**DESIGN AND IMPLEMENTATION OF AUTOMATED MEDICAL DIAGNOSIS SYSTEM FOR GONORRHEA INFECTION**

**ABSTRACT**

The World Health Organization (WHO)’s report on the circumstances of clinical facilities in developing countries indicates that, there is considerable an inefficient delivery of medical services to the rural inhabitants where the services are needed; these services are also very expensive and not affordable to the average citizen. This has raised inadequacies such as prolonged suffering and even death. The slow process of diagnosis trial and error of diseases can be disastrous when a patient is at the advanced stage of a disease. Here we propose an automated system that can aid the diagnosis of sexually transmitted diseases and suggest adequate drug prescriptions and treatment. To achieve this, an extensive review on related diseases was re-evaluated and a common type (gonorrhea) was used as an exemplary study. This is based on the Waterfall Methodology. The system was implemented using web-based technologies. PHP was used for front-end designs while MySQL was used for data storage. The paper shows a system that is most effective and has a fast way of diagnosing and treating sexually transmitted diseases, which serves as a great relief for the doctors and even non-experts in the field.

**CHAPTER ONE**

**INTRODUCTION**

* 1. **BACKGROUND OF THE STUDY**

Gonorrhea is a sexually transmitted infection due to Neisseria Gonorrhoea (the gonococcus) , which effects primarily the anterior urethra in the male and the urethra and cervix in female. In recent years there has been a great increase in the cases of gonorrhoea throughout the world; approximately 60,000 cases are seen annually in the clinics of England and this figure is even higher in the case of Nigeria and other African countries. After three to five days incubation period in male, the following symptoms and signs will be observed; Dysuria, Urethral discharge (i.e Seropurulent becoming purulent and yellowish) Reddening of urethral meatus etc. Gonococcal protitis common in male homosexuals and is often symptomless. In female, Gonorrhoea is frequently a symptomatic and may never be diagnosed on clinical grounds. Almost three quarters of all female patients attend initially as contacts of male cases and not because of their signs or symptoms. The signs and symptomsin female includes symslight dysuris, slight or moderate vaginal discharge, which is often unnoticed by patient, reddening or acute erosion of the cervix, mucopurulent cervical plug, copious vaginal discharge is more likely to due to concomitant trichomonal vaginities and lower abdominal pain and tenderness is also present, with thickening and tenderness of the affected tube on bimanual palpation. Infertility following bilateral gonococcal salpingitis is now uncommon.

In today’s global economy and competitive environment, Information Technology (IT) is becoming a widely accepted tool for multi-faceted development in all fields. Information Technology (IT) is the bedrock for national survival and development in a rapidly changing global environment. The use of IT on individuals, organization and society is changing everything. The growing usage of IT is rapidly spreading through every sector; its permeating effect is noticeable in institutions, government establishments, business organization, homes and offices etc. The implication of these developments is obvious for the Nigerian societies in the sense that traditional way of doing things must give way. Health Information Management is one of the key factors that contribute to the strengthening of health care delivery in every country. Reliable Health Information Management leads to timely health policies and planning, which improves the general health status of a country, as well as, serving as a vital element for individual health facilities in managing and improving healthcare delivery (Teviu, Aikins, Abdulia, et al., 2012). The use of Information Technologies (ITs) in improving the general management of health records cannot be downplayed. This is affirmed by the ability of ITs to capture, store, retrieve, analyze and transmit large volumes of health records across various locations (Norman, Aikens&Binka, 2011). The adoption of ITs in healthcare delivery, which could generally be referred to as E-health, has not only been crowed generally as eminent in improving the reliability and effectiveness of health records, but it has also been gloated for strengthening healthcare delivery systems through its various tailor-made innovative applications and program such as the Electronic Health Records (Yusif& Soar, 2014).

Although the use of IT’s in healthcare delivery is not a new global paradigm, its adoption and promotion has particularly become relevant in resource constraint developing countries whose healthcare systems are characterized by severe financial, infrastructural, technical and human resource constrictions (Yusif& Soar, 2014). Studies conducted in various developing countries report that the use of ICTs in healthcare delivery leads to better access to healthcare facilities on the part of both patients and healthcare professionals and improved quality of healthcare delivery, which consequently translates into productive labour and the development of the country as a whole (Khan, Shahid, Hedstrom & Anderson, 2012; Cecchini & Scott, 2003; Oyeyemi & Wynn, 2014).

* 1. **STATEMENT OF THE PROBLEM**

To identify the problem, we look at current trend in information technology. The world’s information technology is rapidly changing, thanks to the likes of Bill Gates and his cohorts of Microsoft Corporation and International Electronic (INTEL) of U.S.A. In developing countries like Nigeria, the case is contrary, we see a different trend in science and its development altogether. While some private and government hospitals are now computerized most especially in areas like X-Ray services, Laboratory services and Ultrasound services, the STD units, which have not been much computerized, need an urgent attention.

Some of the problems adherent to the manual operation of the STD unit includes:

* Inaccurate diagnosis of the STDs, which may lead to wrong drug prescription, and at the end may lead to ultimate destruction of the organ involved, especially in women
* Bulkiness of the records because of the rate at which both the teenagers, youths and even the married go about patronizing prostitutes, engaging in unprotected sex and thereby, spreading the STDs.
* Monotonous and repetitive computation of data.
* Retirement, transfer or even death of human expert, which when happen goes with his/her knowledge.

Viewing the above-enumerated problems, Computer-Aided Medical Diagnosis for the Treatment of gonorrhoea or STD, as the title of this project study, becomes very imperative.

* 1. **OBJECTIVES OF THE STUDY**

The main objective of this study is to bring together the combined knowledge of different human expertise and develop an automated system for the storage of such information which can aid the diagnosis of the above mentioned sexually transmitted disease and gives adequate drug prescriptions. To achieve the stated objective, the following specific objectives were laid out:

1. Develop a system using web-based technologies for the storage of information about gonorrhea
2. To make the system services available for any user notwithstanding the user’s location
3. To provide an easy to use interface were users will be required to answer questions based on their symptoms and give correct diagnosis and treatment options
	1. **SCOPE OF THE STUDY**

This research covers Obinwanne Hospital Nkpor. The system is web-based hence it is going to run on a browser. The system has two major interfaces, first for the hospital administrators who add the necessary information concerning sexually transmitted diseases, their symptoms and relevant medication required. Second interface are for patients. Patients browse through the list of symptoms pertaining to a particular disease. They are meant to select symptoms which affect them and the system does the diagnosis based on user symptom selection and gives proper treatment or medication advice where necessary. An internet connection is required to give users access to the system irrespective of their location but for the purpose of this study, a localhost server will be used.

**1.5 SIGNIFICANCE OF THE STUDY**

This thesis will be of utmost importance to medical practitioners. Implementing this system provides several possible advantages over paper records which include:

1. **Reduction of cost:** A vast amount of funds are allocated towards the health care industry. The computerized system is implemented, it will reduce the personnel cost.
2. **Improve quality of care:** The implementation of automated disease diagnosis system can help lessen patient sufferance due to medical errors and the inability of analysts to assess quality.
3. **Promote evidence-based medicine:** Computerized medical record provides access to unprecedented amounts of clinical data for research that can accelerate the level of knowledge of effective medical practices. Realistically, these benefits may only be realized if the systems are interoperable and wide spread (for example, national or regional level) so that various systems can easily share information.
4. **Record keeping and mobility:** Automated systems have the advantages of being able to connect too many electronic medical record systems. In the current global medical environment, patients are shopping for their procedures.
5. **Resort for Knowledge:** This study can be of importance to scholars who are researching the field of automated disease diagnosis as it will serve as a reference point to them.

**1.6 DEFINITION OF TERMS**

1. **Hospital:** is defined as the entity that provides the medical services to the patient in questioned at a given period of time which is basically curative and preventive and is offered in clinic unit x-ray/ ultra sound, laboratory and dental unit in the hospital.
2. **Diagnosis:** the identification of the nature of an illness or other problem by examination of the symptoms.
3. **Gonorrhea:**  Gonorrhea is a common sexually transmitted infection (STI) Men with gonorrhea may have a yellowish discharge from the penis accompanied by itching and burning. If symptoms occur, they may include burning or frequent urination, yellowish vaginal discharge, redness and swelling of the genitals, and a burning or itching of the vaginal area.
4. **Patient Record Management System:** It is a system that can manage multiple administrators and can have the track of the right assigned to them. It makes sure that all the Administrators function with the system as per the rights assigned to them and they can get their work done in efficient manner.
5. **Medical Form:** it refers to the medical document describing the patient initials, diagnoses and treatment of a particular patient in question that can be used for future reference in case of no improvement in the health condition of the patient hence changes can be carried out accordingly.
6. **Consultations Fee:** is the money paid by the patient in question at the receptionist desk before any medical attention.

