MASTER'S THESIS IN HEALTH INFORMATICS

NEED ASSESSMENT FRAMEWORK FOR ELECTRONIC HEALTH RECORD MANAGEMENT SYSTEM IN ETHIOPIA

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Abstract

BACKGROUND A standard in the field of Heath Informatics which has been taken for granted up until this point may be disappearing and a new paradigm may begin to take shape as paper-based medical record (PMR) systems are changing to the electronic health record (EHR) systems. Although the PMR has played a critical role in recording patient's clinical information, now many studies report that EHR systems improve quality of care beyond PMRs. For this reason, the governments across the world have initiated various approaches accelerating EHR adoption. However, there have been a small number of studies explaining which factors affect EHR adoption and use in health institutions.

OBJECTIVE The objective of this study is to investigate the actual practice of patient's health record handling throughout the health institutions in Ethiopia and see the gap between the paper based medical record and electronic health record and developing architectural framework for electronic health record.

METHOD The necessary data is collected using questionnaire and interview within and around Addis Ababa to get the overall picture of the health data record handling of health institutions like hospitals.

RESULT The result of the study disclosed that almost all health institutions are exercising paper based health record handling and extremely few institutions are using technological devices to handle some part of their records, like patient registration, together with paper based patient medical record which is highly subject to be misplaced, time taking and the like.

CONCLUSION Architectural framework for electronic medical record is a must to have to all health service providers in all levels in order to improve their performance and to provide up to the standard services to the community at large. The concerned management should provide the necessary attention to it. All health institutions should be ready to implement technology based facility which is believed to be a must to have.

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List of Acronyms

AHR - Automated Health Record

ATS - Admission, Transfer and Separation

A & E - Accident and Emergency

BN - Billion

BPEL4WS - Business Process Execution Language for Web Services

CCOW - Clinical Context Object Workgroup

CDA - CD Audio

CPR - Computer based patient Record

CT - Computerizes Tomography

C$ - Canadian Dollar

DICOM - Digital Imaging and Communications in Medicine

E-CHART - Electronic Chart

eDISCHARGE - Electronic Discharge

EDHS - Ethiopia’s Demographic and Health Survey

e-HEALTH - Electronic Health

EHRA - Electronic Health Record Architecture

EHR - Electronic Health Record

EHRM - Electronic Health Record Management

e-MAIL - Electronic Mail

EMR - Electronic Medical Record

EMRX - Electronic Medical Record Exchange

FGC - Female Genital Cutting

RGID - Global Resource and Information Directory

GP - General Practitioner

HIM - Health Information Management

HIMAS - Health Information Management Administration System

HIS - Health Information System

HIV/AIDS - human immunodeficiency virus/ Acquired immune deficiency syndrome

HL7 – Health Level 7

IBM - International Business Machines

ICD - International Classification of Diseases

IT - Information Technology

M - Million

MOH - Ministry of Health

MRD - Minimal residual disease

MRI - Magnetic Resonance Imaging

NEHR - National Electronic Health Record

NGO - Non Governmental Organization

ODL – Observation of Daily Living

PHD - Doctor of Philosophy

PHR - Professional Health Record

PHR – Personal Health Record

PMI - Primary Mortgage Insurance

PMR - Paper Based Medical Record

RBAC – Role Based Access Control

SNOMED CT - Systematized Nomenclature of Medicine--Clinical Terms

S$ - Singapore dollar

TB - Tuberculosis

UK - United Kingdom

USA - United States of America

US$ - United States Dollar

WAN - Wide Area Network

WFMS - Workflow Management System

WHO - World Health Organization

WSBPEL - Web Services Business Process Execution Language

X-RAY - X-Radiation

XACML - Extensible Access Control Markup Language

XML - Extensible Markup Language

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CHAPTER ONE

Introduction

1.1 Background

Electronic Health Care will help transform all paper and film into computer processable bits and bytes so patients and their doctors have access to this essential data whenever and wherever they need it. It will also have a profound impact on the efficiency and quality of the health care system [1].

The Electronic Health Record (EHR) will allow physicians and patients to share information and knowledge about patients' medical status so that effective medical and self management can occur. According to Anne Diog (Feb.2006), Physicians know that electronic medical records are the essential building blocks to create an electronic health record capability across Canada [2].

Information and communications technology initiatives such as electronic health records enhance the decision-making process. It gives nurses access to timely, evidence-based and expert information, enabling them to make swifter, better-informed judgments on behalf of their patients. The result is safer patient care and better health outcomes [3].

The integrated care “Electronic Health Record” [EHR] is defined by the international organization for standardization (ISO TR 20514:2004) as a repository of information regarding the health of a subject of care in computer processable form, stored and transmitted securely and accessible by multiple authorized users. It has a commonly agreed logical information model which is independent of EHR system. Its primary purpose is to support of continuing, efficient and quality integrated health care and it contains information which is retrospective, concurrent and prospective [4].

The first known medical record was developed by Hippocrates, in the fifth century B.C. [5] He prescribed two goals.

- A medical record should accurately reflect the course of disease;
- A medical record should indicate the probable cause of disease.

These goals are still appropriate but electronic health records are even more than this. The first electronic health record began to appear in the 1960s. By 1965, Summerfield and Empey reported that at least 73 hospitals and clinical information projects and 28 projects for storage and retrieval of medical documents and other clinically-relevant information were started. [6]

As the technology advances, so is to the electronic health records. Nowadays people around the globe are thinking in greater depth about the architecture for electronic health records management which encompasses issues like security, privacy, interoperability and standards.

Having architecture for electronic health record will for sure bring various advantages to the country. Among the benefits of EHRs, some of them are: it decreases repetition of information, information can be accessed by health care professional remotely, all health care providers will have access to the same up to date information, built-in protocols encourage adherence to clinical practice guidelines and improve constancy (loyalty and reliability) and consistency of care, improves communication amongst health care providers. It will also provide more protection in the level of lawsuit, may accurately capture financial data, send electronic prescription requests to radiologists, pharmacies (reducing the risk that hard-to-read handwritings which may lead to medical errors), help researchers (example chemists) see the efficacy of a medicine. In addition to these, it helps for decision support system (government officials for budgeting), provides awareness to government to predict or notify an outbreak (example epidemic), and helps for knowledge sharing, for statistics and analysis [7]. In order to get these advantages, all the health service providers should be computerized and get connected with one another either through a network or a web based system.

1.2 Statement of the problem

It's not time taking to think about the importance of information nowadays in almost all activities of a human being. We are in an era of information where information and information dissemination in an area of health is something vital like a blood to life. Having health information by itself doesn't make or add any value either to the patient or health professionals. This health data should be communicated between and among health professionals, health posts, clinics and hospitals in order to produce the required results.

Currently the world is changing, the technology too, at an increasing rate. The world is becoming a small village connected through internet technology. An information captured at one point (corner) may be needed to be accessed by a health professional who is in a remote area (abroad in other continent).

An electronic health record is a means or method of improving or bringing the required service on a timely fashion. Health data should be recorded electronically and accessed by professionals, such as physicians and nurses. These professionals could be found in various areas of a country. If health data is recorded electronically, data will be found timely without distortion, at least comparing to paper-based data.

The practice of medical record documentation in Ethiopia is putting all the data in a folder within one particular health care provider jurisdiction. This, if best handled, will simply be kept in that health center. If a patient is referred to another heath center, the referred center may be forced to take all the data again which was captured in the previous health center. This practice has created a number of problems. It requires incurring unnecessary cost and will waste time. In a situation where there is a need to diagnose immediately a patient who is refereed to another health center will be forced to face complicated health status because of being late giving a repeated information to the referred health center. The other problem that physician face is that they will not get enough, if not perfect, information which lead them to start from the scratch. In the field of medicine, clue is the very important thing for health service providing professionals to concentrate on that particular situation. This is because majority of the problems faced by the patients have same symptoms which may lead physicians to prolonged diagnosis or lead them to

commit a mistake. Therefore the present study proposes design architecture for electronic health record management in order to provide a standardized health related information for governmental and private health institutions and hospital. To the best knowledge of the researcher all the health service providers are not connected with one another in order to provide a service which is considered up to the standard.

1.3. Objectives of the Research

1.3.1 General objective

The general objective of the research is to study the existing practice of health record handling and management of the health sector service providers and design the appropriate architecture in order to capture, disseminate, and utilize data by the sector's service providers for a better health service provision.

1.3.2. Specific objectives

Towards achieving the general objective, this study will attempt to accomplish the following purposes:

- To understand the status of health record handling in the health institutions.
- To propose suitable architecture that support efficient electronic health record handling.

1.5 Scope and limitation of the study

The scope of this research is limited to exploring the existing practice of patients medical history record keeping and aiming at implementing the necessary architecture for electronic health data record. This includes capturing and disseminating patient data which will help further investigation, reporting, decision making and so on.

It would be great to incorporate issues like network and infrastructure security in this study. But since the study concentrates only on the architecture of electronic health records system, the study will not incorporate issues like network and infrastructure security in its scope.

1.6 Organization of the Thesis

This thesis is organized in to six chapters. The first chapter briefly introduces the research; justification and statement of the problem and objective of the study are among others. The second chapter is devoted to literature review about electronic health record, architecture for electronic health record management. It also presents related works done to evaluate about electronic health record in the health sector.

The third chapter explains methodology of the research. The fourth chapter is all about findings of the current activity of all health institutions in Ethiopia. In this chapter analysis has been made about the people involved in the answering the questions. Chapter five is all about the use of electronic health record. Its use, suitable proposed architecture to the developing countries, if not only to Ethiopia. The last chapter, chapter six is about summary, conclusion and recommendation of this study.

CHAPTER TWO

Literature Review

2.1 Medical record

The terms medical record, health record, and medical chart are used somewhat interchangeably to describe the systematic documentation of a single patient's medical history and care across time within one particular health care provider's jurisdiction[8] The medical record includes a variety of types of "notes" entered over time by health care professionals, recording observations and administration of drugs and therapies, orders for the administration of drugs and therapies, test results, x-rays, reports, etc. The maintenance of complete and accurate medical records is a fundamental requirement of health care providers.

The terms are used for both the physical folder that exists for each individual patient and for the body of information found therein.

Medical records have traditionally been compiled and maintained by health care providers, but advances in online data storage have led to the development of personal health records (PHR) that are maintained by patients themselves, often on third-party websites [9]. Because many consider information in medical records to be sensitive personal information covered by expectations of privacy, many ethical and legal issues are implicated in their maintenance, such as third-party access and appropriate storage and disposal[10]. Although the storage equipment for medical records generally is the property of the health care provider, the actual record is considered in most jurisdictions to be the property of the patient, who may obtain copies upon request [11].

The information contained in the medical record allows health care providers to determine the patient's medical history and provide informed care. The medical record serves as the central repository for planning patient care and documenting communication among patient and health care providers and professionals contributing to the patient's care.

The traditional medical record for inpatient care can include admission notes, on-service notes, progress notes, preoperative notes, operative notes, postoperative notes, procedure notes, delivery notes, postpartum notes, and discharge notes. Personal health records combine many of the above features with portability, thus allowing a patient to share medical records across providers and health care systems.[12]

Health records play an important role in modern healthcare. They have two main functions, which are described as either primary or secondary.

2.2 Primary function of health records

The primary function of healthcare records is to record important clinical information, which may need to be accessed by the healthcare professionals involved in the care providing service.

Information contained in health records includes: the treatments someone received, whether someone have any allergies, whether someone currently taking medication, whether someone have previously had any adverse reactions to certain medications, whether someone have any chronic (long-lasting) health conditions, such as diabetes or asthma, the results of any health tests someone have had, such as blood pressure tests, any lifestyle information that may be clinically relevant, such as whether someone smoke, and personal information, such as somebody's age and address.

2.3 Secondary function of health records

Health records can be used to improve public health and the services provided by the National Health Service providers, such as treatments for cancer or diabetes. Health records can also be used to determine how well a particular hospital or specialist unit is performing, to track the spread of, or risk factors for, a particular disease (epidemiology), and in clinical research, to determine whether certain treatments are more effective than others.

When health records are used in this way, somebody's personal details are not given to the people who are carrying out the research. Only the relevant clinical data is given, for example the number of people who were admitted to hospital every year due to a heart attack.

2.4 Types of health records

Health records take many forms and can be on paper or electronic. Different types of health record include:

- consultation notes, which somebody's general practitioner(GP) takes during an appointment,
- hospital admission records, including the reason why someone were admitted to hospital,
- the treatment someone will receive and any other relevant clinical and personal information,
- hospital discharge records, which will include the results of treatment and whether any follow-up appointments or care are required,
- test results,
- X-rays,
- photographs, and
- Image slides, such as those produced by a magnetic resonance imaging (MRI) or computerized tomography (CT) scanner.

2.5 Confidentiality

There are strict laws and regulations to ensure that someone's health records are kept confidential and can only be accessed by health professionals directly involved in someone's care.

2.6 Personal health record

A personal health record, or PHR, is a health record where health data and information related to the care of a patient is entered by the patient.[13] This stands in contrast with the more widely used electronic medical record, which is operated by institutions (such as a hospital) and contains data entered by clinicians. The intention of a PHR is to provide a complete and accurate summary of an individual's medical history which is accessible online. The health data on a PHR might include patient-reported outcome data, lab results, and data from devices such as wireless electronic weighing scales or collected passively from a Smart phone.

The term “personal health record” is not new. The earliest mention of the term was in an article indexed by PubMed dated June 1978 [14] and even earlier in 1956 reference is made to a personal health log[15] However, most scientific articles written about PHRs have been published since 2000.

The term "PHR" has been applied to both paper-based and computerized systems; current usage usually implies an electronic application used to collect and store health data. In recent years, several formal definitions of the term have been proposed by various organizations [16]

It is important to note that PHRs are not the same as electronic health records (EHRs). The latter are software systems designed for use by health care providers. Like the data recorded in paper-based medical records, the data in EHRs are legally authorized notes on the care provided by clinicians to patients. There is no legal mandate that compels a consumer or patient to store his or her personal health information in a PHR.

PHRs can contain a diverse range of data, including but not limited to allergies and adverse drug reactions, chronic diseases, family history, illnesses and hospitalizations, imaging reports (e.g. X-ray), laboratory test results, medications and dosing, surgeries and other procedures, vaccinations, and Observations of Daily Living (ODLs)[17]

In addition to storing an individual's personal health information, some PHRs provide added-value services such as drug-drug interaction checking, electronic messaging between patients and providers, managing appointments, and reminders [18]

PHRs grant patients access to a wide range of health information sources, best medical practices and health knowledge. All of an individual’s medical records are stored in one place instead of

paper-based files in various doctors' offices. Upon encountering a medical condition, a patient's health information is only a few clicks away.

