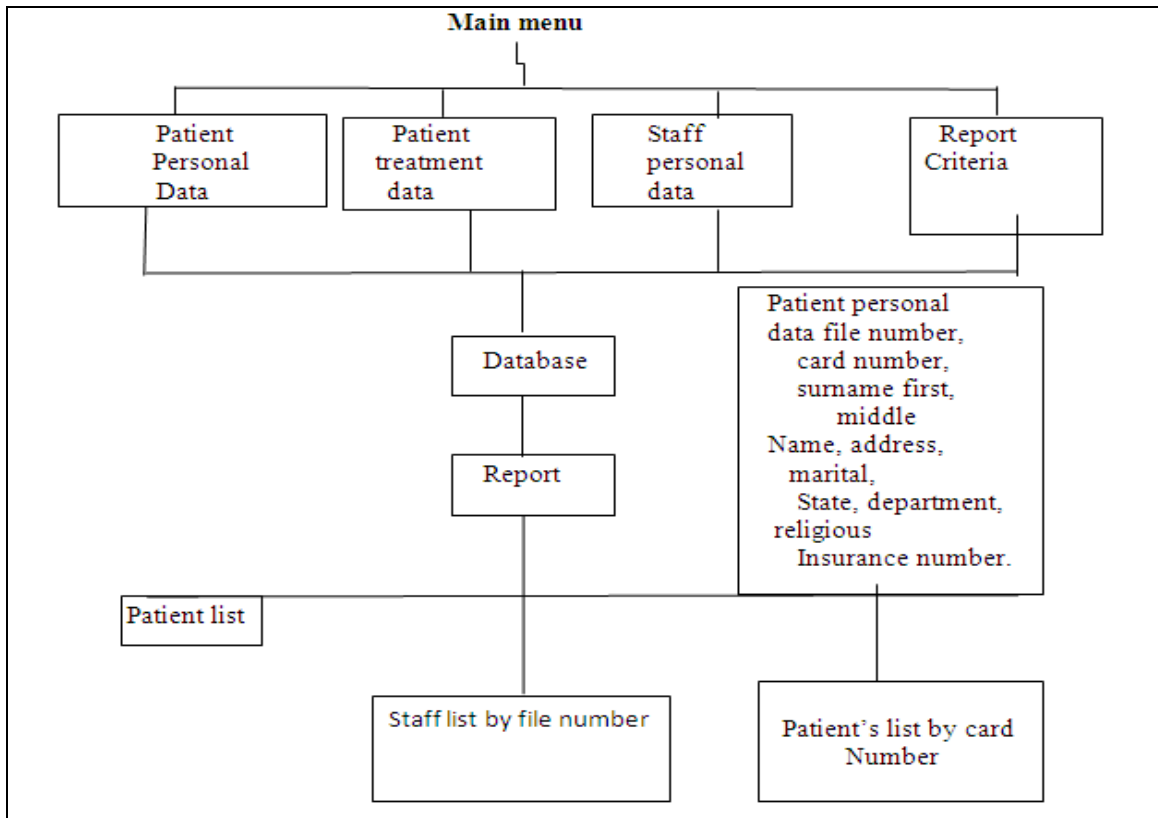This is represented in the figure below.

Figure 2: Unified modeling language (UML) class diagram for KSCOE Ankpa.