**CHAPTER TWO**

**LITERATURE REVIEW**

**2.1 INTRODUCTION**

This literature review includes the contextual issues and brief historical overview of available disease diagnosis systems in Nigeria. The discussion focused on the infrastructural requirements for using information technology into health record management practice alongside the cost implications. A significant portion of the literature review centered on the Nigerian situation as it relates to the poor implementation of hospital information systems. Issues highlighted about Nigeria include lack of support infrastructure, corruption and lack of technical support services. The proper management of data storage and retrieval of records are imperative in any organization. In this vein, the system used in keeping records in any healthcare organization should possess the ability to provide smart search functions, instantaneous and multi-location access, and ability to virtually integrate data elements stored in geographically disperse databases (Berg & Toussaint, 2003), as this is the only sure way to ensure better healthcare delivery. The introduction of EHR in healthcare delivery in recent time is therefore aimed to achieve these functional aims highlighted above. In spite of these functionalities, EHR in the healthcare sector is also aimed to trounce the inherent problems associated with paper-based record management systems that have been used in the healthcare industry for over a century

Bringing information technologies to health record management systems encompasses a variety of applications, in tune with needs, both on an individual basis and on a society level. Information technology increases the efficiency of the administrative processes while optimizing costs by rendering all information flows that were previously based on paper documents and translating it into an electronic form. Many reviews have been made and published to date on use of information technology into various sectors and different issues in health record management system in Nigeria. The implementation of health information technology has become a major priority in the health care industry due to rising health care costs; escalating concerns for patient safety and reducing medical errors; focus on improving the provision of evidence-based care; and the increasing number of regulatory requirements placed on health care providers (Doebbeling et al, 2006).

 The health records in most Nigerian health institutions especially in hospitals has been facing some numbers of problems; these had affected the accessibility and utilization of health information in the treatment of people that have health challenges in those hospitals, as information needed on each patient is not being accessible on time or is not even available.

In this section, a review of other relevant studies relating specifically to the objectivities of this study is presented. This section firstly brings to bear the adoption of Information Technology for the development ofhealth record sector in Nigeria, while considering the challenges and benefits of using Information Technology into health record management system. It then proceeds to a review of record keeping (paper and electronic record keeping) in various health facilities. This section also highlights the benefits and challenges associated with the implementation of EHR as accounted for by other studies. It then concludes with a summary and the rationale for the present study

**2.2 THEORETICAL FRAMEWORK**

Currently, a gap in knowledge exists about the exact number of hospital information systems functionally available in Nigeria, but the subjective data project less than 5% implementation of any form of hospital information technology in a country of more than 150 million people (Idowu et al., 2006). The available literature provides a common position among various authors that disparities exist in the implementation of hospital information systems in developing and developed countries (Williams et al, 2008). Speculated reasons include poor technological and funding support in developing nations, poor management capacity at all levels that ensures seamless workflow, and a complex milieu of health care service delivery. Other possible factors for low implementation include the continual evolution of technology, confidentiality problems with use of hospital information systems, and the poor technological background of the Nigerian society (Krishna et al., 2007).

Holden (2009) posited that much research related to adoption of health care information technology has been a theoretical. In this study, a useful theoretical model is the maturity model to process improvement originally described in software engineering and used in the novice-to-expert approach to competency. The maturity theoretical model describes a modernization framework aimed at the committed use of relevant information technology in a change process (Gillies et al, 2005).

Beneficial uses of information and associated technology as it relates to health care improvement in this model includes monitoring individual and organizational performance, facilitating information sharing among different health care organizations through a multi-agency approach, and empowering individuals by providing relevant information to consumers, thereby helping them to make informed choices (Gillies et al, 2005).

An additional theoretical standpoint in this study is that in a heterogeneous society as Nigeria with significant disparity in accessibility of health care facilities between urban and rural communities, hospital information systems will help to bridge the gap in availability of patient care (Ouma et al, 2008). Sammon et al (2009) associated patient data analysis systems (PDAs) with enhanced storage and analysis of patient data, enabling physicians to reach improved clinical decisions on patient care. Similarly, clinical information systems capture clinical data to enhance prompt and efficient decision making (Ward et al, 2006). Hospital information systems improve workflow (Wallis, 2007). Sisniega (2009) asserted that the applications of information and communication technologies (ICT) facilitate ubiquitous and instantaneous communication between organizations and their stakeholders. Information communication technology enables people and organizations to achieve a seamless workflow and effective processes through improved interactions.

**2.3H EALTH RECORDS MANAGEMENT SYSTEM IN NIGERIA**

The processes used to collect, process, and store patient information to aid clinical treatment are probably as old as medicine. The formats for collection of patients’ records and the ways in which this information is used and subsequently stored for future references has continued to evolve from regular paper note takings to electronic taped records and present-day hospital information technologies. Wilcke (2008) defined information literacy that affects medical practice as the ability to identify the need for incorporating information technology. Information technology infusion that aids globalization refers to the degree to which various information technology tools integrate into organizational activities (Idowu et al., 2006). The growth of computer technology in the 1980s with consequent improvement in information literacy saw the advent of the first breed of hospital information systems (Keenan et al., 2006). Earlier researchers in hospital information systems categorized them into three types: Consumer informatics, medical and clinical informatics, and bio informatics based on areas of application (Detmer, 2001).

Medical and clinical informatics applications relate directly to health care organizational processes, structure, and clinical outcomes. Electronic medical records system is a major medical and clinical information system aimed at the lowering cost of health care therapies (Svensson, 2002), In its earliest applications, hospital information systems were mostly used for patient’s electronic record keeping, but has advanced into almost all areas of medical discipline. Common applications of hospital information technologies include Computerized Physician Order Entry, Pharmacy Information Systems, Laboratory Information Systems, Radiology Information System and Picture Archival and Communication Systems, telemedicine, and many others as these technologies are constantly evolving (Jain, 2012).

**2.3.1 Adoption of Information Technology for the Development ofHealth Record Sector in Nigeria**

Over the last few decades, there has been significant pressure on hospitals and physicians to adopt electronic health records system. Thus, the implementation of Information Technology (IT) has become increasingly common in health record settings (Banga et al, 2004). However, the adoption rate remains fairly low, especially in comparison to hospitals in Europe (Anderson et al., 2006).

 The ambitious and challenging healthcare scenario the healthcare providers completely depend on Health Information Technology (HIT) for timely and instant access to health information. At any given point of time during patient encounter or afterwards, HIT allows the provider to collect, store, retrieve and transfer information in and across healthcare settings. The health sector has always relied on technologies. According to WHO (2004), they form the backbone of the services to prevent, diagnose, and treat illness and diseases (Daly, 2010).

Incorporating different information technologies (ITs) into the healthcare system of developing countries is not all about modernizing the health system but it is about saving life by facilitating communication, practicing evidence based decision, incorporating e-learning to remote health professionals, use it as a medium to access recent healthcare information, data handling and processing activities among staffs (ITU, 2012). Among the different IT system initiatives in developing countries medical records systems are becoming dominant with the vision of improving data handling and communication in healthcare organizations (Davies et al, 2006).

The healthcare industry is among the most information intensive business sectors in the world. Some theorists estimate that health workers spend between 35% and 60% of their time managing clinical data (Ebell, 1999). Several developments in IT implementation have taken place in healthcare organizations, with IT playing an increasingly significant role in its delivery. All these technological developments have been made in providing effectively functioning systems to healthcare organizations to improve healthcare services (Grimson, 2001).

Aljumah et al, (2013) observed that the main problems being faced by hospital authorities in preservation and management of records in most developing countries include: Use of outdated forms: Need of constant revision; Shortage of experienced personnel: Need of trained personnel; Lack of planning in storage of inactive records: Need of effective storage and control of in- active records; Lack of determination of records retention period: Need of determination of records retention period. The unwanted records should be destroyed to save the time and resources; also, Delay in transfer of records: transfer of record entail two stages i.e. dating of unimportant records for destructions and ultimate disposal and moving the records from active to in-active files and from there to the storage area.

Besser (1999) also remarked that there are various types of damage that affect paper documents like: ageing document may become weak, colour alteration; the document may have got stained by various means among others. Weak health information systems (HIS) are a critical challenge to reaching the health-related Millennium Development Goals because health systems performance cannot be adequately assessed or monitored where HIS data are incomplete, inaccurate, or untimely. Evaluations of routine health facility data have identified consistent problems in HIS completeness, accuracy and timeliness. Other factors associated with poor quality data in resource constrained settings include duplicate, parallel reporting channels and insufficient capacity to analyze and use data for decision making (Hayes et al, 2008).

Lack of efficient health information systems also bring about the fragmentation of data as there is no common or central format for collecting or storing whatever data or information is retrieved from the patients. To ensure that HIS contribute to improved health services, it is essential that policy makers and health system managers utilize available information for ongoing monitoring of plans and programs, as well as for resource allocation purposes (Francis et al, 2010).