Moreover, PHRs can benefit clinicians. PHRs offer patients the opportunity to submit their data to their clinicians' EHRs. This helps clinicians make better treatment decisions by providing more continuous data [19]

PHRs have the potential to help analyze an individual's health profile and identify health threats and improvement opportunities based on an analysis of drug interaction, current best medical practices, gaps in current medical care plans, and identification of medical errors. Patient illnesses can be tracked in conjunction with healthcare providers and early interventions can be promoted upon encountering deviation of health status. PHRs also make it easier for clinicians to care for their patients by facilitating continuous communication as opposed to interrupted. Eliminating communication barriers and allowing documentation flow between patients and clinicians in a timely fashion can save time consumed by face-to-face meetings and telephone communication. Improved communication can also ease the process for patients and care givers to ask questions, to set up appointments, to request refills and referrals, and to report problems.

2.7 Electronic health record

With the many advances in information technology over the past 20 years, particularly in healthcare, a number of different forms of electronic health records (EHR) have been discussed, developed, and implemented. Some institutions/countries are currently planning the introduction of a nationwide electronic health record while others have actually implemented some form of EHR. However, the type and extent of electronic health records vary and what one country calls an EHR may not be the same as that developed in another country.

Although work has been undertaken by institutions/countries on some form of a computerized patient healthcare information system, as yet not many hospitals have successfully introduced an electronic health record with clinical data entry at the point of care. while interest in automating the health record is generally high in both developed and developing countries, unfortunately in some cases, the introduction of an EHR system seems overwhelming and almost out of reach to

many healthcare providers and administrators as well as medical record/ health information managers.

Why is this so? The obstacles may not be available technology but technical support and the cost of changing to an electronic system coupled with insufficient healthcare funding. In many developing countries costs, available technology, lack of technical expertise and computer skills of staff, and lack of data processing facilities are in fact major issues which would need to be addressed before implementation is possible. In addition to the above, resistance by some medical practitioners and health professionals generally to a change from manual to electronic documentation may be a problem in both developed and developing countries. Most health administrators and information managers are aware that it may take time to change or at least modify health practitioner behavior and attitudes. The reason for wanting to change to an electronic system is important. Many people involved in healthcare today expect to move from a paper to a paperless environment. This is a major step and has only been successfully achieved in a few healthcare institutions to date. Institutions should not focus on just going paperless. They should focus on encouraging departments and healthcare practitioners to move to an electronic system to:

- Improve the accuracy and quality of data recorded in a health record
- Enhance healthcare practitioners' access to a patient's healthcare information enabling it to be shared by all for the present and continuing care.
- Improve the quality of care as a result of having health information immediately available at all times for patient care
- Improve the efficiency of the health record service
- In some instances there is a tendency to expect that with the introduction of an electronic health record many of the problems currently experienced in maintaining paper health records will be eliminated. This is not the case.

An electronic health record is not a simple replacement of the paper record. If identified problems are not addressed and remedy prior to introducing an EHR system merely automating health record content and procedures may perpetuate deficiencies and not meet the EHR goals of the institution/country.

Current problems identified in healthcare documentation, as well as privacy and confidentiality issues must be addressed and quality control measures introduced before a successful change can be implemented.

Although the introduction of a fully electronic health record system may seem far off in many healthcare institutions/countries they are being introduced rapidly in others and there is no doubt that the future of health information management lies with automation and the automatic transmission of information required for patient management at all levels of healthcare.

Defining an Electronic Health Record as mentioned above when people refer to what they have been using as an electronic health record, it may not be the same as other electronic health records developed in different institutions/countries. This may be confusing. In some cases it may be a longitudinal record widely available across a number of institutions but in others it may be a limited automated system only available within a confined community or within a specific unit or department. It is important, therefore, to know what definitions are being used and determine the type and extent of electronic health record system an institution/country wishes to implement. Over the years a number of terms have been used to describe the move from a manual or paper record to one generated electronically in one form or another. Some of the better known terms include: Automated Health Records (AHR), Electronic Medical Record (EMR), Computer-based Patient Record (CPR), and Electronic Health Record (EHR).

2.7.1 Automated Health Records (AHR)

The term Automated Health Records has been used to describe a collection of computer-stored images of traditional health record documents. Typically, these documents are scanned into a computer and the images are stored on optical disks. Most of the focus in the early 1990's was on document scanning onto optical disks. This addressed access, space, and control problems related to paper based records but did not address data input/output at patient care level.

2.7.2 Electronic Medical Record (EMR)

The term Electronic Medical Record or EMR, as with Automated Health Records, has been used to describe automated systems based on document imaging or systems which have been developed within a medical practice or community health centre. These have been used extensively by general practitioners in many developed countries and include patient identification details, medications and prescription generation, laboratory results and in some cases all healthcare information recorded by the doctor during each visit by the patient. In some countries, such as Korea, the term EMR is used to define an electronic record system within a hospital which as well as the above includes clinical information entered by the healthcare professional at the point of care.

2.7.3 Computer-based Patient Record (CPR)

In the USA the term Computer-based Patient Record (CPR) was introduced in the 1990's. This was defined as a collection of health information for one patient linked by a patient identifier. The CPR could include as little as a single episode of care for a patient or healthcare information over an extended period of time. Early CPR's focused on functions such as medical alerts, medication orders, providing integrated data on a patient's registration, admission, and financial details, and recording information from nurses, laboratory, radiology, and pharmacy. Although this form of a computer-based patient record was implemented in a variety of settings the focus on exchanging health information was limited to inpatient facilities.

2.7.4 Electronic Health Record (EHR)

The term Electronic Health Record is widely used in many countries with variation in definitions and the extent of coverage. In today's environment it is generally accepted as a longitudinal health record with entries by healthcare Electronic Health Records practitioners in multiple sites where care is provided. An EHR is the electronic health record which includes all information

contained in a traditional health record including a patient's health profile, behavioral and environmental information. As well as content the EHR also includes the dimension of time, which allows for the inclusion of information across multiple episodes and providers, which will ultimately evolve into a lifetime record. More simply stated, this type of a longitudinal electronic health record could be defined as:

The Electronic Health Record:

- Contains all personal health information belonging to an individual;
- Is entered and accessed electronically by healthcare providers over the person's lifetime; and
- Extends beyond acute inpatient situations including all ambulatory care settings at which the patient receives care.

The World Health Organization's declaration of Health for All by the Year 2000 [20] highlighted the need for better healthcare services, not only at the hospital (secondary) level, but also for primary healthcare and community health services. This has required a change of focus in healthcare in many areas to ensure, if possible, that the implementation of an electronic health record covers healthcare delivery services across a broad spectrum of healthcare. The USA, UK, Australia and some European countries have adopted this concept promoting the development of a longitudinal electronic health record aimed at improving the delivery of healthcare and ensuring that care given to an individual by various healthcare practitioners from many different settings in their lifetime is maintained in a single record and readily available. This is considered by many to be the ideal situation. This type of system would require a computer program that captures data at the time and place where healthcare is provided, whether at a hospital or primary care level over an extended period of time. It would enable healthcare information, such as a person's allergies, recent test results or prescribing history to be readily available at all times to assist with decisions on diagnoses, treatment and medication at all levels of healthcare. Ideally it should reflect the entire health history of an individual across his or her lifetime including data from multiple providers from a variety of healthcare settings.

Such an extensive system, however, has not been introduced by many institutions/countries to date, although many are planned, but may still not be possible in some developing countries like

Ethiopia or in fact some developed countries. The ideal situation is not always possible and healthcare administrators need to identify how they can proceed to automation with available resources both technical and human. A proposed electronic health record will:

- Contain all personal health information of an individual patient, from the patient's first admission or attendance at the hospital;
- Be entered electronically by healthcare providers at the point of care over the patient's lifetime;
- Have information readily available and accessed by all healthcare providers attending to the patient.

Whatever the type of electronic health record decided upon the health information contained in, it must be organized primarily to support continuing, efficient, and quality healthcare. It must also continue to meet legal, confidentiality, and retention requirements of the patient, the attending health professional and the healthcare institution/country. For the purpose of this study, the title electronic health record (EHR), as defined above, will be used as the preferred definition.

2.8 Importance of Electronic Health Records management

More than ever, the healthcare industry is making significant progress in the quest for electronic health records (EHRs), which will improve the quality and safety of patient care and achieve real efficiencies in the healthcare delivery system. [21] Emphasis has been placed on intelligent systems that support the care process and clinical decisions as well as the creation of health information for patient care.

From a strategic standpoint, it is important to go beyond the information creation phase and develop a plan that results in an EHR and EHR system that maintain a high level of integrity for business and legal purposes. The management of the EHR and the EHR system is and will continue to be a mission-critical function in the provision of care across the healthcare continuum. [22] However, in today's urgency to begin deploying EHRs, healthcare entities, vendors, and others sometimes neglect to build in the processes and system capabilities needed

to enable optimal EHR management functions and ensure the electronic rather than the paper version can stand as the legal business record. [23]

Traditional business and health records management concepts and processes must be evaluated and applied in this relatively new world of EHRs. Business process redesign and an understanding of the change management process are fundamental to this activity. Healthcare organizations need to analyze and assess all downstream uses of EHRs and see those uses reflected in requests for proposals, system selection, development, installation, and implementation in order to ensure that all needs of the organization are met. [24]

2.9 Definition of Electronic Health Records Management

Electronic health records management (EHRM) is the process by which electronic (e.g., digital) health records are created or received and preserved for evidentiary (e.g., legal or business) purposes [25].

An electronic record includes information that is:

• Recorded on any electronic medium (e.g., magnetic medium)

• Intended to provide documentation for long-term retention that has legal or business evidentiary value

EHRM requires decision making and planning throughout the entire life cycle of the EHR—from planning, processing, distribution, maintenance, storage, and retrieval of the health record to its ultimate disposition, including archiving or destruction.[26] Decision making includes, but is not limited to, what EHRs to keep and for how long, the assignments of authorities and responsibilities, the design and administration of the process, and the audit and review of the process's performance.[27] In the early phases of EHRM system development, it is important to make critical decisions about the role and use of paper and film to avoid the dilemma of maintaining dual systems.[28]

2.10 Roles and Responsibilities

Health Information Management (HIM) ensures the availability of clinical, demographic, financial, and administrative data to facilitate real time healthcare delivery and critical health- and business-related decision making for multiple purposes across diverse organizations, settings, and disciplines. HIM professionals are ideally suited to provide the healthcare entity with the necessary leadership to ensure that the EHR and the EHR system are optimally managed. [29]

As the traditional custodian of the paper medical record and medical record system, HIM professionals are trained to ensure the quality, privacy, and integrity of the EHR. [30] Today, the EHR can and often does reside in several different information systems. HIM professionals ensure that information management standards are consistently applied across these various systems in order to maintain the level of integrity necessary for the healthcare organization's records.

The evolution from a paper-based medical record model to an EHR model has opened up many avenues for HIM experts to apply and share their core competencies, knowledge, and skills. Advanced technologies and systems make it possible for HIM practitioners to fulfill roles such as patient advocate, data translator, and public health officer.

The e-health environment encompasses much more than the storage and retrieval of information. It places new demands on the HIM professional to assist the consumer in healthcare across the continuum of care [31]. As a patient advocate, HIM practitioners have a vital role and responsibility in the use of patient portal for e-mail, personal health records, scheduling healthcare appointments, completing patient health questionnaires and surveys, and transferring electronic clinical information. HIM practitioners play a role in working toward the exchange of healthcare data among providers, healthcare professionals, and patients. Other traditional patient advocate responsibilities, such as protecting patient privacy, maintaining confidentiality, and promoting and enhancing public policy, will continue to be a critical HIM responsibility [32].

HIM professionals have long been translators of clinical data for their business and financial offices through their clinical expertise, understanding of documentation, and coding functions. Now is the time for HIM practitioners to share their knowledge with healthcare consumers in the

role of data translator [33]. The shift to a consumer-centric model requires HIM practitioners to educate and assist consumers in accessing secure patient information and translating medical terminology across the continuum of care and in advanced technologies. [34]

The e-health environment is, therefore, increasing the ability of HIM professionals to manage data and assist in the development of decision support systems for individual, aggregate, and public health data.

HIM practitioners have a tremendous responsibility in providing the support for organizational, local, and national systems that ensure quality, integrity, and availability of healthcare data. The role of the public health officer in providing strategic leadership of health information in the public health sector has been gaining importance such that we may, in fact, say that these activities are already underway and can be fully supported by the EHR. [35]

The EHR and EHRM are expanding the roles and responsibilities of HIM practitioners. Legal, regulatory, and accrediting environments will need to adapt to the emergence of new technologies and applications in healthcare, and so the traditional leadership role of HIM will continue to influence and adapt the management of health information.

2.11 Architectural Representation

2.11.1 Electronic health record architecture [EHRA]

Electronic health record architecture [EHRA] a model of the generic features necessary in any electronic healthcare record in order that the record may be communicable, complete, useful and effective ethico-legal record of care, and may retain integrity across systems, countries, and time. [36]

The Architecture does not prescribe or dictate what anyone stores in their healthcare records. Nor does it prescribe or dictate how any electronic healthcare record system is implemented. It places no restrictions on the types of data which can appear in the record, including those which have no counterpart in paper records. Details like “field sizes”, coming from the world of physical databases, are not relevant to the electronic healthcare record Architecture. [37]

The electronic health record architecture must describe standardized structural elements in order to enable automatic processing and interoperability. This structure should not dictate the work patterns or system required to operate an effective health service, rather it should ensure that conforming EHRs should be available in many settings. [38]

The Electronic Health Record Architecture (EHRA) must enable data within the record to be classified in ways that make the data accessible to patients and clinicians who use the record and to the systems that support clinical care. Further, data within the record should be structured in standardized ways to enable automatic processing and preserve clinical meaning.

The importance of structured data, it is recognized that the EHRA must provide a repository for many patient stories and narrative generated by the clinician, through dictation or vocal recording.