3.1.5. Dynamic Modeling

The aim of this is to produce a state diagram. State diagrams are used to describe the behavior of an object as a number of states and transition between these states. A state represents a particular set of values for an object. Given a state a transition represents a future state the object can move to and the conditions associated with the change of state. A state pertains to the product as a whole, but because the classes of KSOCE Ankpa, application product do not move from state to state diagram below is appropriate.
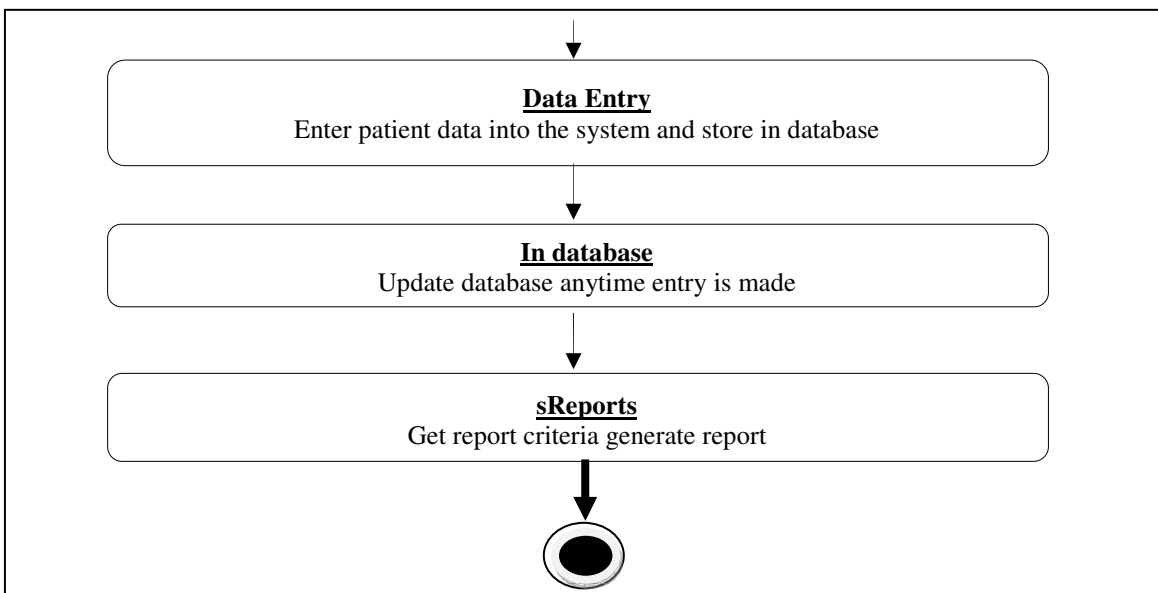

Figure 3: Unified modeling language state diagram for KSCOE Ankpa

3.2. Database Design
The relational database model was used in the design of the database for Kogi State College of Education Ankpa application. The benefits of a database that has been designed according to the relational model are:-
  i.   Data entry updates and deletions will be efficient.
  ii. Data retrieval, summarization and reporting will also be efficient.
  iii. Since the database follows a well-formulated model, it behaves predictably.
  iv. Since mush of the information is stored in the database rather in the application, the database is somewhat self-documenting.
  v.   Changes to the database schema are easy to make. Normalization was used in simplify the design of the database in order to bring it to optimum stauncher.

3.2.1. Table Structure Design

Field Name	Data Type	Field Size
F_No	Text	50
Card_No	Text	50
SName	Text	18
FName	Text	18
MName	Text	18
Address	Text	100
State	Text	15
MNumber	Text	15
Department	Text	20
School	Text	20
Age	Text	20
Gender	Text	6
Date	Date/Time	8
Religion	Text	10
Insurance_No	Text	15

Table 1: Patient Bio Data

Patient treatment data		
Field Name	Data Type	Field
F_No	Text	50
Card_No	Text	50
SName	Text	15
FName	Text	15
MName	Text	15
Address	Text	100
M_Status	Text	7
M_Number	Text	15
Department	Text	20
School	Text	20
Doctor_Name	Text	30
Nurse_Name	Text	30
Diagnosis	Text	100
Treatment	Text	100
Date _Admitted	Date/Time	
Date_Release	Date/Time	
Reason_for_Release	Text	50

Table 2: Patient treatment data

4. Creating the Application
The application was created using Java programming language.

4.1. Graphic User Interface (GUI)
The graphic user interface (GUI) is an interface with which users interact with the system. The GUI defines how various elements look and function. Java was used for the design of the graphic user interface. The application was designed as a single a single document interface (SDI) application and can be menu driven. The SDI form provided by Java was ultilised to achieved this. This

allows each form to act independently of the others and thus only one form can be open and contained within a single document interface (SDI) form.

4.2. Main Menu
The menu editor was used to create a standard bar which contained the main items based on catergories with each category containing sub menu items.