Electronic information can be viewed as the raw material, which can then be made available to end users via a range of methods and platforms. Therefore in Nigeria there is a dire need to strengthen the health information system through the provision of appropriate infrastructure, and the establishment of mechanisms or procedures for collecting and analyzing health data to provide needed information (WHO, 2010).

**2.3.2 Challenges of Incorporating Information Technology into Health Record System**

Digital projects are expensive. Many health practitioners understand the benefits of hospital information technologies, but they do not find easy justification for the cost (Thielst, 2007). Digitization of records requires enormous funding due to frequent hardware and software upgrades, and increasing cost of subscription to electronic databases, this makes them to be easily by information seekers globally (Jain, 2012). The upgrade and running cost burden is remarkable and outside the reach of small hospitals and health care trusts. Compounding the cost issues, the lack of interoperability of information systems marketed by different vendors is a significant concern (Brailer, 2005).

Management of electronic health record systems is constantly evolving with different systems currently available to service various clinical applications, facilitate strategic decision making and improve administrative workflow (Hikmet et al., 2007). Due to inadequate skills in information technology, many traditional librarians, record keepers and archivists are conservatives and have phobia for computers. Because of generation gaps between the new and old professionals, computers are perceived as a threat to their status as experts (Ayoku et al, 2008).

Problems with Interoperability do not allow seamless retrieval of patient information across different operating systems. Patient clinical data may be accessed only in hospitals with compatible information systems, thereby hampering the key benefit of easy and universal access to patient data that the technology is meant to support (Arrow et al., 2009). Other key concerns constituting major limitations of hospital information technologies include wrong identifications, wrong or incomplete information documented in hospital systems, the possibility of making changes to patient information by unauthorized persons (Fuji et al, 2008).

One of the challenges to preservation and conservation of hospital records in developing countries is educating the record keepers in hospital community on the best ways to handle hospital records. This challenge is exacerbated by the fact that preservation of records is not at the center of most medical science curricula. There are few places or nowhere, for example in Nigeria where one can receive formal specialized education in preservation and conservation of archives and records (Adeyemi, 2012).

There is shortage of personnel/human capital. Those few librarians that possess basic knowledge in computer science and its applications work in archives and record units, hence the consequent frequent break down of ICT facilities and disruption of services in digitized record units. Human resources with appropriate skills, competences and attitude are not readily available to initiate, implement and sustain digitization project (Chinyemba et al, 2005). Frequent power outage also constitute a serious challenge to digitization in Africa as the cost of running
them becomes prohibitive (Zulu, 2008). A paucity of government policy regarding the implementation of information systems exists in Nigeria. The lack of strategic government programs has culminated in the poor adoption of hospital information technologies in health care facilities across the country.

According to Benham-Hutchins (2009) because of challenges involved in integrating new hospital information systems with old paper documentation and record systems, clinicians, and other health care practitioners may become encumbered with multiple and conflicting sources of patient information. Multiples of paper and electronic documentation may disrupt a seamless workflow and influence the quality and efficiency of service delivery. These circumstances also have the potential to cause new types of medical errors resulting from poor harmonization of patient information. Understanding these concerns requires examination of human factors in the design of technology that is able to adapt to the way health care providers do their job. The delivery of patient-friendly services demands that health care providers continue to work toward improvement in the method of care pathways and processes.

Georgiou, et al. (2005) asserted that hospital information technologies eliminate some aspects of human interaction among staffs, thereby hindering workplace collaboration and cohesion. Keenan, et al. (2006) concurred that the human element is still very important in health care delivery and technology is just a tool in the hands of trained personnel. Other economic limitations of incorporating information technologies into health record system includes

1. The inability to ascertain an accurate return on investment (Menachemi et al., 2006),
2. Problems with appropriate reimbursement for technology use, and
3. Focus on technological issues at the expense of health care services and business concerns (Ward et al.,2006).

In their pilot study of the implementation of an electronic medical record, Samoutis, et al. (2007) found that the physician's perceptions of the system's effect on their workflow, legal concerns, transition issues, and lack of familiarity with electronic equipment were among the impediments of implementation.

**2.3.3 Benefits of Incorporating Information Technology into Health Record System**

ICT helps to improve on the seamless workflow among people and the organization; effective processes can also be achieved through efficient and effective interactions. Samoutis, et al. (2007) observed that computerized systems increased work efficiency and improved the quality of care to the patients served. Recent health care debates reinforced the demands for reimbursement that are associated with quality of care outcomes. Implementing the right systems to incorporate the appropriate components is a necessity.

Weiner (2013) stated that network effectively among themselves with the use of electronic health technology, by allowing the review of patient’s treatment online and to accurately prescribe the necessary drugs. The workflow among the various healthcare entities is improved upon by the healthcare information system and also, patient’s access to healthcare increases (Shekelle, 2012). The communication between organizations and stakeholders is facilitated by the application information and communication technologies.

Another benefit of ICT is in aspect of intra-organizational communication as mostly interpersonal. Synchronous interruptive communication is recognized as a primary source of inefficiency and error in healthcare. Information about patient can be easily read by healthcare providers through the computer, the information is always available, cannot be lost or left sitting on a desk. The information is available to users in different locations. For record keeping, this can be explained in terms of patient laboratory or any clinical test results in the hospital and can be added to patient’s record as soon as the test result is complete and ready (Brudnick Centre Report, 2003).

Incorporating Information Technology into Health Record System will speed up the access to medication administration records easily, and the ease by which consultation reports are shared, the decreased time taken to transmit test results are parts of the benefits of healthcare information system (Keenan et al, 2006). Woodside (2007) agrees that electronic exchange of patient’s records between physician and pharmacist can help to protect the patient by detecting the prescription of drugs combinations that are not compactible, stating potential allergens to patients. Clinical data captured by clinical information system helps to improve on the clinical decision making of the physician on patients care (Williams et al, 2008). Policy makers in healthcare that seeks ways to improve the quality of healthcare at some reduced cost can also leverage on the healthcare information system to deliver the inexpensive healthcare (Simeon et al, 2008). Demographic disparity in health care accessibility benefits from hospital information technologies and telemedicine foster collaboration between clinicians in urban areas and those in rural settlements (Ouma et al, 2008).

Electronic Health (E-Health) facilitates healthcare to reach remote population which are not properly serviced by traditional means. There is evidence that having electronic health records that are readily accessible can reduce errors that result from gaps in knowledge regarding past medical history, allergies, or medications, especially when patients are being treated by multiple providers. Additionally, there is evidence that decision support tools can integrate electronic patient information directly into the provision of care and can reduce errors of omission that result from gaps in provider knowledge or the failure to synthesize and apply that knowledge in clinical practice (Shekelle et al, 2009).

**2.4 RECORD KEEPING IN HEALTHCARE DELIVERY**

There are two major means of keeping medical or health records of patients in any healthcare delivery facility. These are paper-based record keeping systems and EHR keeping systems. These record systems (whether paper-based or electronic) accomplish two crucial functions (Berg, 1999). Firstly, health record systems helps in the accumulation of data gathered during the course of a patient trajectory, which in turn help create an ‘external memory’ for future use (Berg & Toussaint, 2003). Secondly, health record helps in coordinating activities and events at various departments and even other geographical locations (Berg & Toussaint, 2003).The following sub-section further throws light on these categorizations.

**2.4.1 Paper Base Record Keeping in Healthcare Delivery**

The healthcare industry has widely made use of paper based record system as a means of keeping patient’s medical information for the past two hundred decades (Scott, 2006). Although, it has helped the entire healthcare delivery system a great deal from antiquity to date, Coeira (2003) observes that, paper based record inherently pose some corporeal and informational challenges that makes it difficult for it to be sustained as a proper means of record keeping in healthcare delivery. Thus according to many practitioners, paper-based system alone is just not good enough anymore and they justify this by citing various challenges of the paper record which include;

Difficulty in accessing and sharing medical history of patients: Paper based record system makes it extremely knotty for medical professionals at different geographical location to access previous medical information of patients for proper diagnosis or treatment regimes. It is true that paper-based medical information of patients can be conveyed with the aid of fax machine, telephone conversation, and even via courier services or through the post, but these modes of transmitting medical information have the potential for the misreading or mishearing of data, loss of information and delay (Institute for Medication practices, ISMP, 2000). Even in cases where health professionals at various geographical locations get hold to previous medical information of patients, it is intimates that reconciling the medical data could still be impossible (Coeira, 2003). According to Coeira (2003), different interpretations are sometimes given to the same medical records as making sense from the medical data often vary among professionals due to illegibility or improper spelling of a medical terminology.

Improper Organization of Patient Records: Following from the preceding point, paper based records could lead to improper certification of medical records. With paper based records there is high risk of assigning wrong codes or symbols to medical files, which in turn makes it extremely difficult to locate these same files in a future date. Again, retrieval of medical file from a pile of health records according to Warshawsky, Pliskin, Urkin, et al., (1994) can also be daunting and time consuming. These improper classifications of medical records impede access to data and sharing data for proper healthcare delivery.