The linkages and relationships between assessment and monitoring data and the problem definition, goals, interventions and outcomes need to be kept in the electronic patient record.
The language of healthcare can be complex, unstructured and diverse. It can include regional and sub-domain variations. Health professionals and consumers use different words to describe the same concept. These variations create barriers to the retrieval, comparison and exchange of health information. Although it is very important that clinicians and consumers should use their preferred expressions, it is also essential that their language is subject to a measure of control that enables retrieval, comparison and exchange of health information. [39]

These competing needs can be managed by the EHRA supporting multiple coding systems (terminologies, classifications etc). The foundation for an EHR is a comprehensive reference terminology, whose structure unambiguously represents concepts by using a knowledge-based approach. The reference terminology performs or facilitates such tasks as data entry; presenting, querying, retrieving, sharing, comparing and integrating information; navigating or browsing, authoring or indexing knowledge.[40] Entry or interface terms used by clinicians or consumers are related or mapped to the terminology foundation. Similarly, the terminology foundation is mapped or related to classifications used for statistical analysis, planning and policy setting, providing a solid conceptual base to support, represent and reflect the healthcare process.

2.11.2 Shift in the direction to the development of Architecture for Electronic Health Records management System

The following section will allow readers for comparison of approaches followed, including similarities and differences between and among countries of the world towards the emerging international trends in EHR development. Few of the countries are:

Thanks to a major e-health initiative, Singapore, already a healthcare leader in Asia may soon join the short list of countries with nationwide electronic health records. [41] In April 2011, Singapore launched the first phase of its National Electronic Health Record (NEHR) system, which by June 2012 will link all of the country's public healthcare institutions, as well as a number of community hospitals, general practitioners and long-term care facilities, to a central repository of electronic patient information at a cost of S$176m (US$146m). [42] Doctors and nurses at these institutions will be able to access a wealth of data, including clinical diagnoses, medication histories and lab results for about 70% of Singaporeans, no matter where a patient was last treated.

Although many of Singapore's public hospitals have been sharing patient data since 2004, the introduction of the NEHR represents a major step towards the goal of improving health outcomes and the efficiency of Singapore's health sector, which faces many of the public health challenges common to developed countries: a rapidly ageing population, increase in chronic disease and rising demand for healthcare services [43]. As successful e-health initiatives in places like New Zealand and Denmark have shown, the widespread digitization of Singapore's health sector promises to help healthcare providers and policymakers make better decisions about care, modernize the delivery of services and manage demand.

Singapore has already achieved much in the way of electronic patient information exchange, an important goal of national e-health strategies, but its existing platform, the EMR exchange (EMRX), has critical limitations [44]. In addition to connecting only public institutions, the EMRX exchanges unstructured documents. This means that x-rays, for example, cannot be shared between facilities that use different imaging systems and patient data, which follow no

particular format, cannot be analyzed to support clinical decisions, research or disease management. [45]

EMRX has played an important role in improving the continuity of care for many patients, but the New Electronic Health Record (NEHR) will be a considerable step up, ultimately allowing sharing of detailed, integrated data across all of Singapore's healthcare institutions. [46]

The NEHR will also make national health planning, disease management and resource allocation easier. In its second phase, the NEHR will incorporate technology to analyze clinical, financial and usage data in order to measure the impact of care, the cost effectiveness of medications and procedures, and overall performance—information that should allow policymakers a strategic view of the strengths and weaknesses of the sector.

The NEHR project is expected to take five to ten years to complete. Each phase of the project will incorporate lessons learned, IT training for healthcare providers and clinician feedback—an incremental, multi-stakeholder approach that was critical to the success of the Danish model.

The feasibility of Singapore's e-heath endeavor will probably owe much to other important similarities with Denmark, such as the role of a single organization in guiding the development of the national healthcare IT architecture. In Singapore's case this is Ministry of Health (MOH), which provides leadership on overall IT strategy. And then there is Singapore's small size, a distinct advantage when it comes to implementing a nationwide project.

"Size and scale in Singapore have allowed us to accelerate the pace of the project," [47]. The government's strong political vision and backing for e-health, and the city-state's existing e-health infrastructure. "All of those things are very important to setting an environment that is conducive to this kind of project.

In 2001 Canada Health Infoway was created to promote an Electronic Health Record (EHR) system, which promises to enable a safer and more efficient healthcare environment and to save taxpayer dollars along the way. Once the national system is fully functional, says Infoway, which

works with Canada's provinces and territories to build their EHR capacities, it will lower the country's annual healthcare costs by more than C$6bn (US$6.3bn) [48].

However, the system is not yet fully operational despite a decade of work and federal funding of more than C$2.1bn. Canada still falls behind other developed countries in overall healthcare IT adoption: only 37% of Canadian physicians use Electronic Medical Records (EMRs)—necessary building blocks for exchangeable EHRs—compared with almost universal adoption in Australia, Denmark, the Netherlands, New Zealand and the UK. [49]

Behind physicians' low take up of healthcare IT, say critics, is a misalignment of technology investments with the actual needs of the healthcare system. For example, provinces have often prioritized national EHR interoperability over the adoption and exchange of electronic medical records at the local level. But because most health care is provided locally, clinicians consider the ability to exchange patient information between local facilities more important than to do so across provincial lines. [50] Another criticism is that physicians have not been given sufficient incentives to adopt healthcare IT. [51]

However, there have been significant local successes. Ontario, for example, has established province-wide sharing of medical images, with early evidence pointing to significant reductions in cost and increasing care quality. [52] Another example is Alberta, which leads the country with almost 60% of its physicians using EMRs, thanks to financial incentive programs it established early on. E-Chart Manitoba, Canada's first province-wide EHR platform, launched in March 2011 and is expected to provide clinicians with access to 30 million patient records with a single logon. Canada has also put in place a number of successful tele-health projects, a benefit for those living in remote locations far from specialized care.

Canada has also made important progress on a national level, even if that progress has been more modest than expected. [53] Infoway's pan-Canadian technology blueprint and its work creating e-health standards and patient registries has laid the foundation for national information exchange, which will arguably happen quickly once local IT takeup happens in significant numbers.

Policymakers have also shifted their focus away from national EHR inter-operability to building healthcare IT capacity at a local level. British Columbia, Alberta, Saskatchewan, Ontario and Nova Scotia all have comprehensive programs to support physicians' adoption of EMRs, and the 2010 federal budget included C$500 million in support of the same goal. [54]

"Right now our goals are just to try to get technology moving effectively within jurisdictions," says Denis Protti, professor emeritus and founding director of the University of Victoria's School of Health Information Science in British Columbia. Someday we'll have the ability to link data across the country, but it's not seen as a major priority [currently]. There's so much more that needs to be done.

In Denmark, healthcare IT is so developed that ambulance technicians can access a patient's electronic medical record (EMR), and even update it, while traveling to the emergency room. Virtually all Danish primary care physicians use EMRs, while 98% percent of all lab orders, 89% of prescriptions and 90% of clinical communications between primary and secondary healthcare providers take place electronically. [55] For Denmark, which is widely regarded as a world leader in e-health, the benefits are clear: digitization saves time and money, and has enhanced communication across the Danish healthcare landscape, from physicians to specialists to patients.

An early adopter of healthcare IT, Denmark's success story is one of incremental change, innovative policy and doctor buy-in, all of which have allowed it to overcome some of the challenges inherent to all e-health initiatives, the most fundamental of which can be healthcare providers' opposition to adopting new technology in the first place. "For most physicians, time is money," says Denis Protti, an expert on global healthcare IT and founding director of the University of Victoria's School of Health Information Science in British Columbia. And the benefits of spending time to learn new technology may not be immediately obvious.

To overcome this resistance, the Danish government in the late 1990s temporarily dispatched "data consultants" to encourage general practitioners (GPs) to use computers and to communicate electronically. Now a permanent fixture, data consultants meet with doctors a couple of times a year to help them make best use of their technology and to reassure them that IT support is always available to them. The government also engages "practice coordinators",

specialists who communicate with their fellow doctors and hospitals on their technical needs and transmit their feedback to policymakers, where IT has an impact on how policy develops. [56]

Recently Denmark has also been successful in encouraging doctors to communicate with patients via email, something they have been traditionally reluctant to do. Professor Protti attributes this to uncertainty about the legal status of email consultations, how they fit into patients' records and, again, fear of extra work. But by doubling the payment doctors get for an email consultation versus a phone consultation, along with mandating email use in 2009, physician email use has been on the rise. [57] "Studies around the world are increasingly showing that many patients would like to be able to communicate electronically with their physicians," says Professor Protti. [58] "Denmark is one of the few that has made some progress in that arena. A lot of countries around the world are still struggling with that particular aspect of healthcare delivery."

Innovative policy has also helped drive the adoption of healthcare IT standards in Denmark, which are critical in ensuring the interoperability of IT solutions, their utility to practitioners and privacy for patients. To develop broad consensus around new standards, the Danish government will send all of its healthcare IT vendors along with a few specialists and GPs on an overseas trip, tasking them only to return home with an agreed standard. [59]

Increasingly such efforts are international in scope. Denmark's initial healthcare IT infrastructure was based on proprietary technology, which does not lend itself well to future enhancements or expansion. However, increased attention is being paid to global standards, for instance those recommended by Integrating the Healthcare Enterprise, a non-profit organization that promotes unified standards that enable flexible, scalable sharing of healthcare information. Denmark's next goal is to reinvest in healthcare IT to ensure international interoperability, allowing greater flexibility and cost-effectiveness in future. [60]

From limiting the traditional confusion caused by doctors' handwriting, to ensuring that general practitioners (GPs) are kept up to date with the treatment received by their patients in hospital, electronic discharge systems are increasingly popular in UK hospitals.

Replacing handwritten notes that had to be posted by the GP and could easily be mislaid, eDischarge systems, as they are known, allow doctors to write up discharge notes directly into an electronic program [61]. At the Royal Cornwall Hospitals NHS Trust, which manages three sites and serves a population of 450,000 people, Discharge was initially introduced in pediatrics in July 2010 [62].

Under the pilot program, pediatric staff found that the administration of discharging patients was significantly sped up and the turnover of beds was accelerated. “What’s great about the eDischarge system is that it cuts administration and improves bed management,” says Yadlapalli Kumar, consultant pediatrician at the Royal Cornwall Hospital, Truro. The time it takes for case notes to be fully dealt with has been cut by days [63].

The system has since been rolled out to other departments and has become an integral part of hospital management. Hospital notes are automatically sent to the pharmacy, and any subsequent corrections or changes of medication dose are updated on a central system, reducing the possibility of error. Electronic copies are also emailed to the GP, and a paper copy is given to the patient [64].

“It means there is now immediate communication with GPs, who in the past haven’t always had the information they need about why a patient has been admitted, or what treatment they’ve received,” says Dr Kumar. [65] “The feedback we’ve had has indicated that discharge notes are reaching them far quicker than they used to, and nursing staff have reported that drug errors are significantly reduced.” [66]

A further advantage is that the eDischarge system has a secondary function as a database. As it retains diagnostic and treatment information, patterns and trends can be distinguished across groups of patients, in a way that would be impossible with paper records. From the perspective of patients, greater communication between hospitals, GPs and pharmacies reduces the need to repeat their symptoms and history, and provides increased confidence that their treatment is understood by all practitioners concerned.

CHAPTER THREE

Methodology

3.1 Introduction

Research methods are a variety of techniques that people use when studying a given phenomenon. They are planned, scientific, and value-neutral. What that means is that good research methods don't "just happen". Instead, they are deliberately employed in a way that is designed to maximize the accuracy of the results. [67]

Research methods may be understood as all those methods/techniques that are used for conduction of research. Research methods or techniques, thus, refer to the methods the researchers use in performing research operations [68]. In other words, all those methods which are used by the researcher during the course of studying his research problem are termed as research methods. Since the objective of research, particularly the applied research, it order to arrive at a solution for a given problem, the available data and the unknown aspects of the problem have to be related to each other to make a solution possible. Keeping this in view, research methods can be put into the following three groups:

1. In the first group we include those methods which are concerned with the collection of data. These methods will be used where the data already available are not sufficient to arrive at the required solution;
2. The second group consists of those statistical techniques which are used for establishing relationships between the data and the unknowns;
3. The third group consists of those methods which are used to evaluate the accuracy of the results obtained.

Research methods falling in the above stated last two groups are generally taken as the analytical tools of research. [69]

Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically. In it we study the various steps that are generally adopted by a researcher in studying his research problem along with the logic behind them. It is necessary for the researcher to know not only the research

methods/techniques but also the methodology. Researchers not only need to know how to develop certain indices or tests, how to calculate the mean, the mode, the median or the standard deviation or chi-square, how to apply particular research techniques, but they also need to know which of these methods or techniques, are relevant and which are not, and what would they mean and indicate and why. Researchers also need to understand the assumptions underlying various techniques and they need to know the criteria by which they can decide that certain techniques and procedures will be applicable to certain problems and others will not. All this means that it is necessary for the researcher to design his methodology for his problem as the same may differ from problem to problem.

In research the scientist has to expose the research decisions to evaluation before they are implemented. He has to specify very clearly and precisely what decisions he selects and why he selects them so that they can be evaluated by others also. From what has been stated above, we can say that research methodology has many dimensions and research methods do constitute a part of the research methodology [70]. The scope of research methodology is wider than that of research methods. Thus, when we talk of research methodology we not only talk of the research methods but also consider the logic behind the methods we use in the context of our research study and explain why we are using a particular method or technique and why we are not using others so that research results are capable of being evaluated either by the researcher himself or by others. Why a research study has been undertaken, how the research problem has been defined, in what way and why the hypothesis has been formulated, what data have been collected and what particular method has been adopted, why particular technique of analyzing data has been used and a host of similar other questions are usually answered when we talk of research methodology concerning a research problem or study.

When a researcher starts to think about a research methodology, he/she need to think about the differences between qualitative and quantitative research.

Qualitative research explores attitudes, behavior and experiences through such methods as interviews or focus groups. It attempts to get an in-depth opinion from participants. As it is attitudes, behavior and experiences which are important, fewer people take part in the research,

but the contact with these people tends to last a lot longer. Under the umbrella of qualitative research there are many different methodologies. Whereas Quantitative research generates statistics through the use of large-scale survey research, using methods such as questionnaires or structured interviews. If a market researcher has stopped you on the streets, or you have filled in a questionnaire which has arrived through the post, this falls under the umbrella of quantitative research. This type of research reaches many more people, but the contact with those people is much quicker than it is in qualitative research [71].

3.2 Study Area

This research is conducted in and around Addis Ababa, which is the capital city of Ethiopia. Ethiopia, officially known as the Federal Democratic Republic of Ethiopia, is a country located in the Horn of Africa. It is the second-most populous nation in Africa, with over 82 million inhabitants, [72] the tenth largest by area, occupying 1,100,000 km2. Ethiopia is bordered by Eritrea to the north, Djibouti and Somalia to the east, Sudan and South Sudan to the west, and Kenya to the south. With its capital at Addis Ababa, it is also the most populous landlocked nation in the world.