Figure 4: Electronic Medical Record platform.

4.3. Patient Registration
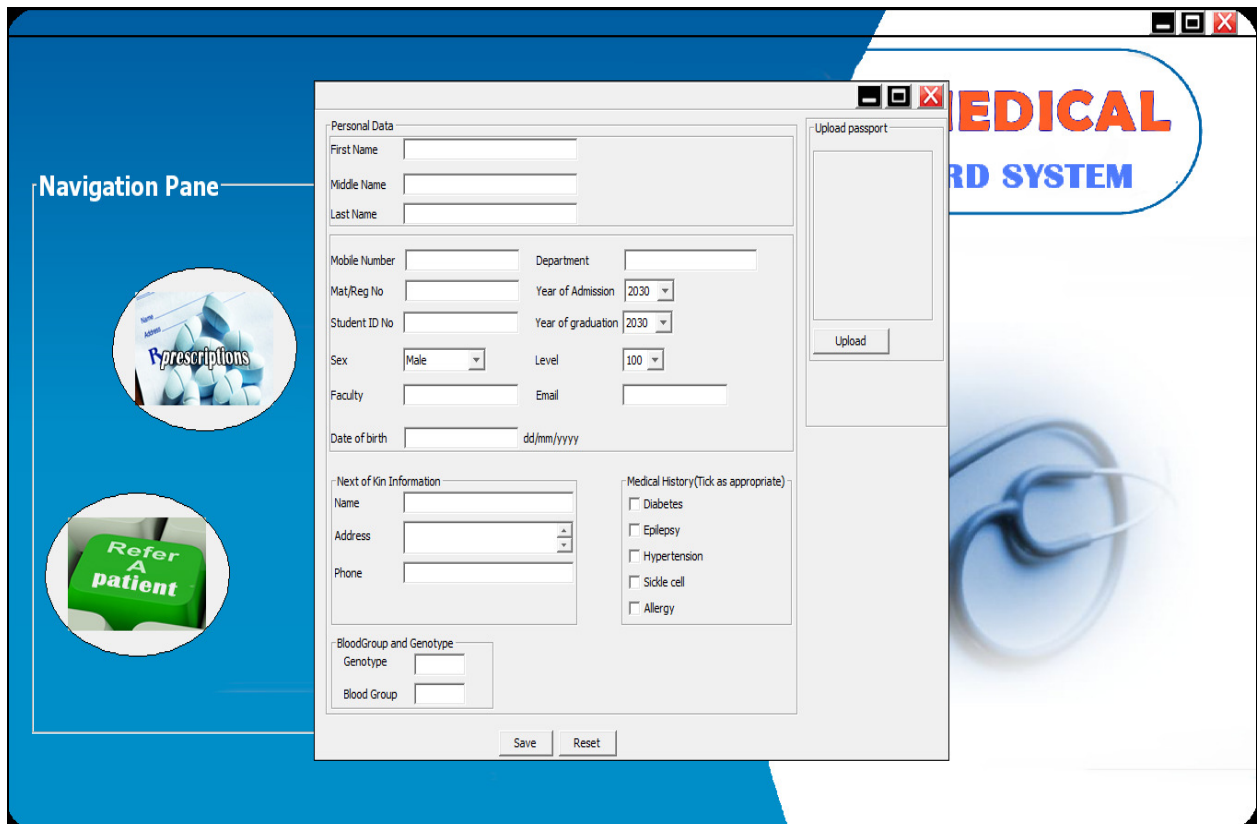This form is used for entering all needed information about the patients.

Figure 5: New Patient Data entry form

4.4. Patient Prescription Form
 The information contained in this form is used by the facility that the patient is been referred to. It shows the record of the patient previous complains and what was diagnosed.

Figure 6: Patience description form

4.5. Common Features
- Some common features are found almost on all of the forms. They are described as follows;
- Save: After all the required entries for a record have been made, a click on the save button saves the records in the database.
- Delete: This is used to remove a particular record from the database.
- Update: After a record has been retrieved or corrected, this button is used to effect changes to the same record in the database. This does not create a new record.
- Add new: This is used to add a new record to the database, a click on this button clears the form for a new entry.
- Edit: This button is used to retrieve a particular record from the database for the purpose of updating it.
- Exit: This terminates the program and returns back to the main menu. It closes all the active displayed form.