Error in Prescriptions and Medications: With paper based record systems, prescriptions are usually written completely by hand. This could lead to a pharmacist making mistakes in filling prescriptions because of an illegible handwriting, or may have to spend extra time calling the doctor’s office to get clarification about a prescription. The Institute for Safe Medication Practices in a report estimated that pharmacists make more than 150 million calls to physicians each year to clarify what was written on prescription forms in order to avoid error of medication (ISMP, 2000). Another report by the institute calculated approximately 39% of medication errors; which occurs at the time of prescribers order medications, occurring due to the illegibility of prescribers’ handwritings which is often misinterpreted by pharmacists (ISMP, 2002). According to the report, handwritten prescriptions or paper-based prescriptions serve as a major source of medication error which occurs at the very beginning of the medication use process (ISMP, 2002).

No guarantee for information backup. Paper-based records could be ruined by fire, flood, or other natural catastrophe, like Hurricane or they could be damaged or stolen completely. Unless a copy of every paper in the filing cabinet was made, that part of a patient’s medical history would be lost forever and this could be detrimental to assessing the progress of a recovering patient or an old patient of the facility (ISMP, 2000).

Breach of Patients’ Privacy: With paper based records there is little room of keeping track of who sees paper records or completely preventing unauthorized people from seeing the medical records of a patient. Medical records of patients can be accessed without any traces of who accessed them or when it was accessed or copied. Thus patients, especially those with serious illnesses or those who have confided compromising secrets to their doctors, risk irreparable damages like loss of job, embarrassment at home or work, bias, and the inability to even get insurance coverage (ISMP, 2000).

**2.5 ELECTRONIC HEALTH RECORD (EHR) IN HEALTHCARE DELIVERY**

**2.5.1 Meaning of EHR and Its Components**

There exist numerous names with its accompanying acronyms for describing the use of computer systems or ICTs in healthcare delivery. Some of the names could be mentioned as Electronic medical record (EMR), electronic patient record (EPR), computerized medical record (CMR), computer-based patient record (CPR), and electronic health record (EHR). These lexicons are often used to mean the same thing but there could still be some minor differences in the meanings depending on the defining country of origin, health sector, professional discipline, and period of time (Nøhr, 2006). In giving meaning to consistency, this study prefers to adopt electronic health record (EHR) to describe the ICT implemented in the hospital. Again, Nøhr (2006) noted that the term ‘health’ in EHR refers to a person’s vital data independent of any specific periods of being a patient, therefore the use of EHR is deemed as most suitable for this study.

Many writers have ascribed various definitions to EHRs; however the internationally recognized definition of EHRs was given by the International Standard Organization (ISO). ISO (2005) defined EHRs as “a repository of information regarding the health of a subject of care, in computer processable form”. This definition narrowly focuses on only the structure of EHR systems, therefore Hayrinen, Saranto and Nykanen (2008) sought to explain EHRs by broadening the focus given to EHRs in the ISO definition. According to Hayrinen et al. (2008), EHRs should be construed as comprising of retrospective, concurrent as well as prospective information which has the primary objective of supporting continuous, efficient and quality integrated healthcare delivery. Luo (2006) also asserts that EHRs go beyond just the electronic version of the paper based record to encompass the whole management of data required for patients’ care. Thus Bernstein, Bruun-Rasmussen, Vingtoft, Andersen and Nøhr (2005) agreed to the point that EHRs play a many-sided role in healthcare delivery than just being a computer system.

**2.5.2 Components of EHR**

Tang (2003), has noted that an effective EHR system: should have the capacity of storing patient health information and data longitudinally; should enable results generated from the system to be managed proper; also enables the facilitation of electronic communication and connectivity; it should provide patient support and help in administrative processes and report. Nøhr (2006), also highlights the common components of EHR as:

1. Clinical Documentation: EHR should enables health professionals to better handle progress notes of their patients either as free text directly entered into the system or by predefined structured notes.
2. Physician Order Entry (POE): EHR should also allow for ordering diagnostic test and medication in a standardized and formalized way. Other EHR systems provides for checking drug interactions and alert for patient allergy.
3. Booking service: An EHR system allows for patients to book appointments with their medical professionals be it face to face or online.
4. Communication/Messaging: EHR systems should also enable the exchange communication between various hospitals, General Practitioners, pharmacies, and laboratories.
5. Results Management: EHR systems also facilitate the assaying of medical results. The system is should be able to show some warnings to abnormal results. The system should also depict trends of a particular result.
6. Charge Capture/Billing: EHR makes it easier to track expenses owed to the facility by virtue of the health service provided to the patient.
7. Disease Management: EHR also help in management of chronic diseases, by allowing health professionals to access data to assess whether or not disease is been managed properly.
8. Management of security issues: All EHR systems have special features that help manage authentication and authorization of users.

Further, Coeira (2003) also provides various components of EHR, which could be illuminated, graphically from Fig.1 below:



Source: Coeira, 2003.

**2.5.3 Structure of Electronic Health Records**

In explaining the structure on EHR system, this study will adopts the structure of EHR system in Dickinson, Fischetti and Heard (2004). The writers identified three (3) structures or functions of every effective EHR system and they classified these structures as direct care functions, supportive requirement and Information Infrastructure. This could further be explained by the aid of Figure 2 below.

**2.5.4 The Direct Care Functions of An EHR**

The direct care function of every EHR system according to the writers, concerns itself with the carrying out the functions associated with general clinical tasks. And it involves the capturing or generation, storage, management, retrieval and communication of health information that are directly definable with the provision of healthcare. As Dickinson et al. (2004) opine, the direct care function of EHR ensures the delivery of everyday healthcare to patients. These include functions such as diagnosis, goal setting on patient management, planning and carrying out interventions, examination and evaluation of results (Bernstein et al., 2005). It also includes stand-alone reminders or alerts which provide prompts for contraindications and wrong prescription of medication to patients (Veselý, Zvárová, Peleška, Buchtela& Anger, 2006).

The direct care function of an EHR also provide task tracking to ensure timeliness in the provision of care (Dickinson et al., 2004). Hayrinen et al. (2008), however, were of the view that referral; patient present complaint and past medical history; physical examination; diagnosis; tests; procedures; treatment; medication and discharge are some of the commonly known Direct care functions of an EHR.

**2.5.5 The Supportive Function**

The supportive functions of EHR systems are those functions that are not directly related to the provision of healthcare but are subsidiary direct provision of healthcare though relevant for the overall delivery of health care (Dickinson et al., 2004). The supportive functions seek to improve quality healthcare delivery through the provision of inputs for medical researches and promotion of public health. It also provides assistance for general administrative and financial management (Dickinson et al., 2004). Examples of these supportive functions are optimizing patient bed assignments, provision of health guidelines and resources available, administrative and financial coding assignments as well as the provision of providers’ location in the facility.

**2.5.6 The Information Infrastructure Function**

The function of EHR as an Information infrastructure, relates to the provision of technical groundwork for the successful achievement of the direct care functions and the supportive functions. EHR thus becomes the force which propels the well-functioning of both direct and supportive functions. According to Coeira and Clarke (2004), it involves security, which entails controlling access and privacy of data. It also involves interoperability or the exchange of clinical and administrative information through standard-based solutions as well as the sharing of information and records across management and various units (Dickinson et al., 2004).

**2.6 THE HYBRID HEALTH RECORD SYSTEM**

In an empirical study conducted in the US by Varga (2011), it was noted that although EHR is needed to aid in the automation of paper based health records, the complete migration to EHR system; and thus the consequent elimination of the cosmic majority of paper in the delivery of healthcare, will take at a minimum of 10-15 years or potentially many years longer. The study again noted that high percentage of healthcare professionals will continue to receive health information from patients in the form of paper documents for some long time to come, even if healthcare professionals themselves convert to an EHR system. Therefore many healthcare facilities are now combining the use of both EHR systems and the paper based records systems. This is nonetheless, not exclusive to Varga’s study amongst US medical professionals but the same phenomenon of combing paper based health records with EHR has been observed by some writers in the implementation of EHR systems (Adjorlolo&Ellingsen, 2013). Kalra and Ingram (2006:135) sum it all up by instigating that; “Clinical care increasingly requires healthcare professionals to access patient record information that may be distributed across multiple sites, held in a variety of paper and electronic formats, and represented as mixtures of narrative, structured, coded and multimedia entries”.

**2.7 BENEFITS OF ELECTRONIC HEALTH RECORDS**

EHR are highly configurable, and may be adjusted rather comprehensively for different groups of staff and departments (Bossen, Jensen &Udsen, 2013). These set of characteristics are itself important contributing factor to the success of EHR implementation (Ibid). But previous studies conducted by Nah, Lau and Kuang (2001) as well as Ludwick and Doucette (2009) in seven different countries illustrate that successful implementation of EHR largely depend on a wide range of contextual and organizational factors (Bossen et al., 2013). And for this reason, other merits of EHR deserve further elaborations. From the perusal of literatures, benefits of EHR could be largely grouped under the following headings; Improve quality of care, Enhance productivity and efficiency, Improved Care Coordination and Communication, Reduction of cost, and Protection of Privacy of patient records.