Ethiopia was a monarchy for most of its history, and the Ethiopian dynasty traces its roots to the 2nd century BC [73]. Ethiopia is also one of the oldest sites of human existence known to scientists today, having yielded some of humanity's oldest traces [74]. It may be the region from which Homo sapiens first set out for the Middle East and points beyond [75].

According to the head of the World Bank's Global HIV/AIDS Program, Ethiopia has only 1 medical doctor per 100,000 people [76]. However, the World Health Organization's 2006 World Health Report gives a figure of 1936 physicians, [77] which comes to about 2.6 per 100,000. Globalization is said to affect the country, with many educated professionals leaving Ethiopia for a better economic opportunity in the West.

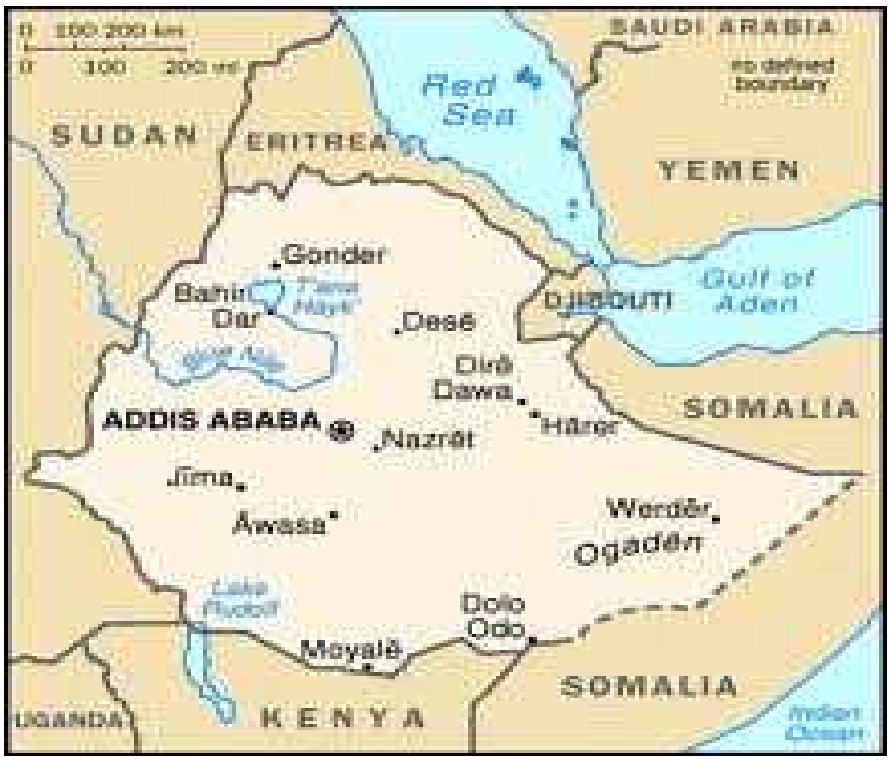


Figure 3.1 Map of Ethiopia with neighboring countries.

Ethiopia's main health problems are said to be communicable diseases caused by poor facility, sanitation and malnutrition. These problems are exacerbated by the shortage of trained manpower and health facilities [78]

There are 119 hospitals (12 in Addis Ababa alone) and 412 health centers in Ethiopia [79]. Ethiopia has a relatively low average life expectancy of 45 years [80]. Infant mortality rates are relatively very high, as over 8% of infants die during or shortly after childbirth, [81] (although this is a dramatic decrease from 16% in 1965) while birth-related complications such as obstetric fistula affect many of the nation's women. HIV is also prevalent in the country.

The other major health problem in Ethiopia is spread of AIDS. AIDS has mainly affected poor communities and women, due to lack of health education, empowerment, awareness and lack of social well-being. The government of Ethiopia and many private organizations like World health Organization (WHO), and the United Nations, are launching campaigns and are working aggressively to improve Ethiopia’s health conditions and promote health awareness on AIDS and other communicable diseases.

Many believe that sexually transmitted diseases like gonorrhea result from touching a stone after a female dog urinates on it and there is a general belief that these diseases are caused by bad spirits and supernatural causes. Others believe that eating the reproductive organs of a black goat will help expel the diseases from those same organs in their body. Ethiopia has high infant and maternal mortality rate. Only minorities of Ethiopians are born in hospitals; most of them are born in rural households. Those who are expected to give birth at home have elderly women serve as midwives assist with the delivery. The increase in infant and maternal mortality rate is believed to be due to lack of women's involvement in household decision- making, immunization and social capital. On the other hand, the "WHO estimates that a majority of maternal fatalities and disabilities could be prevented if deliveries were to take place at well-equipped health centers, with adequately trained staff".

The low availability of health care professionals with modern medical training, together with lack of funds for medical services, leads to the preponderancy of less reliable traditional healers that use home-based therapies to heal common ailments. One medical practice that is commonly practiced irrespective of religion or economic status is female genital cutting (FGC) or female circumcision, a procedure by which some of a woman's external genital tissue, such as the clitoral hood, the clitoris or labia are removed. According to a study performed by the Population Reference Bureau, Ethiopia has a prevalence rate of 81% among women ages 35 to 39 and 62% among women ages 15–19 [82]. Ethiopia's 2005 Demographic and Health Survey (EDHS) noted that the national prevalence rate is 74% among women ages 15–49 [83]. The practice is almost universal in the regions of Dire Dawa, Somali and Afar; in the Oromo and Harari regions, more than 80% of girls and women undergo the procedure. FGC is least prevalent in the regions of Tigray and Gambela, where 29% and 27% of girls and women, respectively, are affected [84]. In 2004, the Ethiopian Government enacted a law against FGC. Female circumcision is a pre-marital custom mainly endemic to Northeast Africa and parts of the Near East that has its ultimate origins in Ancient Egypt [85]. Encouraged by women in the community, it is primarily intended to deter promiscuity and to offer protection from physical attack [86]. About 76% of Ethiopia's male population is also reportedly circumcised [87].

The main reasons for the development of architecture for Electronic Health Record in Ethiopia are the following. As it is clearly stated in the above paragraphs, Ethiopia has a lot of health

related problems. These problems emanates as somehow described in the above paragraphs from:

- Traditional believes
- Lack of technological advancements
- Proper treatment or awareness of people, etc

While the above points are reasons for health complications, improper infrastructure for health records produces its contribution for low quality of health care. An architecture which enables us to connect all health service providers would help Ethiopia get the following advantages. Among the benefits of EHRs, some of them are: it decreases repetition of information, information can be accessed by health care professional remotely, all health care providers will have access to the same up to date information, built-in protocols encourage adherence to clinical practice guidelines and improve constancy (loyalty and reliability) and consistency of care, improves communication amongst health care providers. It will also provide more protection in the level of lawsuit, may accurately capture financial data, send electronic prescription requests to radiologists, pharmacies (reducing the risk that hard-to-read handwritings which may lead to medical errors), help researchers (example chemists) see the efficacy of a medicine. In addition to these, it helps for decision support system (government officials for budgeting), provides awareness to government to predict or notify an outbreak (example epidemic), and helps for knowledge sharing, for statistics and analysis. In order to get these advantages, all the health service providers should be computerized and get connected with one another either through a network or a web based system. So a mechanism should be there that facilitates the transfer of health data between and among health service providers in order to supply a service which is up to the standard. Therefore it’s a must to study the importance of developing an archetecture for Electronic Health Record.

Type of Health Institution	MOH Private	NGOs	Private (for-profit- sector)
Health center/clinics/health posts/health stations	3200	322	1119
District/zonal/general hospitals	77	8	12
Specialty hospitals	5	0	0
Total	3282	330	1131

Source: MoH and Regional health Bureaus.

3.3 Study Design

A study design is a specific plan or protocol for conducting the study, which allows the investigator to translate the conceptual hypothesis into an operational one. This study uses a non-experimental, retrospective, cross-sectional study design to investigate the relationship between internal features of hospitals and develop Architecture for EHR or adoption of EHR. A cross-sectional study is suitable for this study than longitudinal study that it involves observation of all of a population, or a representative subset, at one specific point in time [89]. In contrast longitudinal study involves repeated observations of the same variables over long periods of time, often many decades. It is a type of observational study. Longitudinal studies are often used in psychology to study developmental trends across the life span, and in sociology to study life events throughout lifetimes or generations. The reason for this is that unlike cross-sectional

studies, longitudinal studies track the same people, and therefore the differences observed in those people are less likely to be the result of cultural differences across generations. Because of this benefit, longitudinal studies make observing changes more accurate and they are applied in various other fields. [90] A retrospective study uses existing data that have been recorded for reasons other than research. [91] This study uses interview, questionnaire and document analysis for data collection purpose.

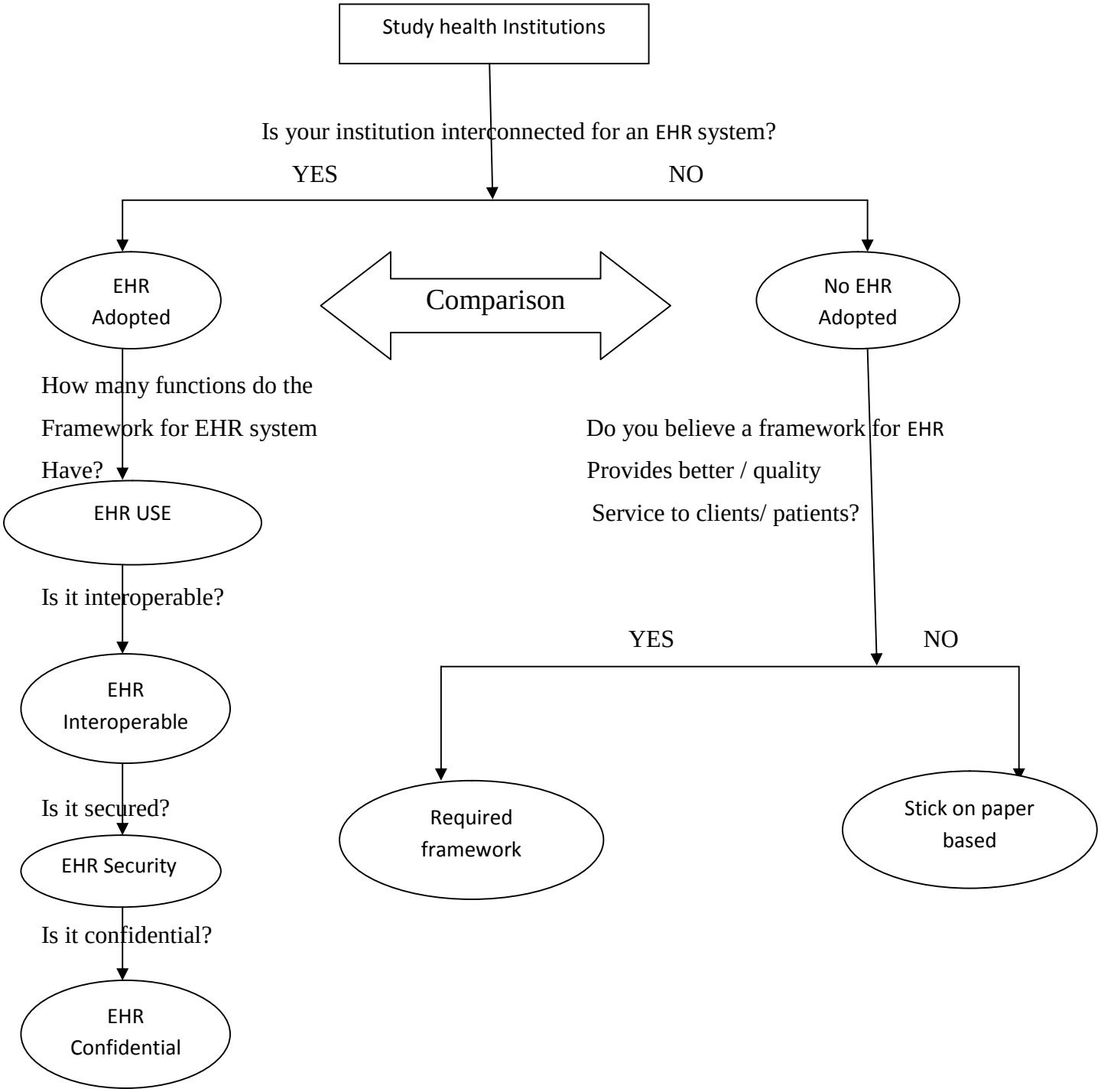


Figure 3.2 study design flow chart

3.4 study population

A research population is generally a large collection of individuals or objects that is the main focus of a scientific query. It is for the benefit of the population that researches are done. However, due to the large sizes of populations, researchers often cannot test every individual in the population because it is too expensive and time-consuming. This is the reason why researchers rely on sampling techniques [92].

A research population is also known as a well-defined collection of individuals or objects known to have similar characteristics. All individuals or objects within a certain population usually have a common, binding characteristic or trait [93].

This study comprises a population of all healthcare providers like Specialists, General Practitioners, Health Officers, Nurses, Management body, Filing Clerks, Receptionist, etc who are employees of health service providing institutions throughout the country. Table 3.2 shows the number of health care providers in the country.

Human resource distribution by region year 2001

Profession	Tigray	Afar	Amhara	Oromia	Somalia	Ben-G	SNNPR	Gamb.	Harar	A.A.	D.D.	Total
GP	64	12	178	184	56	8	193	10	21	396	29	1,151
Specialists	37	3	126	194	15	4	49	3	8	538	24	1,001
Health Officer	188	29	434	448	12	42	220	13	31	170	19	1,606
Pharmacist	51	8	159	119	10	9	50	5	16	193	12	632
Pharma. Tech	241	55	603	382	27	39	395	6	22	237	22	2,029
All nurses	2,332	185	3,790	5,040	314	452	3,980	91	276	3,377	272	20,109
Midviews	185		212	287	45	37	316	4	29	244	20	1,379
Lab technologist	58	13	213	184	12	2	97	7	6	259	15	866
Lab Technicians	173	27	534	346	46	33	372	2	41	343	40	1,957
Envi'al health	96	16	226	452	20	23	266	9	25	83	30	1,246
Health Assistant	498	0	298	93	53	13	290	4	18	192	27	1,486
Radiographer	NA	NA	25	17	3	NA	14		5	96	8	169
HEW*	1,259	375	6,415	12,875	1,100	499	7,492	457	32	NA	74	30,578
others	156	0	282	379	475	9	125	7	18	258	24	1,733
Total	5,339	723	13,730	21,125	2,188	1,170	13,859	618	555	6,386	621	66,314

Source: report on human resource for health profile study by WHO, 2009, Ethiopia *annual performance report of HSDP III 2009

3.5 Sample population

Sampling is concerned with the selection of a subset of individuals from within a population to estimate characteristics of the whole population [95].