4.6. Coding
Java codes were written behind the control on the graphic user interface to manipulate them, to enable them function as required and to communicate with the database. The code performs the background work necessary for communicating between the user interface and the database.

4.7. System Testing, Debugging and Compilations
This is the verification that the whole system works according to the design. Each unit module in the software design is tested in order to ensure that there is no error as a result of incorrect code, syntax error and typographic error. After the successful testing of the unit modules, the same testing is done for the system as a whole in order to ensure that the program is working as required. The unit and the system module will be brought together after testing in order to integrate the program into a single module.
During the debugging stage, the integrity of the program was tested by comparing program performance to requirement specification also the level of user friendliness was evaluated observing how easy it is for system users to get along with the system.
The final step in the implementation of this system was the compilation of the project. The purpose of this was to compile the code so that it becomes an executable file. This prevents access to the codes and makes the application standard software that can be installed and run on any system that meets the minimum specifications. It also makes the application independent of the existence of Java and MS Access that were used to develop it.

5. Discussion and Recommendation

5.1. Discussion
An electronic medical record's goal is to streamline patient's information and its accessibility for health care providers. These changes will improve patient care quality and safety over time. The research work has been able to identify that the Electronic records management software have proven to be a far better approach to documentation than conventional, paper-based systems.
The research has also come with the findings that the challenges of manual system are
     i. Records can't be retrieved if lost as a result of fire outbreak.
     ii. No security measures are taken in order to protect the files from unauthorized access.
     iii. The documents can easily be destroyed by water etc.

It has also been able to establish that despite the fact the Electronic Medical Records system improves the efficiency of keeping patient's records, specialist staff will need to be employed to ensure the software is kept, updated and running smoothly. The system captures and records patient demographic and visit at the point of care. Registration of data will be display constantly and automatic on screen in the clinician system. When health care providers have access to complete and accurate information, patients receive better medical care. Electronic health records (EHRs) can improve the ability to diagnose diseases and reduce even prevent medical errors, improving patient's outcome. With EHRs provider can reliable access to patient complete health information. This comprehensive picture can help provide diagnosis patients problem sooner. Qualified EHRs may not keep records of patients' medication or allergies. It also automatically checks for problem whenever a new medication is prescribed and alerts the clinicians to potential conflicts. EHRs can expose potential safety problem ever they occur, helping provider avoid more serious consequences for patients and leading to better patient's outcomes. EHRs can help providers quickly and systematically identify and correct operational problems. In a paper-based setting, identifying such problems is much more difficult and correcting them takes time.

5.2. Recommendation
The researcher recommends this work to the management of Kogi State College of Education Ankpa that this software be given the proper attention it deserves. If possible, management should employ the service of an expert in the art of software development to look into the need of making the software complete product with high utility.
To achieve the set goals of this project, the following is also recommended.
    i. Staff Training Requirement:
    ii. Changeover Method
    iii. The office should be marked "Out of bound to unauthorized personnel".
    iv. Uninterruptible Power Supply (UPS) should be installed along with the computer system.

5.3. Suggestion for Further Studies
The researcher suggests that further studies should be carried out on Database records management system for larger organizations, its implementation, maintenance and challenges.

6. References
    i. Barclay, T. B (2004). An Enterprise Content Management Premier. The Information Management Journal. Retrieved October 2004. PP 64-66
    ii. ISO 15489 (2009). Information and Documentation. Records Management. General. Part 1
    iii. Margaret H (2011). Building Records-keeping system; Archivist are not alone on the wild
    iv. Melvin, D (2001). Terrorist Attack on America. A Terrible Tragedy That is Still Hard to Believe. Available at http://melvindurai.com/tragedy.html
    v. Gray D; Aileen A; Barry D.K (2002). A Hand book on electronic Medical Records
    vi. EPA (2013): Basic requirement of an electronic recordkeeping system.