**2.7.1 Improve Quality of Care**

The EHR system, when successfully implemented advances and improve the access to precise and up-to-date health records thereby strengthening the quality of care given to patients (Bossen et al., 2013; Boyer, Samuelian, Fieschi&Lancon, 2010; Khalifehsoltani&Geremi, 2010; Randeree, 2007; Sood et al., 2008). EHR systems are able to improve quality of patient care through greater access to health information, which leads to the reduction of medical errors which were largely associated with the paper-based record systems. Quality of patient care is also reflected in reduction of test result wait times and the general reduction in patient wait times in the health facility. In an empirical study conducted by DesRoches et al. (2008) a mammoth majority of 97% of respondents indicated that EHRs add to timely access to health records whiles about 82% reported that EHRs positively affected the quality of clinical decisions. Again, a systematic review of the impact of health IT on quality of care by Chaudhry Wang, Wu, et al. (2006), revealed an increase in care delivery in the ranges of 5 to 66 percentage points. Further, findings from a recent study by Jarvis, Johnson, Butler, et al. (2013) suggest that EHR use is associated with higher clinical process quality of care in U.S. hospitals

**2.7.2 Enhance productivity and efficiency**

Anecdotally, health professionals who operate the paper-based records, habitually spend most of their time completing paperwork at the expense fulfilling their core duties of giving care. So a lot of time is spent in sorting out duplicate records, and finding records that are not available for days or weeks. The implementation of EHR systems in most health facilities has largely decreased the paperwork for clinicians. This has in turn reduced record-keeping time thus leading to the optimization of workflow efficiency and increase in the general productivity of health professionals (Erstad, 2003). As a result, health professionals turn out to be more productive as they do not now have to defer or reschedule their own duties while waiting for other colleagues to complete their duties (Essex, 2000; Menachemi& Brooks, 2006). By ensuring improved utilization of resources and minimizing duplication of efforts, EHR systems are able to improve productivity and efficiency in any healthcare delivery facility (Agrawal, 2002). This is attested to by a study conducted in Bangladesh by Khan, Shahid, Hedstrom and Andersson (2012), where a 25 year old female doctor said, using an EHR makes her more efficient and ‘make her work easier’. These improved efficiencies have the likelihood to result in improved employee morale and maintenance. Similarly, evidence abound that e-health tools and for that matter EHR have positive effect on users (Bedeley&Palvia, 2014). Thus users of EHR are more inclined to become well-informed, better supported, and have improved behavioural outcomes, as compared to non-users of EHR (Murray, Burns, See, Lai, & Nazareth, 2005), in the same health facility.

**2.7.3 Improved care coordination and communication**

In a study by Smith et al. (2005), it was reported that one out of every seven hospitalizations is as a result of missing clinical or health information. This is because health records of patients; like test or diagnosis results and other significant data, are often not available when needed, or are often mislaid, and even in some cases, completely missing (Ibid). EHR thus reduces the likelihood of misplaced and lost records, which ensure that health records of patients and other vital patient data are readily available when needed. This enables health professionals to have access to better information at the various healthcare delivery points and departments. Furthermore as observed by Burton, Anderson and Kues (2004), EHR advances an improved level of communication and facilitates overall improved coordination of care, over and across different health facilities. The coordination of care across various facilities made possible by the use of EHR is very paramount in the management of chronic disease or chronic care management (Bodenheimer, Wagner &Grumbach, 2002).

That said, the built-in email feature of many EHRs also result in enhancing communication by allowing staff of various hospitals the ability to communicate with each other from any department or work station (Erstad, 2003; Menachemi& Brooks, 2006). Again, these email feature also allows for instantaneous and real-time communication amongst health professional (Menachemi& Brooks, 2006) and this provides the ability to concurrently complete tasks by clinicians at various locations thus leading to saving of time. Again, and empirically, DesRoches et al. (2008) found majority of respondent in their study (72%), saying EHR does not only improve care coordination but also improve communication with patients.

**2.7.4 Reduction of cost and enhanced revenue**

The general cost of providing healthcare is on the increase partly because of the inefficiencies of paper-based work. Manual processes such as expenses incurred for the transcription of physicians’ dictated notes, pulling, filing, and maintaining charts together with the cost of maintaining the storage of health records are some of the identified cost associated with the paper-based records (Cisco Systems Inc, 2005). The introduction of EHR in many health facilities has however resulted in the reduction of supply and printing cost (Menachemi& Brooks, 2006). Hence the cost incurred in initiating and maintaining paper health records including clerical supplies, cost of paper, and printing costs are squashed or reduced when EHRs are used (Ibid; Sandrick, 1998). In a work done by Ewing and Cusick (2004), a health facility reported a sketchy 90% reduction in the paper backlog after a few months of implementing an EHR system (Menachemi& Brooks, 2006), which resulted in the reduction in paper and supply costs. Remlex (2007) has also agreed that using ICT in health sector largely reduces the cost of running hospitals. The implementation of EHRs does not only help reduce cost but also lead to increased revenues by ensuring timely and accurate capture of charges for medications, medical supplies, and clinical services. EHR is hence seen as a measure to increase the cash flow of health facilities (Menachemi& Brooks, 2006). Incorrect coding of health records according to Mildon and Cohen (2001) and Erstad (2003) results in a loss of between 3–15% of the total estimated revenues of healthcare providers. Furthermore, a studies by Agrawal (2002) pointed to the role played by EHRs is increasing the cash flows of health facilities that implement them.

**2.7.5 Privacy of patient records**

EHRs ensure that maximum protection is given to patients’ information, which may be very sensitive. Health records contain immense quantity of sensitive information, such as fertility and abortions, emotional problems, sexual behaviours and diseases, substance abuse, and physical abuse (Rindfleisch, 1997; Palvia, Lowe, Nemati& Jacks, 2012). Hence when access to this kind of information are uncontrolled, it can be injurious and detrimental to the wellbeing of a patient. EHRs, however, ensure that patient’s records are electronically kept behind login passwords or even biometric sensors. It also ensures the tracking of providers that accesses patient information in the system. Thus EHR does not only ensure compliance with privacy regulations but also provides pliant security measures to protect patient information across the entire wired and wireless environment (Cisco, 2005).

**2.8 CHALLENGES OF ELECTRONIC HEALTH RECORDS IMPLEMENTATION**

The progression and sequence of EHR, particularly in developing countries’ health facilities has never been an easy undertaking as there are many peculiar factors impeding the progression and diffusion of such technologies (Bra, Monteiro&Sahay, 2004; Sood et al., 2008). But the point ought to be made fiercely that challenges of EHR implementation in developed countries, somewhat differ from the challenges of EHR implementation in developing countries. The works of Sood et al. (2008) titled “Electronic Medical Records: A Review Comparing the Challenges in Developed and Developing Countries” is a clearer manifestation of the differing challenges of EHR implementation in developed and developing countries. This section of the work thus, would be much more interested in the challenges of EHR implementation in developing countries owing to the research objectives.

Khalifehsoltani and Gerami (2010), in their study obtained a model, which considers the challenges facing E-Health in Developing Countries. This model included challenges relating to six areas of Technology and Operational; Social and Cultural; Native Environment; Legal; Policymaking; and Financial. However, their model had a general outlook of e-Health, which EHR is just a fraction. Therefore upon a further review of other works regarding the challenges of EHR implementation in developing countries, some peculiar issues that affront EHR implementation in developing countries were discovered. Inadequate Electric Power Supply; Lack of ICT Infrastructure; lack of basic ICT knowledge/skills; Poor Internet connectivity; financial issues; and Resistance to New Technology were identified broadly (albeit others) as the major challenges that hinder the successful implementation of EHR is developing countries like Nigeria.

**2.9 USABILITY AND USER SATISFACTION**

Generally, the effective use and the general satisfaction with respect to EHR on the part of users is a prerequisite for a successful implementation of EHR systems in any healthcare facility (Coeira, 2003; Vikkelsø, 2005). Usability of EHRs has also been identified as one of the key barricades to the adoption of EHRs (Gans et al., 2005). Hence Perednia and Allen (1995), in what could be described as a much detailed review of telemedicine applications, emphasised that the definitive success of EHR hinges on the ability of health facilities to address managerial challenges, which include user technology acceptance (Chau& Hu, 2002). Again, in a study of three interconnected organizational EHR systems, Payton (2000) also concluded with a clear emphasis on the significant role played by physicians in the process of implementing an EHR. These conclusions invariably led Chau& Hu (2002) to assert “given the potential impact of telemedicine technology, it is therefore important to investigate factors essential to its acceptance by individual physicians” (p.298). Usability testing should therefore be an unambiguous element in the pre-purchase assessment of EHR (Walker et al., 2005). Usability as a term connotes the characteristics of human–computer dealings or interactions in a system (Tang et al., 2006). Therefore, to describe an EHR system as having good usability means that the system is easy to learn and remember, efficient to use, generates very few errors, and leads to great satisfaction on the part of users (Nielsen, 1994; Tang et al., 2006).