Researchers rarely survey the entire population because the cost of a census is too high. The three main advantages of sampling are that the cost is lower, data collection is faster, and since the data set is smaller it is possible to ensure homogeneity and to improve the accuracy and quality of the data [96].

The sampling population of this study is encompassed from professionals who are working in health service providing institutions throughout Ethiopia. Among others sample units of this study are Specialists, General Practitioners, Nurses, and Managers.

Sampling units of this study will be selected based on their knowledge of the area and active engagement of service rendering. Samples will be selected bearing in mind that they will represent well the entire population.

3.6 Sample Size

This study has managed to select professionals like specialists, general practitioners, nurses, management professionals, among others, as the respondents for the questionnaire distributed and interview conducted. I have selected 120 professionals as a sample unit. This sample size ensures that the responses are sufficiently reliable to get the necessary and genuine data from the professionals.

3.7 Data collection Procedures

Data Collection is an important aspect of any type of research study. Inaccurate data collection can impact the results of a study and ultimately lead to invalid results.

Data collection methods for impact evaluation vary along a continuum. At one end of this continuum are quantitative methods and at the other end of the continuum are Qualitative methods for data collection.

In this study there are basically two main categories of data collection procedures or methods. The first is qualitative data collection method, which plays an important role providing information useful to understand the processes behind observed results. The qualitative method most commonly used in evaluation can be classified in three broad categories.

- ✓ In-depth interview
- ✓ Observation methods, and
- ✓ Document review

Whereas the quantitative data collection methods rely on random sampling and structured data collection instruments that fit diverse experiences in to predetermined response categories. They produce results that are easy to summarize, compare, and generalize. Most commonly used methods of quantitative methods are interview [in quantitative research (survey research) interview are more structured than qualitative research [97].

3.8 Data Quality Management

Data quality is a perception or an assessment of data's fitness to serve its purpose in a given context. Aspects of data quality include: [98]

- Accuracy
- Completeness
- Update status
- Relevance

- Consistency across data sources
- Reliability
- Appropriate presentation
- Accessibility

In order to be sure that the data collected through various means (either qualitative or quantitative data collection method) are up to the standard, the following points will be done in this study prior to the collection of data.

- Whether the questionnaire is very well communicative and is up to the standard or not, it will be checked as a lead start in some area by some individuals. This will help facilitate the questionnaire's wholeness or totality to collect the necessary information in order to attain the stated objective.
- Training is a must to the data collectors as to how they collect the data. This will somehow guarantee that errors made through data collection can be minimized.
- Responses which are regarded as irrelevant or inappropriate should be treated as either "rejected" or "non-respondent" or other better way.
- Interview and observational results will be assimilated in such a way that they are organized in its right category.

3.9 Ethical Consideration

The joint administration of the school of information science and school of medicine will give ethical clearance before conducting any kind of data collection. A formal letter will be submitted to the concerned body in order to get appropriate help or cooperation. Participants in either interview or questionnaire are fully free to either give a response to a given question or withdraw from a pool. And they are highly secured for the response they provide. They can anytime disregard the participation. All the activities of the participants are highly protected. No personal detail mentioned even if he/she asks for assistance in the filling of a questionnaire; it will be kept as a secret. No record will be found in any document about respondents.

3.10 Dissemination of Results

The finding of this research will be presented to the joint Academic Commission of faculty of Informatics and Faculty of Medicine, Addis Ababa University as part of the fulfillment for the degree of Masters of Science in Health Informatics. In addition, it will be distributed to the Ministry of Health and some NGOs like World Health Organization.

CHAPTER FOUR

Findings and Presentation

4.1 Finding, Presentation of data and Discussion

To assess the existing practice of medical record of health institutions questionnaires are distributed to various ranks of health institutions within and around Addis Ababa. These questionnaires were distributed to health posts, health care centers, clinics (both privates and public), and hospitals (both governmentally owned and held by individual investors), research institutions, individuals who specializes in the area of health and technology, etc

The responses obtained through questionnaires are supplemented with the right people and observations of the way the institutions mentioned above handle their medical records. Table 4.1 below shows the total number of questionnaires distributed and collected and the percentage of collection as well from within and outside Addis Ababa. Questionnaires were distributed to the institutions which are performing their daily activity in relation to the maintenance of health of the people of Ethiopia. In addition to this, the questionnaires are distributed to the medical directors, general practitioners, nurses, pharmacists, receptionist, management, researchers of the health sector. Physical observation also have been taken by being in some selected health institutions in order to understand the way they handle their medical records, the interaction professionals have with their patients. Apart from this interview, discussions have been taken with various professionals of the health sector whenever ambiguity arises.

Table 4.1 Number of distributed and collected questionnaires.

		Number of questionnaires		
No	Name of Institutions	Distributed	Collected	Percentage %
1	Black Lion Hospital	6	6	100%
2	Zewditu Hospital	6	4	66.7%
3	Yekatit 12 Hoapital	6	4	66.7%
4	Ras Desta Hospital	6	4	66.7%
5	Balcha Hospital	6	6	100%
6	Hayat Hospital	6	5	83.3%
7	K.Gebreal Hospital	6	6	100%
8	T/Haymanot hospital	6	1	16.7%
9	Africa Clinic	6	4	66.7%
10	Bitania Clinic	6	5	83.3%
11	Brook Clinic	6	4	66.7%
12	Abinet Clinic	6	4	66.7%
13	T/haymanot Health Center	6	6	100%
14	Lideta Health Center	6	6	100%
15	Pastor	6	5	83.3%
16	Kidus Paulos hospital	6	3	50%
17	Ministry of Health	6	6	100%
18	WHO	6	6	100%
19	Miscellaneous people	6	6	100%
20	Police Hospital	6	0	0%

In general, the requirement distributed to all the health sectors were 120. Among these questionnaires the number of questionnaires collected is 91. This is 76% of response rate.

4.2 Demographic Analysis

This section of the survey is concerned with background of the respondents to understand the employees or respondents who participate in filling the questionnaire for this research. The questionnaire distributed to respondents is divided in to two main sections. A profile and Survey proper. The profile contains socio demographic characteristics of the respondents such as age, gender, educational status, the number of years they have served the health center as well as their assigned job position.

The Survey proper explored the perception of the sector's professionals on architecture, particularly on its usability and reliability of health data record. The profile or detail of respondents is presented in table 4.2

When we look the respondents in gender wise 47.3% of the respondents are males where as the remaining percentage of respondents which are 52.7% are females. This shows participants who are female are larger than male in the research.

The majority of the respondents are comprised from the health service providers, which accounts 68% whereas 32% of respondents are from management, reception and people working in NGO's. this shows that majority of the respondents are those who actively participating in the health service providing like specialists, general practitioners, nurses.

When we analyze the age category of respondents they fall in the following range.

20 - 30 years 11%

31 - 40 years 24%

41 - 50 years 57%

>= 51 years 8%

This shows 92% of the respondents below the age of 50.

Table 4.2 profile of respondents

Measures		Frequency	Percentage %
Position	Medical Director	19	20.9%
	General Practitioner	19	20.9%
	Nurse	11	12.1%
	Specialist	12	13.2%
	Management	15	16.5%
	Receptionist	15	16.5%
Age	20 - 30	10	11%
	31 - 40	22	24.2%
	41 - 50	52	57.1%
	>= 51	7	8%
Gender	Female	48	52.7%
	Male	43	47.3%
	Not given	0	0%
Level of Education	Specialist	22	24.2%
	2^{nd} Degree	12	13.2%
	1^{st} Degree	38	41.6%
	Diploma	19	20.9%
	Certificate	0	0%

Year of experience of respondents in the health service providers (Institutions) that participate in this study is depicted here in figure 4.1

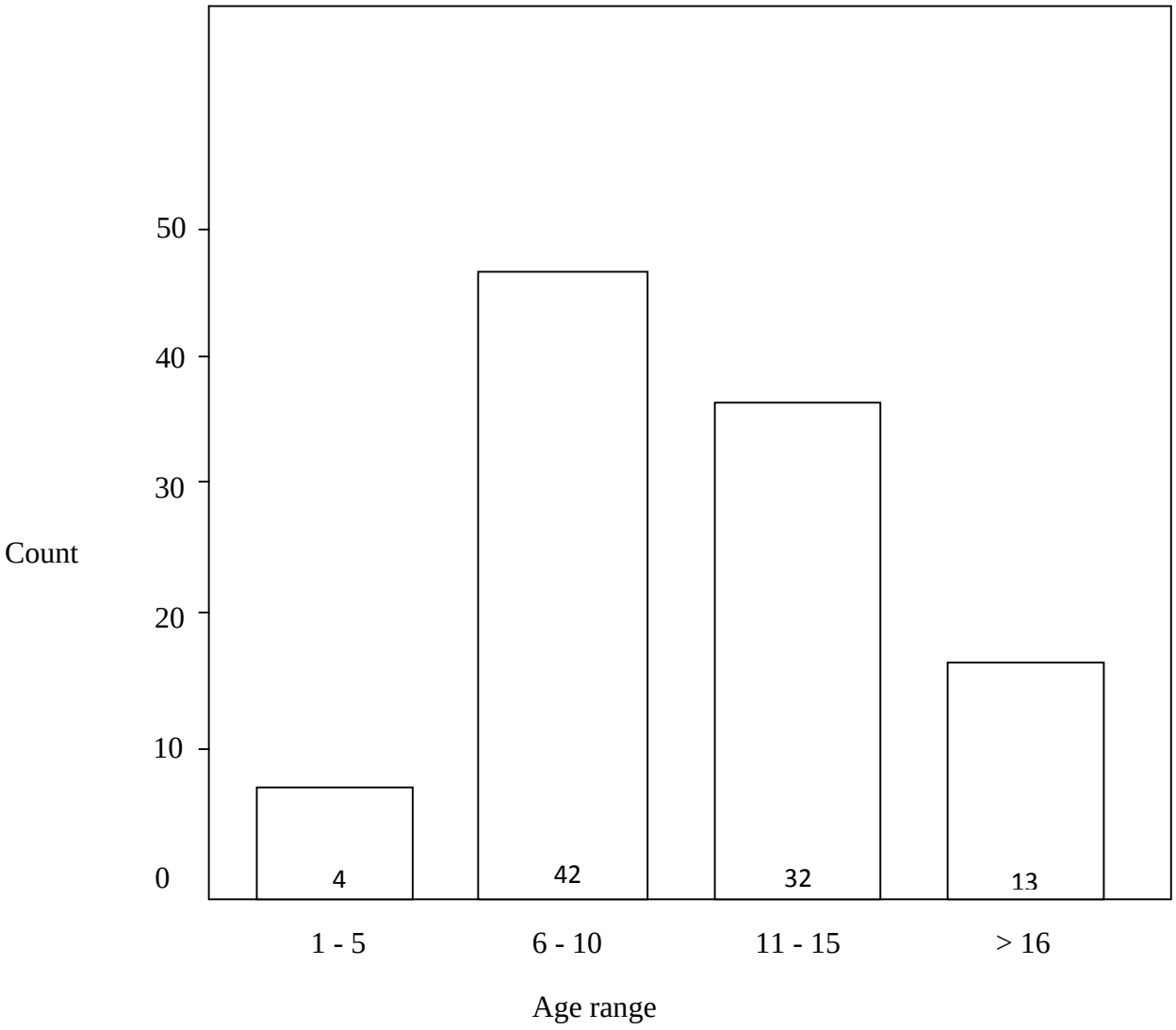


Fig.4.1 Respondents years of experience in health institutions

4.3 Discussion of Health Records Practice of Health Institutions

Personal health information is recorded and stored in paper format. Printed laboratory reports, copies of clinic notes, and health histories created by the individual may be parts of paper-based PHR. Paper-based PHRs may be difficult to locate, update, and share with others. Paper-based PHRs are subject to physical loss and damage, such as during a natural disaster. Some of the disadvantages of paper based records over the electronic ones are the following and for the reasons mentioned below all the respondents have suggested having an electronic medical record.

4.3.1 Improved Accuracy

Medical errors in a paper-based medical record system can sometimes be related to incomplete documentation and illegible handwriting. Electronic systems come with features that make sure all information necessary for patient care is included on the form. Some EMR software packages have edits in place that require the user to add additional information as needed.

4.3.2 Reduced Costs

Although, providers may have the initial costs of implementing an electronic medical record system, the overall costs are less than those associated with the paper record. Paper medical records have higher costs due to the necessity of more personnel to manage, access, file, and maintain paper charts.

4.3.3 Ease of Access

With a digital record, access is virtually unlimited. Physicians can have access to test results almost immediately. Multiple departments can add clinical information to the health record without having to locate or checkout a paper medical record chart.

4.3.4 Increased Risk Management

With all patient information in digital form, providers are able to track clinical issues more effectively allowing them to easily identify areas of risk. Processes can quickly and accurately be put in place in order to improve patient care.

4.4 Gaps identified in architecture for EHR development

In Ethiopia, where, according to WHO, there is only one physician per 100,000 people, there is a need for having an electronic health record which could play its part in increasing efficiency at a relatively low cost and is vastly important in the health system's ability to provide high quality care. The following are the gaps I identified to the development of electronic health record.

Standard is a means by which all health institutions share patient health data across the country. In Ethiopia, there is no any standard which enable structured clinical content for the purpose of exchanging patent data. Due to this lack of standards we could not talk about the following points as well.

4.4.1 Health Information Privacy and Security - Anyone who works in the Healthcare sector understands the importance of maintaining confidentiality with a patient's personal and often highly sensitive information. This can be traced back to the 'Hippocratic Oath' (4th century BC) which defines the basis of ethics in medicine for our physicians. Since we don't have any technological advancement in the field we could not talk about issues like privacy and security. It is understood from the interview I made that paper based patient medical record is highly subject for being exposed to data theft.

4.4.2 Interoperability – e-Health interoperability at the systems level can be defined as the ability of two or more information systems to exchange both computer interpretable data and human interpretable information and knowledge [1]. It spans multiple levels – from the physical network through data, information and knowledge levels. Standards are essential for the development and deployment of

interoperable e-Health systems. They ensure that risk is minimized when developing new technology, enable re-use of solutions, and eliminate costly custom development and integration. As mentioned in one of the above bullets there is no standard at all in the country in relation to electronic health record. Due to this we are unable to talk issues of interoperability between and among health institutions. This study has also identified it as a gap.