**2.9.1 Factors That Impede Usability**

Empirical studies abound in ascertaining the relationship between individual’s perception to use a technology sufficiently and his or her actual use. Hence, Chau& Hu (2002), in their study, which seeks to probe healthcare professionals’ decisions to accept telemedicine, the authors aimed to find out how perception affects the actual use of EHR. The study found out that the perception of health workers of the degree to which telemedicine technology is easy to use, affects both their attitude toward using the technology as well as perception of usefulness of the system itself. In other words, attitude of health professionals are influenced by the usefulness of EHRs, as they perceived it. From a skewed technology management standpoint, however, their findings made known the substance of attitude cultivation and management.

Various studies on user satisfaction in connection with the implementation of EHRs in various health facilities (Bonner et al., 2010; Christensen &Grimsmo, 2008) have all suggested the possibility to realize a general level of satisfaction among health professionals. However these studies observed that usability of EHRs and the satisfactions thereof by the users are often thwarted with apprehension emanating from shift from paper based records to EHR. Users’ reluctance to adapt to new technology (Fitzgerald, Piris& Serrano, 2008) has led to the poor usage or in some situation the complete neglect of EHR systems in most health facilities.

Schumacher, Berkowitz, Abramson and Liebovitz (2010) identified ‘failure to use human factors design principles’ as a major factor that impede usability and user satisfaction in their use of EHR. According to them, management, designers and vendors of EHR systems often fail to apply human and social factors when designing the system, rather they just concentrate on the technological aspect. These results in little time dedicated to appreciating the context of use. Designers of the system thus focus on workflow (for instance, click here to fill a data or open here to access this file) at the neglect of what Schumacher et al. (2010) described as “less obvious, but often more important, ‘thought flow’ - the review and thinking which physicians inherently do before finishing a task” (p. 818). They also identified other barriers to the use of EHRs as “Physician's attitudes that they want a computer system to mimic a paper system as closely as possible as well as IT staff's attitudes that technology solutions are more important than the purpose of the solution and the problem it was intended to solve” (p. 818) The process of entering and retrieving information from EHR systems itself may contribute adversely to usability and thereby user satisfaction (Bonner et al., 2010). This is particularly the case where the system interface is complicated to decipher or go around it. Again, the case is made worse where there is lack of interpersonal communication mechanism in various health facilities.

**2.9.2 Measure to increase usability**

In the opinion of Chau and Hu (2002:308), to foster users’ acceptance of EHR, management in the health facility needs to work out a plan for cultivating positive attitudes toward using the technology. Management must robustly ‘emphasize, demonstrate and communicate the usefulness of the system regularly to not only the users but also the entire organisation. This is the only way to reinvent the negative attitude or perceptions of users towards the use of the system.

In order to increase usability and user satisfaction, the EHR system but be seen to be smarter and add to the overall intellectual value of health professionals after an encounter with a patient (Schumacher et al., 2010). The system should be able to reveal buried content and interrupt or suspend apparent medical mistakes. Users of EHR in various health facilities would likely be more satisfied with the system if it presents inconspicuous assistance with context sensitive reference algorithms and data-sets (Ibid).

To ensure usability and maximum user satisfaction of EHR, there is a need for continuous awareness and training workshops or courses concerning basic ICT skills as well as the actual usage of EHR systems (Walker et al., 2005). The technical intricacies of EHR systems necessitate the need for a high level of technical competence on the part of users (Sahay&Walsham, 2006). These technical competences are achieved largely by organising training and other workshops for users of the system. Further, there is a need for training in order to alleviate or lessen the problems associated with general usage of EHR such as poor preparation of data for use, and low initiative for using the data. This is reflective of empirical findings from a study in Tanzania conducted by Smith et al. (2007).

**2.10 SUMMARY**

Cebul et al, (2008) asserted that modern information technology promotes the sharing and coordination of patients’ clinical information, but its adoption has been slow in the health care arena. Various authors have suggested ways of improving adoption of hospital information technologies in developed and developing countries. Although undeniable demographic differences exists in different regions of the world, some common themes emerge that can enhance implementation of e-health applications anywhere in the world. Suggested remedies include replacement of fee for service payment systems with a system that rewards and encourages use of innovative information systems, establishment of a funding agency to sponsor adoption of health care information technologies and identification of revenue sources accruable from the use of hospital information systems.

Other measures to encourage adoption of HIS include the provision of tax incentives for full adoption and the development of hospital information systems that promote data exchange by interoperability and easy access to a national database functioning as a repository of patient clinical information (Arrow et al., 2009; Ouma et al, 2008; Moore, 2009). Other recommendations for improved adoption of hospital information systems in Nigeria include improving staff training on e-health applications; purchasing cheaper options in the form of user-friendly software, especially in rural hospitals with limited economic resources, and improving rural electrification to power information communication infrastructures in suburban communities. To ensure long-term use of e-health facilities, contract agreements with ICT experts are necessary for regular maintenance of information system hardware. Government should also facilitate the adoption of hospital information systems in both urban and rural hospitals (Ouma et al, 2008).

The demand for adoption of innovative technology abounds, but the economic implications and other infrastructural requirement put a barrier to adoption. The Nigerian government and governments of other African countries will have to invest heavily on infrastructure to facilitate any attempt aimed at catching up with the developed world in the adoption of hospital information technologies (Ouma et al, 2008).

The literature review identified some challenges with the use of paper-based records in health care delivery which Electronic health records helps to address.

The literature also indicated that, the implementation of EHR and hence its success is limited by human, organisational and technological factors which varies in both developed and developing countries although some challenges are commonly shared by these countries. In the face of these challenges, evaluating the EHR at the various levels of implementation; preimplementation, implementation and post-implementation, seemed viable in reducing the failure rates associated with the implementation of such systems.

**CHAPTER THREE**

**SYSTEM ANALYSIS AND DESIGN**

**3.1 SYSTEM METHODOLOGY**

System development methodology is a technique that is used to show how the proposed system will be developed. In this case, the methodology used will be a waterfall model. Waterfall Model is comprised of the stages that the developer will use when developing the system. It is a sequential model hence, the name waterfall. The developer has to finish with one stage before going to the next one. It comprises of the feasibility study, analysis phase, design phase, coding phase, testing phase, implementation phase and finally the maintenance phase. It is a simple model and easy to use and understand. With waterfall development based methodologies, the analysts and users proceed sequentially from one phase to the next. The deliverables from each phase are voluminous and are presented to the project sponsor for approval as the project moves from phase to phase. Once the phase is approved by the sponsor it ends and the next phase begins.

**3.2 METHODS OF DATA COLLECTION**

**Oral Interview**

This was done between the researcher and the doctors in the hospital used for the studies, and the lab attendance was interviewed. Reliable facts were got based on the questions posed to the staff by the researcher.

**Study of Manuals**

Manuals and report based used by lab attendance were studied and a lot of information concerning the system in question was obtained.

**Evaluation of Forms**

Some forms that are necessary and available were assed. These include admission card, lab form, test result, bill card Etc. These forms help in the design of the new system.

* 1. **ANALYSIS OF THE EXISTING SYSTEM**

The existing system of medical system and drug prescription in Obinwanne Hospital Nkpor involves manual activities. It has been observed that to receive medical treatment in most of our hospitals the Patients queue according for several hours in the sequence of first come first serve (FCFS) though, a new patient usually register into the hospital by filling patients form which signifies that the person is an official patient of that hospital. Also, this gives the person access to own a hospital folder. This is used to store the basic information about the diagnosis and drug prescribed to the patient.

In other hand, if it is an old patient, the staff retrieved his hospital folder using the patient’s form which the doctor have a look at first, before examining the patient and carry out the appropriate therapy which is either he referred the patient to laboratory unit for lab test (if the need be) or to the pharmacy unit to obtain the prescribed drugs (if the matter is not too complex). But, any treatment offered to the patient by the doctor must be recorded on the patient’s folder to avoid inappropriate therapy. Though, it sounds so easy but it has some stumbling blocks.

* + 1. **Weakness of the Existing System**

The weaknesses of the existing system are highlighted below.