4.4.3 Technological and infrastructural aspect - Technology has increased productivity, reduced costs, and led to better services and products for most industries and professions, but health care is just beginning to catch up. Information technology – the use of computers, other electronic devices, and software designed to support clinical decisions – is now becoming an all-encompassing and critical part of health care delivery for the benefit of both physicians and patients. All health institutions in Ethiopia are quite late behind to catch up at least the benefits to be acquired out of it. In addition to this there is no infrastructure at all to support technological products which are found in the country either bought or denoted. This reason is a hole for easy implementation and use of electronic health record.

4.4.4 Policies - Among other ways of gathering information for conducting this research are interview and document analysis. In my data collection I realized that the government of Ethiopia did not exert any effort in order to connect and reconnect various health institutions throughout the country. A policy is typically described as a principle or rule to guide decisions and achieve rational outcomes. The term is not normally used to denote what is actually done; this is normally referred to as either procedure or protocol. Policies are generally adopted by the Board of or senior governance body within an organization whereas procedures or protocols would be developed and adopted by senior executive officers [1]. This is one of the major holes I found in the area of my study. There is no yet any issue from the government side to develop any architecture for electronic health record.

4.4.5 Readiness – as per the study's findings all the institutions and their manpower are not ready in implementing electronic health record. This has several reasons. One the government did not by itself; pay any attention towards the development of architecture for electronic health record. The other main point is that people working in this activity are not very well suited to technological aspects which are a setback for them to urge the concerned body like the government or ministry of health to facilitate the implementation of electronic health records. In general this study has found that there is no readiness from both parties (government and professionals) as to the implementation of electronic health record.

CHAPTER FIVE

Development of Architecture

5.1 A Framework for Design and Development of Architecture for Electronic Health Records Management System

More than ever, the healthcare industry is making significant progress in the quest for electronic health records (EHRs), which will improve the quality and safety of patient care and achieve real efficiencies in the healthcare delivery system. Emphasis has been placed on intelligent systems that support the care process and clinical decisions as well as the creation of health information for patient care [99]. From a strategic standpoint, it is important to go beyond the information creation phase and develop a plan that results in an EHR and EHR system that maintain a high level of integrity for business and legal purposes [100]. The management of the EHR and the EHR system is and will continue to be a mission-critical function in the provision of care across the healthcare continuum. However, in today's urgency to begin deploying EHRs, healthcare entities, vendors, and others sometimes neglect to build in the processes and system capabilities needed to enable optimal EHR management functions and ensure the electronic rather than the paper version can stand as the legal business record. Traditional business and health records management concepts and processes must be evaluated and applied in this relatively new world of EHRs. Business process redesign and an understanding of the change management process are fundamental to this activity [101]. Healthcare organizations need to analyze and assess all downstream uses of EHRs and see those uses reflected in requests for proposals, system selection, development, installation, and implementation in order to ensure that all needs of the organization are met.

Architecture is a passion, a vocation, a calling – as well as a science and a business [102]. It has been described as a social art and also an artful science. Architecture must be of the highest quality of design. Architecture provides a sense of place and support of all types of human activity. Architecture helps the man-made fit in harmony with the environment while promoting health and well-being, enriching lives aesthetically and spiritually, providing economic opportunities, and creating a legacy that reflects and symbolizes culture and traditions. [103]

Information technologies are revolutionizing the medical profession by increasing the efficiency of health care provision and reducing costs [104]. Notable technologies attracting widespread attention are portable medical monitoring devices for the home and electronic medical records [105]. But as “e-health” becomes more pervasive within the medical industry, one prediction is that health care technologies will shift focus “from a central, hospital-based system to a patient centered system, where patients will be the manager and owner of their health information” [106].

Despite the current inroads being made into e-health, serious problems remain. Two major issues include inter-operability and security and privacy. The lack of mandated or cooperation between inter-operability standards in the industry are hampering efforts to improve the provision of health care. For e-health to advance, it is imperative that inter-operability standards exist; for example, to allow monitoring devices to communicate with one another, to allow electronic medical records to be compatible with the information systems in all medical institutions, etc. Inter-operability itself raises security and privacy concerns. For example, it is unclear how the confidentiality and privacy of medical information could be safeguarded in the situation where electronic records are circulated between medical professionals affiliated with different organizations. Related to data circulation are workflows. Workflows are a standard way to model and manage coordination and interaction between businesses and customers. Workflow Management Systems (WfMS) control the execution of workflows. WfMS operate by interpreting process definitions, interacting with the workflow participants and invoking external software applications.

Although these systems once focused on automating isolated office tasks, nowadays, there is a shift towards WfMS managing inter-organizational information flows (to achieve automation of the entire business process) [107]. For workflows which spread across multiple organizations, web services have emerged as a promising implementation option considering their suitability for heterogeneous and Internet-based environments.

Although there are many specific languages to describe workflows [108], some standards, especially in the context of web services such as WSBPEL (originally called BPEL4WS) [109], have emerged. When such technology is applied to medical systems, the availability of standards such as Health Level 7 (HL7) and DICOM have not fully helped in overcoming the complexity associated with medical workflows [110]. Health Level Seven (HL7) is a non-profit organization

involved in development of international healthcare informatics interoperability standards [111]. "HL7" is also used to refer to some of the specific standards created by the organization (e.g., HL7 v2.x, v3.0, HL7 RIM) [112].

HL7 and its members provide a framework (and related standards) for the exchange, integration, sharing, and retrieval of electronic health information. v2.x of the standards, which support clinical practice and the management, delivery, and evaluation of health services, are the most commonly used in the world. [113]

DICOM (Digital Imaging and Communications in Medicine) is a standard for handling, storing, printing, and transmitting information in medical imaging. It includes a file format definition and a network communications protocol. The communication protocol is an application protocol that uses TCP/IP to communicate between systems. DICOM files can be exchanged between two entities that are capable of receiving image and patient data in DICOM format [114].

This is particularly true in developed countries where there are two logical components, viz., administrative aspects and actual medical services. The situation is not clear even if one focuses only on the security aspects of workflows in medical systems. In general, the most widely recognized web services security technology for providing access control is extensible Access Control Markup Language (XACML) [115].

The use of role based access control (RBAC) for medical systems has been explored to model issues such as trust and privacy. They show how multiple roles arranged in a hierarchy can be used to represent trust and jurisdiction. While RBAC can be used to implement privacy requirements by controlling access to data, the privacy guaranteed by a particular RBAC set of policies is not always clear. It is possible to use temporal logic [116] to describe privacy related security constraints directly (such as separation of duty) - but such specifications are hard to use in practice (from both the health practitioners' and the software engineers' perspectives). Modeling and verification tools can be used instead to apply the logic indirectly. In this paper, I propose architecture for the circulation of electronic medical records amongst medical professionals, with a focus on protecting patients' privacy. I also show how a realistic version of the "need to know" principle can be implemented. The architecture is designed to support inter-organizational information flow, and for that reason, it considers interoperability issues as well as security and privacy issues. As in any inter-organizational information flow scenario

involving document circulation, a major challenge faced is enforcing access control when the document is outside the security realm of the data owner. This challenge exists as inter-organizational workflows assume no centralized global authority to enforce security. Instead, each security realm which the document flows through is separately administrated by its respective organization.

In the proposed architecture, privacy conditions are governed by policies. I discuss two types of policies for protecting patients' privacy. Global privacy policies list the privacy rules that apply to all medical records. Patient privacy policies are unique for each patient and list the patient's own preferences in terms of privacy. Technically it is possible to implement privacy using RBAC, Chinese wall policies etc. I use the RBAC model, together with encryption, to enforce privacy conditions. In any case, privacy is the main policy driver of my research - RBAC is simply one of many possible implementation options that can be used.

Problems arise if the privacy conditions do not adequately describe the situation under which the medical record is being used. For example, the policy rules may not be explicit enough to provide an accurate decision. Policies across organizations may be such that they do not allow access to data. For instance, I do not assume that the definition of roles and access control are defined in a uniform fashion. It is possible for particular RBAC definitions to prevent the completion of a particular task.

To address such situations, I apply an extension to the architecture that allows users to provide a reasoning to justify their usage of the medical record. If their reasoning is valid, permission is granted for the user to perform their requested action in accordance with the privacy conditions.

Additionally, the patient may specify in their privacy policy the trust relationships that it shares with various medical practitioners. If the requesting user is trusted by the patient, then permission can be granted based on the conditions of the trust relationship. Issues such as privacy can be associated with both the flow of information as well as the tasks performed.

For instance, the requirement that a patient's medical record will not be sent to the hospital administrator is related to the flow of information. On the other hand, a doctor treating a patient may need to know some details to complete the task on hand.

The electronic processing of medical data which is expected to improve quality and efficiency of health care services will lead to an increasing amount of medical data exchanged across institutional boundaries. The greatest benefit is expected if concise medical data are available for the patient himself as well as for medical institutions involved in the treatment process.

Currently trans-institutional data exchange is only partly realized for specific fields. Up to now, and to my best knowledge no systems for a transparent integration of medical data across institutional boundaries have been implemented here in Ethiopia.

Presently communication among institutions in the healthcare environment is mainly based on directed data flow, implying that the intended receiver has to be known at the very beginning of the communication process. Particularly in a medical context this is very limiting, resulting in multiple transmissions of documents from the producing institution to all the possible recipients.

In this paper I illustrate the development of a network architecture for electronic health record (EHR), using a technical infrastructure based on Medical Data GRIDs. The architecture is designed to comply with the cross enterprise document sharing specification and the Ethiopian federal law for Public Health. The main challenge is to design the architecture in the way to comply with both requirements.

The architecture is designed to be highly scalable and to offer a standardized interface which simplifies the process of joining for new institutions as much as possible. For this reason an architecture following the blueprint of Medical Data seem to be most appropriate. Data are usually defined in the following way: “Data is an emerging technological paradigm for the seamless access, via virtualized middleware, to heterogeneous and distributed ensembles of data storage resources” [117].

A commonly agreed on definition, which takes into account the very specific context in which medical data is treated, is not known to us. Legal and organizational requirements in the medical domain vary vastly for every country. Data handled by a shared electronic health record are specific to a medical domain such as laboratory results or radiological images. Analysis and procession is closely bound to the originating medical domain. These specific requirements demand for adaptation of the data architecture definition. For this paper I propose to extend the

original definition as follows: “Medical Data is an emerging technological paradigm for the seamless access to medical data for electronic health record with special focus on legal and organizational requisitions of the environment they are operated in, via virtualized middleware, to heterogeneous and distributed ensembles of data storage resources” [4]. The development of the network architecture follows an iterative approach which I have chosen to gradually adopt the architecture to evolving requirements of the major players.

5.2 Examples of EHR Practice

Implementation of some form of electronic health record has been achieved in a number of countries over recent years. Examples of a few EHR practices are as follows:

5.2.1 Malaysia

In Malaysia two hospitals have already gone paperless. A 960-bed hospital was the first and a 270-bed hospital, the second. One primary healthcare facility also has an electronic health record and does not maintain a paper record. In addition, in 1985 a Teaching Hospital in Kuala Lumpur developed a Health Information Management Administration System (HIMAS) using an IBM mainframe computer covering patient admission, transfer, and separation (ATS), appointment scheduling and a medical records tracing system. The present INFOMED system being used now at the hospital is an upgraded version of HIMAS which includes the ATS, patient scheduling, and medical records tracking applications, pharmacy ordering, laboratory ordering/reporting, radiological ordering and reporting, patient accounting and a small system on case-mix. All the systems are not fully integrated, but the hospital started a new Health Information System (HIS) in 2004 aimed at upgrading INFOMED to integrate the present systems and add more systems complete with e-records. The hospital administration started the implementation of HIS in phases in 2004 and plan for completion within seven years. [119]

5.2.2 Korea

In Korea 11 hospitals have implemented a fully Electronic Medical Record (EMR). They include all inpatient and outpatient healthcare information. Broken down by bed size, one with the bed capacity of 300-399, two with the bed capacity of 500-599, two with the bed capacity of 600-699, and six with a bed capacity of over 700. In addition, there are three hospitals with over 500 beds with an EMR implemented for inpatients only, and two hospitals with over 700 beds with an EMR for outpatients only. Another three hospitals have partially implemented an EMR system. In one of the major hospitals the EMR was introduced in October 2004 for both inpatients and outpatients. Most of the old medical records have been scanned and very recent ones are currently being scanned with the hospital hoping to complete them by the end of 2005. For inpatients, data is entered at the bedside using a notebook computer. For outpatients, doctors input data at the point of care via computer terminals, but if they are too busy, physician's assistants enter data for them. The language being used for the EMR is SNOMED CT. Signed consent forms for treatment are scanned immediately after discharge and connected to the EMR as are letters from referring practitioners and hospitals. Some test reports which are produced from equipment not yet interfaced to the EMR are also scanned immediately after discharge enabling users to view them via a monitor. This equipment is to be interfaced as soon as possible. A goal of the hospital is to share information with all the national hospitals and public healthcare facilities but at present they can only share data with one branch of the hospital. [120]

5.2.3 Indonesia

An EHR standard is being developed in Indonesia and is mainly concerned with the hospital-based environment even though some data may also come from community healthcare sectors. In an area in the middle of Java, there is a district that has already linked the reporting and recording of several primary healthcare centers into their computer system (using a Local Area Network, approaching to WAN). The health workers are now able to determine how many TB patients are being treated as well as a number of other diseases treated in their area. This area has been chosen to be the centre of training for primary healthcare facilities. Most hospitals, however still use traditional non-EH records although progress is being made in developing an EHR policy and standards. [121]

5.2.4 China

In China, a number of hospitals have successfully introduced some form of electronic health record but as yet, as far as can be ascertained, none have been able to go paperless. The concept of a longitudinal electronic health record is envisaged by the Chinese Health Ministry but problems have arisen because some institutions are unable to share data due to the incompatibility of their systems. This is an extremely important issue and compatibility with other systems with which the proposed system needs to interface with is an important consideration before the introduction of an HER. [122]

5.2.5 Australian

The Australian Government is funding the implementation of a national health information network, called HealthConnect – a proposed network aimed at improving the flow of information across the Australian health sector (HealthConnect 2000). It is a system involving the electronic collection, storage and exchange of patient health information via a secure network and within privacy safeguards. The HealthConnect objective aims at improving the overall delivery and efficiency of healthcare, achieve better quality care and patient satisfaction. Under this system health related information about a person would be documented in a standard electronic format at the point-of-care, such as at a hospital or a general practitioner's office. The information could then be retrieved online whenever it was needed and exchanged, with the patient's consent, between authorized healthcare professionals. Across Australia a number of initiatives based on HealthConnect are already in place with more being developed and implemented. Other countries such as Singapore, Taiwan, Hong Kong and Thailand are also developing electronic health records in one form or another with successful implementation. There is no question that electronic health records are here to stay. The extent and type of automation, however, will differ considerably not only between countries but between institutions within a country [123].

The introduction of an EHR can be a huge undertaking. Some administrators and medical practitioners may still be hesitant about such a major step but with clearly determined goals as to the type and extent of the system required and well prepared plans for implementation, the introduction of an EHR should go smoothly. There may be some teething problems and some people may not be supportive at first but as the benefits become visible its value will become

apparent. Once fully up and running it should be as accepted as mobile phones and e-mail facilities are in the current environment.

5.3 Preliminary Steps

When considering a move from a manual medical record system to some form of electronic health record the major question is: Where to begin?
The steps would be to review the existing medical record system to assess the quality of current records and medical record services, identify problems and prepare a formal report summarizing results. Such a review would be extremely useful when assessing the type of system to be selected and the possible benefits of moving to an electronic health record.

Review of Current Health Record System

When reviewing current medical record services the first questions to be asked are: [124]

- ✓ Are medical records currently kept on all patients - inpatients, outpatients and accident and emergency (A & E) patients?

- ✓ What type of medical record is kept? Is the medical record system centralised using a unit numbering system? That is, are all admissions, outpatient notes and accident and emergency records filed under one number in the one medical record?

- ✓ How are patients identified? Do all persons have a national identification number? Is this used to uniquely identify the patient? If a national identification number is not issued what information is used to identify each patient?

- ✓ Does the institution have a Patient Master Index (PMI)? Is it computerized?

- ✓ A well designed electronic health record is dependent on the patient being correctly identified and all information for that patient maintained in the one record within the system.
- ✓ Are medical records well documented? What is the quality of the medical record?
    - o Has all essential information been recorded, are all entries signed and dated?
    - o Are quality checks performed on current paper records? If so, have any documentation problems been identified?
- ✓ Are daily admissions and discharge lists produced?
- ✓ Does the MRD receive loose forms after patients have been discharged?
- ✓ Are inpatient morbidity statistics collected and compiled by medical record staff? Are they responsible for the submission of monthly returns and the annual report of hospital activity? What about Outpatient statistics? Are there any problems with the collection and are they produced within the anticipated time frame?
- ✓ Are medical records returned to the medical record department on discharge of the patient? If they are returned promptly have they been completed or are they usually incomplete and without a discharge summary? How should staff handle incomplete medical records?
- ✓ How are medical records filed? Are medical records filed by the medical record/hospital number? What system of filing is used?
- ✓ Is there a problem with duplicate medical records? If the patient's medical record cannot be found, although he or she has attended the hospital previously, should staff prepare a new or duplicate medical record?
- ✓ How is information released for medico-legal purposes? Is the information readily accessible and available? Is there a delay experienced in the completion of the reports by medical staff?
- ✓ When the medical record has been completed by the doctor do medical record staff code the main condition using a classification system such as ICD 10? Do they code procedures? Are coders trained in coding using ICD 10? Are the codes indexed to enable the retrieval of medical records for research, health statistics and epidemiological studies?

- ✓ What are the areas that need immediate attention before a successful EHR system could be introduced? Important items include:

    - o All patients should have one medical record: Is this the case?

    - o All patients should be uniquely identified: Is this the case? Any problems associated with patient identification should be solved as soon as possible.
    - o A PMI is maintained: Is this the case? If not, it should also be introduced as soon as possible.
    - o Health practitioners complete the medical records by documenting patient care information at the point and time of care using standard terminology: Is this the case?

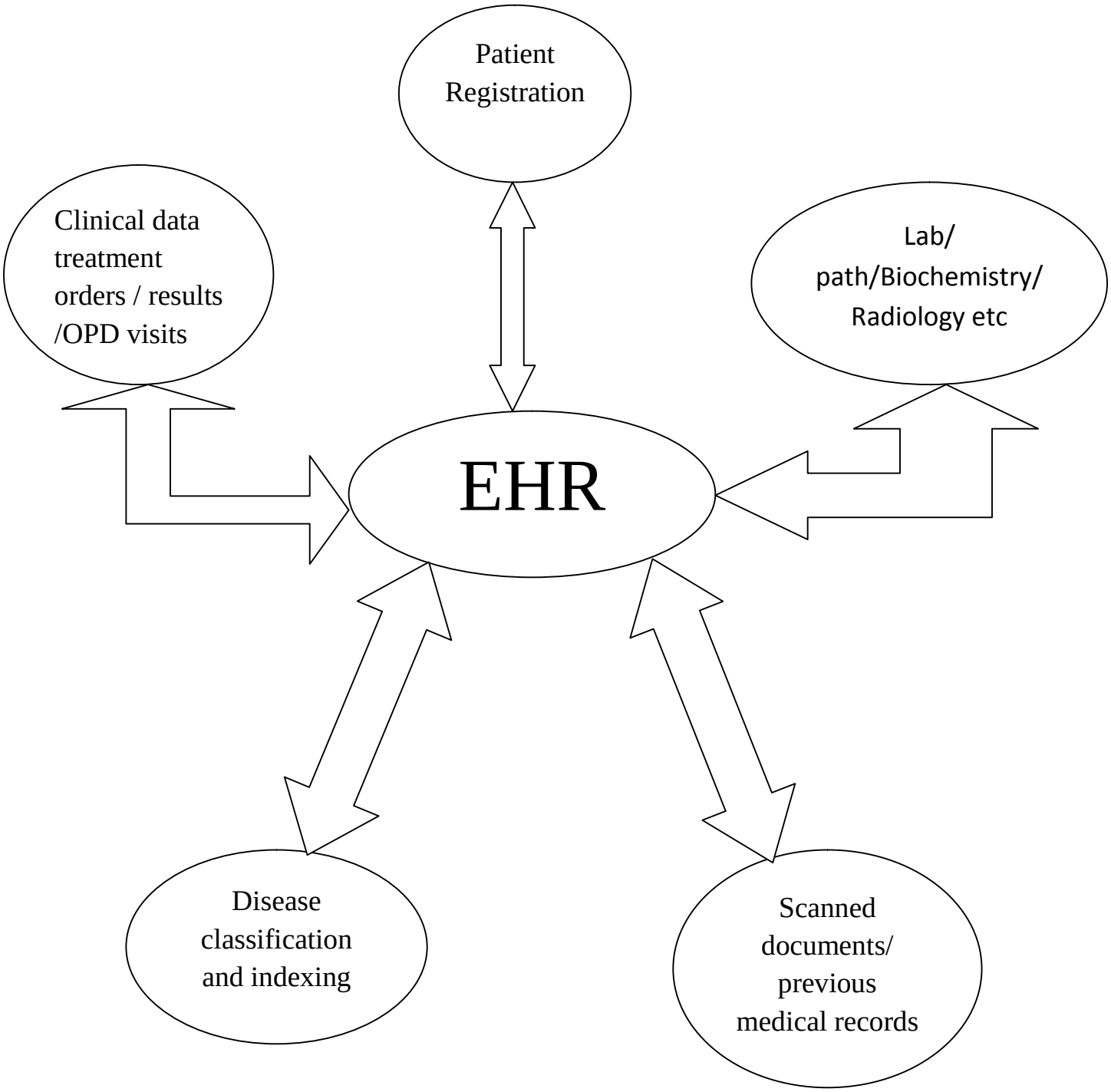
5.4 Issues and Challenges

If a decision to introduce an electronic health record system has been made, the next step is to identify and address issues and challenges that may affect successful implementation. The benefits of an electronic health record system are many. If the planned benefits are not achieved or do not seem to have been achieved, the value of the system or future systems may be questioned. Issues and challenges therefore must be identified and addressed before proceeding.
Accurate patient identification is the backbone of an effective and efficient health record system, whether manual or electronic. As discussed previously unique patient identification is a major issue that should be addressed before moving forward to automation. Other possible issues may include:

1. Clinical data entry issues and lack of standard terminology
2. Resistance to computer technology and lack of computer literacy
3. Strong resistance to change by many healthcare providers
4. High cost of computers and computer systems and funding limitations
5. Concern by providers as to whether information will be available on request
6. Concerns raised by healthcare professionals, patients and the general community about privacy, confidentiality and the quality and accuracy of electronically generated information

7. Quality of electronic healthcare information and accuracy of data entries
8. Lack of staff with adequate knowledge of disease classification systems
9. Manpower issues – lack of staff with adequate skills
10. Environmental issues – electrical wiring and supply of electricity, amount and quality of space needed for computers, etc.
11. Involvement of clinicians and hospital administrators

5.5 Proposed Architectural framework for EHR



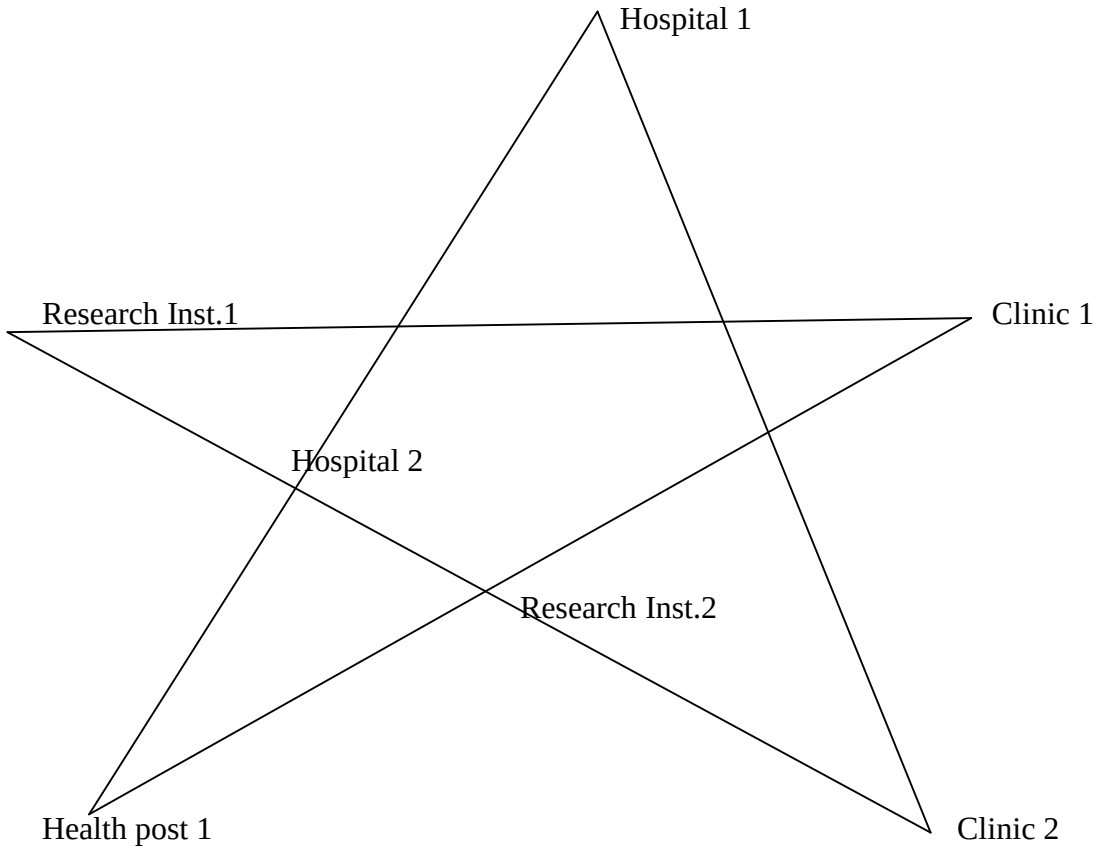


Figure 5.1 Architectural framework for HER

5.6 Medical Record Information Flow

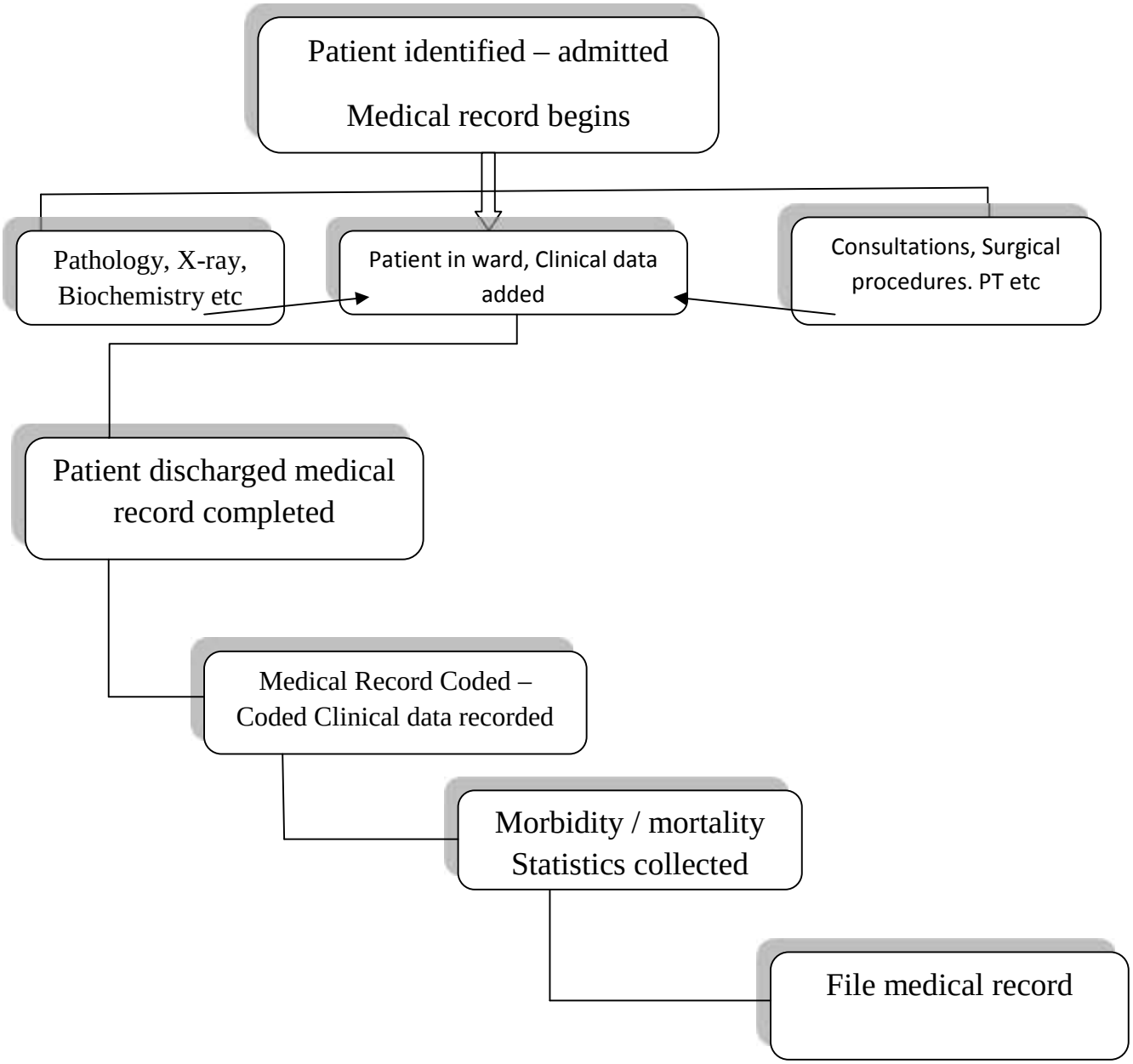


Figure 5.2 Medical Record Information Flow

In an electronic health record information flow for inpatients should be the same as for manual medical records as outlined in the diagram above. The record begins on the admission of the patient with registration and identification data verified. In the ward, all healthcare data would then be entered electronically at the bedside or nurses station via a terminal or other electronic device by attending healthcare practitioners. Other data would be added to the patient's record electronically from other departments such as pathology, biochemistry, radiology, etc. On discharge or death the health record would be checked electronically for completion, diseases and procedures coded, and statistics compiled.