1. **Lack of Accuracy:** This situation crates problem in the sense that proper and adequate medical attention is far-fetched. Due to doctors usually hurries over their duties in order to attend to all the patient present in the hospital and along the line they may became exhausted, and the cases of traits and errors may be practiced. In addition, the diagnosis, and prescription depends on the doctors memory so their brain are often loaded with different diseases, symptoms and various drugs for treatment, hence, to remember and process the hug information is his clinical work is very tasking. For this reason accurate diagnosis and prescription may not always be obtained.
2. **Lack of speed of operations and effectiveness:** It has been observed that to receive medical treatment in most of our hospitals, The patients queue up for several hours from one units of the hospital to another, Normally, the medical records system is based on the traditional file keeping system. Although, many patients are attended to with the method of information recording or retrieving an old file but above all, wastes time. And at times many patients are as spillover. Moreover, the problem of redundancy may occur due to human brain is too complex and may not perform and may not perform effectively especially when new folders and card save obtain each year.
	1. **ANALYSIS OF THE PROPOSED SYSTEM**

The proposed system curbs the problems associated with the manual method of disease diagnosis. Using the proposed system, patients can from the comfort of their home visit the website and get information about gonorrhea. Users just need to go through the displayed symptoms and select those been experienced.

* + 1. **Justification For the New System**

The new system among other things will have the following characteristics which will improvement the current system in use

1. The new system designed will help the management to use computer system to find gonorrhea treatment information with regards to symptoms, etc.
2. Accuracy is maintained, as the computer information will yield an accurate result.
3. There will not be much congestion in hospitals, as the medical system developed will assist patients to be treated and the information stored.
4. The speed of operation of the medical system is high when compared to manual method.
	1. **SYSTEM ANALYSIS**
		1. **Input Analysis**

The input to the new system is derived from the patient’s symptoms. When a patient visits the hospital, he/she fills the patients form from where a card is issued to the patient. He meets the doctor who examines the patient and writes down the symptoms. This forms the input to the new system designed. The information required for entry into the system includes:

1. Patients Name
2. Sex
3. Address
4. Age
5. Disease Symptoms
6. Date visited
	* 1. **Process Analysis**

Based on the information collected from the patient, an analysis is carried out. The symptoms are processed to obtain the accurate diagnosis of the sickness. Also the diagnosis will help in the processing of the system to obtain the best emergency health care system to be administered to the patient.

* + 1. **Output Analysis**

The output is derived from the processing carried out on the input data. The output is presented in form of reports on a patient’s diagnosis and possible treatment to the ailment. The reports are displayed on the screen and can also be printed out as a hard copy.

**3.6 SYSTEM DESIGN**

**3.6.1 Hospital Operation Flow System**

The diagram in fig 3.2 shows the basics flow of operation in a standard hospital, from this diagram, a patient falls under three categories thus;

1. General out patient
2. Accident/Emergency patient
3. General in Patient

During attendance at a hospital, a patient can switch from one patient category to another depending on the circumstances. For instance, General Out Patient Department (GOPD) patients come from their residences to consult with the doctors in a hospital after which they go back to their homes. All In-patients are admitted in the hospital for example, a patient who came as an out patient may be admitted if the patient has a serious health condition in which case he becomes an in-patient. If the patient is rushed to a hospital in an emergency state or after an accident, he or she is first managed in an emergency unit. If the patient is subsequently admitted he /she becomes an in-patient else he/she is an out-patient.

In the flow diagram, a newly visiting patient proceeds to the carding room to obtain a card where he/she is assigned a hospital unique identification number after registration. The patient enters a queue system (waiting list) until he/she is pre-examined by a nurse. The patient then proceeds to see a medical specialist by referral. This stage repeats at both the GIPD and GOPD but data in both cases are pulled from the initial registration data from the carding system. At the doctors’ workbench, diagnosis takes place. The result of the doctors diagnosis determines the medical flow of the patient if the patient will be an in- patient or out-patient.

Finally, other systems find attachment from the doctor workbench. This includes Diagnosis, Drug prescription, Pharmacy, Treatment, laboratory test, Referral, Billing, Death report.

**3.6.2** **Patient Registration / Carding System**:-

This module deals with registering of new patients, for either OPD (Out-patient department) or IPD (In-patient department) and issuing unique identification numbers to the patients. These numbers are unique throughout the system. A patient is first registered at the OPD front office. If eventually the patient is admitted, the same number is used. The IPD / OPD identification number is used for tracking the medical records of the patient for any OPD visit or IPD admission. All medical records of this patient are identified by this number. The number helps in a flexible search in finding the patient records. This number is assigned to the patient together with a patient card. The number will be used to track the patient record and medical history throughout the life cycle of the patent medical section.

**PATIENT REGISTRATION FLOW DIAGRAM**

patient

**Yes**

Is new or old patient

**no**

Diagnose

End visit

Registration GOPD/IPD

Track using Patiient ID

**Fig3.3 Patient Registration Flow Diagram**

* + 1. **Patient History and Record System:-**

This module is provided for use in generating or queuing existing patients’ information. It is more of a reporting system than an output system or data entry system.

Patients

Doctor checks past record

Output/History report



End visit

Discharge

Radiology/lab/pharmacy

Fig 3.3 **Patient History and Record Flow Diagram**

The patient history and record system generate the following records:

* + - * Bio data records
			* Patient’s Medical record
			* Patient’s Diagnostic record
			* Patient’s Appointment record
			* Patient’s billing record.
		1. **DOCTORS WORK BENCH**

This is a special diagnostic plat-form for doctors. Through the doctor’s workbench, doctors can perform various tasks such as:

* Viewing and editing patient’s registration data
* Requesting and viewing laboratory test and result
* Performing diagnosis
* Referring patients to specialist / clinics
* Managing beds / wards
* Issuing admission and discharge orders
* Scheduling appointments
	+ 1. **DOCTOR’S DIAGNOSTIC SYSTEM**

This is a data Entry system used by doctors to document and follow up patient’s diagnosis and treatment.The follow up system is also used by the nurses to augment the activities of doctors.

Patient

Doctor

Diagnostic

Patient

Nurses

Preliminary Examination

Injection

Diagnosis

Drug

Fig 3.6 **Doctors Diagnostic System**

* + 1. **Entity Relationship Model (ERM) Of The Design**

Entity relationship model is the conceptual representation of data; it is a database modeling method that is used for producing semantic data model of a system. Diagrams created by this process are called entity relationship diagrams. The entity relationship of the design shows how two or more entities are related to one another. Each entity must have a minimal set of uniquely identifying attributes which is called the entity’s primary key. The entity relationship diagram of fig 4.2 shows the entity sets and relationship sets.

To identify a particular record in a unique manner there must be a key.

There are three types of key

* **PRIMARY KEY (pk):** The primary key is like a field name which can be used to uniquely identify a given record in a database table.
* **FOREIGN KEY (fk):** Is a key in a table ‘’schema’’ that is a primary key in another table schema of a database.
* **UNIQUE KEY (uk):** Is a key in a table schema which is not a primary key but can uniquely identify a record in table schema.

**Referral Patient Registration**

Referral number (pk) patient id (pk)

Referral form surname

Refer to other names

Referral from clinic sex

Referral to clinic birth day

Date referred phone

Patient id (fk) email

**Admission table**

**Laboratory request**

lab id (pk) lab type requested by request table lab detail patient id (fk)

Admission number (pk) Clinic

Ward

Bed number Date Health status Next of kin name

Next of kin address

Next of kin phone number Next of kin relationship Next of kin addressAdmitted Patient id (fk)

**Nurses Death**

**work bench**

Exam id (pk) Temperature Pulse

Blood pressure Blood group Weight

Height Patient id (fk)

death id (pk) date of death time of death reported by

Patient id (fk)

**Fig 4.2.** Entity Relationship model.

In fig 4.2 the primary key in patient registration module is the patient identity number and this module is related to all the other modules like admission, laboratory, death, referral etc, in the sense that the same patient with patient identity can be admitted, referred, sent to laboratory or examined by the nurse but the primary key in the patient registration of this patient now becomes a foreign key in other modules because the primary key of each module is that key with which the patient is primarily identified there. For example, in Admission table, the admission number is the primary key while the patient identity number is the foreign key, in laboratory; the laboratory identity is the primary key while the patient identity number is the foreign key and so on.

* 1. **DESIGN DATABASE SCHEMA**

Database schema is the structure of the database that defines the objects in the database. A schema is a collection of logical structures of data, or schema objects. A schema is owned by a database user and has the same name as that user. Each user owns a single schema. Schema objects can be created and manipulated with SQL and include the following types of objects:

* Clusters
* Database links
* Database triggers
* Dimensions
* External procedure libraries
* Indexes and index types
* Java classes, Java resources, and Java sources
* Materialized views and materialized view logs
* Object tables, object types, and object views
* Operators
* Sequences
* Stored functions, procedures, and packages
* Synonyms
* Tables and index-organized tables
* Views

Other types of objects are also stored in the database and can be created and manipulated with SQL but are not contained in a schema:

* Contexts
* Directories
* Profiles
* Roles
* Tables paces
* Users
* Rollback segments -

There are **four levels** of database schema thus:

1. **Conceptual schema:** is a map of concepts and their relationships. This describes the semantics of an organization and represents a series of assertions about its nature. Specifically, it describes the things of significance to an organization (entity classes), about which it is inclined to collect information, and characteristics of (attributes) and associations between pairs of those things of significance (relationships).
2. **Logical schema**: is a map of entities and their attributes and relations. The logical schema was the way data were represented to conform to the constraints of a particular approach to database management. Logical Schema is a data model of a specific problem domain expressed in terms of a particular data management technology.
3. **Physical schema**: is a particular implementation of a logical schema. It describes how physically data would be stored on disk drives.
4. **Schema object:** is an Oracle database object. Schema objects are logical data storage structures. Schema objects do not have a one-to-one correspondence to physical files on disk that store their information. However, Oracle stores a schema object logically within a table space of the database. The data of each object is physically contained in one or more of the table space’s data files. For some objects, such as tables, indexes, and clusters, you can specify how much disk space Oracle allocates for the object within the table space’s data files.

**CHAPTER FOUR**

**SYSTEM IMPLEMENTATION**

System testing involves checking each of the system modules to make sure that they are functioning properly. System implementation is done after successful system testing to incorporate the new system into an organization using any of the various changeover methods. A design may be implemented in various ways depending on the priorities of the software developer. In this work, several factors were taken into consideration during implementation. These factors include:

* Correctness: The implementation was carried out with the aim of the final product meeting the user’s need.
* Robustness: Robustness is the quality of being able to withstand stresses, pressures or changes in procedure or circumstance. Robustness was emphasized extensively in the implementation of this work. Defensive programming techniques were applied. Strict checking procedures were included to eliminate the possibility of unacceptable effects on system response.
* Performance: Software performance is the extent to which a product meets its constraints with regard to response or space requirements. Performance optimization especially as regards speed / response time and appropriate search techniques were employed to ensure good response time.

**4.1 CHOICE OF IMPLEMENTATION TOOLS AND PLATFORM**

This section is broadly divided into system platform, Integrated Development Environment and Programming Language. These are discussed below.

* **System Platform:** The system was on the Windows 10 Operating System which meets all the requirement for the proper functioning of the project.
* **Integrated Development Environment (IDE):** The JetBrains PhpStorm IDE was used in implementing this project. It cross\_platform IDE for PHP. This editor makes the work pretty easier to handle as it provides an editor for PHP, HTML and JavaScript with on-the-fly code analysis, error prevention and automated refactoring for PHP and JavaScript code.

**4.1.2 Choice of Programming Language**

PHP was chosen as the programming language which serves as the client to enable me to create the input and output forms while the MySQL database was used as the database server. PHP is a framework (programming) for development of enterprise application using object oriented programming. For most software applications there exists a wide variety of languages in which the application may be implemented. Apart from mere suitability of the programming languages, many factors influenced the use of PHP as the programming language for the source code shown in the APPENDIX and the oracle database as the server.

* + 1. **Reasons for Choosing PHP**
1. Speed: Being a compiled language, it is very fast and speed is important

in database application.

1. Environment: It can run in windows.
2. Efficient: The final code tends to be compact and run quickly.
3. Portability: If compiled, it can be executed in different machines with

alteration of source code.

1. Maintainability: To ensure maintainability, this program is broken into

modules and each module is assigned a specific function. This will make

maintenance of the system easier.

1. Security: it has proper backups, quality control mechanism for all modules

and unauthorized access to sensitive data is prohibited.

* 1. **SYSTEM REQUIREMENTS**
		1. **Hardware Requirements**

The following hardware resources are needed to be put in place in order to power the application: A host for the system and clients to connect to it via intranet.

1. Pentium IV Computer (2.6 GHz processor’s speed)
2. 40GB or harder disk space requirement
3. 1GB or more of RAM
4. A high-speed intranet connection
5. 1024\*768 pixels screen resolution
6. Mouse
7. Keyboard
	* 1. **Software Requirement**
8. Any operating system that support GUI e.g. Windows.
9. WAMP Server
10. Macromedia Dreamweaver 8, Fireworks.
11. Browser such as (Firefox, internet explorer, chrome)
	1. **DESIGN INTERFACE**

The flow diagram below explains the working flow of the application from the time the user starts it to the control panel where a patient can be handled for diagnosis and treatment. When the software starts the user is presented with a log in page where he /she can enter login information (user name and password) as in fig 4.5



**Fig 4.5 Login form**



**FIG 4.6** LEVEL 1 FORM

* + - In (A), the user enters the Universal resource language address of the application and continues to login.
		- In (B) the software checks to see if the user has the necessary login authentication (Username and password).
		- In (B) if the authentication is correct, the software continues to (D) else the user is redirected to the error page in (C) and back to (B) again
		- In (D) if the authentication is correct the user is directed to the general page or home page.

From the home page shown in fig 4.6 patient administration can start. The home page contains various services which include:

1. Laboratory System
2. Report And Analysis
3. Patient Registration System
4. Billing System
5. Pharmacy System
6. Admission System

In (F): CONTROL PANEL, from the control panel, a patient can be explicitly managed as shown in fig 4.7. Here several clinical functions can be performed on the patient.



**FIG 4.7** LEVEL 2 FORM

These clinical functions include;

1. X- Ray Services
2. Billing Services
3. Referral
4. Death Report
5. Laboratory Service
6. Discharge
7. Diagnosis
8. Examination.

From the fields of the home page the user can choose a particular option. Menu items like admission, diagnosis, examination, billing, laboratory, discharge, referral and death are selected by pointing with a mouse and clicking.

The main menu consist of the following main options

* + - Nurses Workbench
		- Doctors Workbench



fig 4.8 nurses and doctor’s form

**REPORT AND ANALYSIS:**

ADMISSION: The admission is for the in-patient. It provides comprehensive data pertaining admission of patient and ward management as shown in fig 4.11. The option displays a submenu which consists of the following options:

**Ward type**

* + - General ward
		- Male ward
		- Female ward
		- Children ward



**FIG 4.11** ADMISSION FORM

The admission operation follows the following sequence: click the cursor at the combo box of the general ward, choose ward, type click on the ward

Enter the bed number to fully admit the patient. Enter the additional detail like the patient’s ailment for admission of the patient in question, click admits now.

* 1. **LABORATORY**

The laboratory request form is shown in fig 4.12



**FIG 4.12 LABORATORY FORM**

Click the cursor on the combo box of the general examination, chose the type of examination to be done on the patient; Click on it. Type the details of the test click the combo box request now.

* 1. **EXAMINATION (NURSES WORKBENCH)**

This is the pre-examination form used by nurses to examine and take basic

health information from the patient before the patient sees the doctor as in shown fig 4.13



**FIG 4.13 EXAMINATION FORM**

Such data include height, weight, blood pressure and eyesight. The details of the examination may be added,

* 1. **DIAGNOSIS (DOCTOR WORKBENCH)**

The diagnosis form (fig 4.14) is the main doctors work bench area, handling diagnosis and doctor to doctor, doctor to nurse, nurse to doctor and nurses to

nurses follow up activities.



**FIG 4.14 DIAGNOSTIC FORM**

Here all diagnosis is logged into the database serially according to the date and time. The doctor carrying out the diagnosis will have to provide his name, clinic or department, go through the previous diagnosis and then enter details of the new diagnosis.



**DIAGNOSTIC FORM**

Submenu option displays the doctors name combo box, type of clinic, Automatic update and time.

Enter diagnosis detail and submit diagnose box to finish the process.

* 1. **X - RAY.**

This form is used by doctors to make an x-ray request for a particular patient at the patient specific level.

**CHAPTER FIVE**

**CONCLUSION AND RECOMMENDATION**

* 1. **SUMMARY**

Without the use of computerized system for medical system, I wonder what will be the stand of our economy today. Since, the implementation of this system does more good than harm in our country especially health sector. Hence not only does it provide good health with the help of the following factors, accuracy, flexibility, and speedy treatment. But, also it will be a big relief for medical doctors and nurses when attending to patients. This project is well designed with reliability and efficiency as our mainstay, have come just in time to correct those weaknesses and anomalies, which exist in the existing manual method. The achievements made up this design can be summarized

* + 1. Result of high processing speed of the computerize system
		2. Patient’s records can now be retrieved easily.
		3. Faster diagnosis of diseases
		4. Similarly there is also an easy accesses to clinical reports for research purpose and decision making
	1. **CONCLUSION**

Based on the findings, the following conclusions were reached. The implementation of automated diagnosis system for the treatment of gonorrhea for a hospital will be a big relief for medical doctors and nurses when operational. The system can be a tremendous help to hospital management. It will also serve as a tool for quick operational decision making of the patient, thus enabling them to reach the solutions of their problem more quickly and more accurately than human being. Thus the overall effect of the use of computer in medical system is that patients acquire competence, accuracy, and effectiveness within the shortest time in their operations and can break into new ground with certainty.

* 1. **RECOMMENDATION**

Since data management of a hospital is a vital part of its operations and its survival in the modern world, it must be well updated. I recommend further work on the possibility of putting the project online with a security code to stop unauthorized persons from accessing the information.

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