The introduction of an EHR should be aimed at increasing the efficiency of healthcare delivery by the institution and/or country, and containing costs by eliminating the unnecessary duplication of services. In addition, as for current paper records, it must ensure the confidentiality of data, improve the quality of care and help to promote the health and wellbeing of the population.

5.7 Perceived benefits of an EHR system

In our society today, computers are everywhere. They have been used to simplify our lives and make our work easier and more accurate. In order to be a part of this fast spreading technology the medical industry is on its way to do away with the pen and paper system and embrace computers to keep and track patient medical records, hence electronic health record.

When an individual goes to his or her doctor with a complaint the doctor will obtain information from the patient in an attempt to build a complete story of the origin and probable causes of the complaint. Information obtained from the patient will include the patients past and present medical history, laboratory results, previous medical conditions and medications prescribed, radiological images etc., all make up the patient's medical records. This information when put in a digital format is known as the individual's electronic health record.

The present administration has made it a priority to move ahead with centralizing and putting patients' medical record in digital format. A huge chunk of the economic recovery stimulus package has been earmarked for this project. It is hoped that when all is said and done, electronic medical records, a better way to keep records than pen and paper will be the order of the day.

Just like any new approach to doing things, EHR (Electronic Health Records) has its advantages and disadvantages. The advantages of Electronic medical record keeping includes:-

5.7.1 Better documentation

Doctors are legendary for illegible hand writings leading to inaccurate data entry by a second or third party. With EHR this problem will mostly become a thing of the past.

5.7.2 Lower Cost

It is hoped that the use of EHR will reduce healthcare cost in the long run and promote evidence based care. As information is readily available, and easily and quickly referred to before proceeding with the best treatment option, resources will be saved as the patient's sick period is reduced.

5.7.3 Better storage

Huge amounts of information can be stored in digital format taking up a minuscule amount of space thereby eliminating file storage problems that presently exists with the pen and paper system.

5.7.4 Easy retrieval of information

With information in a digital format it is fast and easy to retrieve information saving time and manpower. With patients medical records just a mouse click away, Individuals previously involved in locating and retrieving files will be redeployed to other positions.

5.7.5 Reduced malpractice insurance premiums

With the legible and accurate documentation an electronic health record system provides, insurance companies tend to reduce malpractice premium for institutions using EHR system. Also in cases of litigation the information trail is easy to follow and will make a difference in the outcome of a case if things were ambiguous.

5.7.6 Increased level of medical care

With the patients complete medical record a few clicks away, a physician has immediate access to the patient's medical information allowing for a faster and better response to providing medical care.

5.7.7 Accurate record keeping

EHR makes it easy to keep accurate records of who has access to patient's information, when it was accessed and by whom. And when alterations are made to a patients record you can find out who altered it and when.

In general the introduction of an electronic health record has a lot of benefits. For example, benefits could include but not be limited to the following:

- Patients will be uniquely identified at all times
- All healthcare information generated within the institution will be documented at the point of care
- Standard terminology will be used to ensure information is universally understood
- All health records will be accurate, reliable, and completed promptly
- Data will be processed to support better decision-making by healthcare practitioners
- Information about an individual patient will be immediately available at all times for present and future care
- Quality of healthcare will be enhanced by the provision of better information for clinicians to make decisions about treatment and healthcare planning
- Patient confidentiality and privacy will be maintained

- With improved clinical documentation at the point of care, problems associated with coding of diseases and procedures will be eliminated
- Morbidity and mortality statistics will be completed promptly and accurately
- Problems relating to filing, loose sheets, etc will be eliminated
- Space problems associated with the storage of paper medical records will be eliminated
- Increased efficiency of the institution with decreased costs in the long-term

5.8 Clinical Document Architecture

The Clinical Document Architecture is a HL7 standard for the representation and machine processing of clinical documents in a way which makes the documents both human readable and machine processable and guarantees preservation of the content by using the eXtensible Markup Language (XML) standard.

It is a useful an intuitive approach to management of documents which make up a large part of the clinical information processing arena.CDA is being used also in electronic health records projects to provide a standard format for entry, retrieval and storage of health information. This is of much interest to those projects as the progress will help their understanding of the best data storage techniques for medical files. Storing patient files and health records is a key part of running a successful medical facility.

All in all the development of a family of standards for interoperability under HL7 is somewhat inevitable. CDA and CCOW (a standard for compatibility for modules within a clinical health record of are both examples. A new standard for conduct of business between different sectors has emerged electronic business XML. The place of this standard and its position Vis a vis HL7 needs exploration. The Clinical Document Architecture is a Health Level Seven (HL7) standard for the creation of clinical documents using XML (extensible markup language). XML is a process for adding (non-printable) characters to text documents to allow the computer system to process the text eg. Change the format or presentation as in bolded text or to allocate specific meaning eg. Storing data or encoding data embedded in the text.

The CDA specifies the structure and semantics of clinical documents in health care. A document can be defined as a piece of text or information that would usually be authenticated by a signature eg. a progress note, a pathology request, a radiology report, or an account. A CDA document may contain text, images and multimedia, coded data. The CDA document can be stored either permanently or temporarily as a document in a computer system; and transmitted as the content of a message using e-mail, HL7 or any other messaging system.

CDA was created in the recognition that much of health care is involved in creating and managing documents and the document paradigm is well understood by clinicians and administrators

A clinical document has the following features which form the framework for the CDA.

- Persistence
- Stewardship
- Authentication
- Wholeness and context
- Human readability

CDA aims to give priority to documents generated by clinicians in order to:

- Standardize the format of the many thousands of types of clinical documents
- To support exchange of clinical information for human readability, and information processing;
- To promote longevity of information by separating the data from the systems that store it (to avoid obsolescence as occurs with technological processes and by being computer platform independent;
- Allow appropriate local adaptation of the standard to meet national or specific user requirements.

1. Header - this contains the key descriptive information about the document (metadata) such as who wrote it, type of document.
2. Body - this contains the text of the document which may be structured at least under key headings or sections. It is possible for the text to contain coded values. It is also possible

to have not text information in the body such as an image of an x-ray (using the DICOM standard representation)

CDA has been developed in 3 stages: Level 1 through Level 3. Level one has a structured header and structured body of message with limited coding capacity for content. Levels 2 and 3 impose more structure to allow the representation of "context" or constrained fields and more coded data. CDA documents (along with the standard electronic health record architecture) require the use of templates and archetypes, which define the key information and context of complex health concepts such as family history or blood pressure.

CHAPTER SIX

6 conclusion and recommendation

6.1 Conclusion

"New" is not necessarily better!

Electronic Health Record presents a great opportunity for the health services of developing countries in the enhancement of the quality of healthcare delivered, the opportunity for early detection of epidemics and clinical examination. It has so far received very little attention from policy makers of these countries.

This research is carried out or conducted in Ethiopian health institutions to find out as how they maintain patient's health records, to introduce EHR in Ethiopian hospitals, benefits of EHR in Ethiopian hospitals and what sort of data an implemented EHR would capture. Some of the challenges of EHR implementation that I identified are the initial huge start up costs, poor computer skills of the healthcare professionals, poor maintenance culture.

The weak state of information infrastructure at the hospital will be another challenge in an EHR implementation. EHR could potentially reduce waiting times for patients, reduce the cost of the hospital's operations, improve interdepartmental communication and collaboration, provide an opportunity for sharing best practices among physicians within Ethiopian hospitals, and enhance better resource allocation. The data an EHR will primarily capture will be patients' demographics, care plans, laboratory results and billings.

This research has some limitations and should be treated that it can serve as a basis for the other researchers who can carry on from this. There are a lot of issues like network infrastructure security, privacy, interoperability that one can take care of. Further studies should concentrate in this matter and examine whether the capacity of the EHR to improve the overall care delivery process of patients will likely outweigh the barrier associated with the additional time required to use the system. New methods to measure the impact of the EHR on time efficiency from an

institution's or a system's perspective will have to be developed. Further research is needed to examine the impact of EHR on system efficiency and how this will influence adoption rates by all users, particularly physicians.

6.2 Recommendation

The following recommendations are given based on this study of architectural framework with a view to enhance electronic health record in Ethiopia.

- Electronic health records can benefit clinicians, patients and payers by reducing human error and improper data handling, improper payment and the like. Therefore policy makers, officials in the health sector like ministry of health, governance of the country should give appropriate support and encouragement to the development of architectural framework for electronic health record. They should give considerable time and effort to increase the electronic health record activity of health institutions by taking appropriate measure.
- Each health institution has to have a plan and budget in order to let the staffs of that institution get appropriate skill of operating technological devices like computers, scanners, network and networking as well.
- Each health institution should manage to organize in some predefined interval events like seminar, workshop, and meeting to its staffs which can give an opportunity to know where the world is in relation to electronic health records.
- Intensive studies should be carried on in order to enjoy the advantage of technology in health area.

References

1. Stephen Harper (1995, April 19). Health and Technology. *Medicine Hat News* Retrieved on sept. 15, 2011, from http:// infoway-inforute.ca

2. Dr. Anne Diog (2006, February 20). The health care community. The daily courier,165 retrieved sept 15, 2011 from http:// infoway-inforute.ca

3. Better Health Care, better patient outcome (2006). The Canadian nurse association retrieved on sept. 15,2011 from http:// infoway-inforute.ca

4. Karen Madill (2010). Electronic journal of health informatics, vol 5(1): e2

5. J.H. Van Bemmel and M.A. Musen, ed., handbook of medical informatics, springer. The nether land, 1977.p.99

6. Richard Dick, Elaine B. Steen, and Don Detmer, editors, the computer based patient record: An essential technology for health care, Institute of medicine, National academic press, 1977,p.111

7. http:// wiki.answer.com

8. Personal Health Record. April 2011.CMS.Retrived February 10, 2012, from http://en.wikipedia.org/wiki/Medical_record

9. MyPHR.com. Retrieved February 10, 2012, from

10. Frequently Asked Questions. MyPHR.com. Retrieved 2012-04-14, from http://library.ahima.org/xpedio/groups/public/documents/ahima/bok1_009223.hcsp?dDocName=bok1_009223

11. Medical Records. McKinley Health Center. Retrieved April 2012, from *www.**mckinley**.uiuc.edu/*

12. Health Information Privacy. Hhs.gov. Retrieved April 2012, from http://www.hhs.gov/

13. Tang, Paul; Ash, Joan; Bates, David; Overhage, J.; Sands, Daniel (2006). "Personal Health Records: Definitions, Benefits, and Strategies for Overcoming Barriers to Adoption". *JAMIA* **13** (2): 121–126. DOI:10.1197/jamia.M2025

14. "Computerization of personal health records". *Health Visitor* **51** (6): 227. Jun 1978. PMID 248054

15. DRAGSTEDT, CA (1956-04-14). "Personal health log". Journal of the American Medical Association 160 (15): 1320. DOI:10.1001/jama

16. American Health Information Management Association. The Role of the Personal Health Record in the EHR. July 25, 2005, retrieved on 25 April 2012 from ttp://en.wikipedia.org/wiki/Personal_health_record

17. Greenhalgh T, Potts HWW, Wong G, Bark P, Swinglehurst D (2009). Tensions and paradoxes in electronic patient record research: A systematic literature review using the meta-narrative method. Milbank Quarterly, 87(4), 729-88

18. Kim, Matthew; Johnson, Kevin (2002). "Personal health records: evaluation of functionality and utility". JAMIA 9 (2): 171–180. DOI:10.1197/jamia

19. Patrick Kierkegaard (2011) Electronic health record: Wiring Europe's healthcare, Computer Law & Security Review, Volume 27, Issue 5, September 2011, Pages 503-515, ISSN 0267-3649, 10.1016/j.clsr.2011.07.013. Retrieved April 25, 2012

20. Wager, K., Lee, F., & Glaser, J. Health care information systems: A practical approach for health care management (2nd ed.)Jossey-Bass,pages 253-254, 2009

21. Himmelstein DU, Wright A, Woolhandler S (2009). Hospital Computing and the Costs and Quality of Care: A National Study. American Journal of Medicine, doi:10.1016/j.amjmed.2009.09.004

22. RWIF,GWUMC, and IHP Staff: "Health Information Technology in the United States: The Information Base for Progress", Robert Wood Johnson Foundation, George Washington University Medical Center, and Institute for Health Policy, 2006, Retrieved February 17, 2012

23. Blumenthal, D.; Tavenner, M. (2010). "The "Meaningful Use" Regulation for Electronic Health Records". *New England Journal of Medicine* **363** (6): 501–504.

24. Defining and Testing EMR Usability. Healthcare Information and Management Systems Society (HIMSS), June 2009

25. E-HIM Work Group on Implementing Electronic Signatures. “Implementing Electronic Signatures.” Updated October 2003.

26. Welch, JJ. “Correcting and Amending Entries in a Computerized Patient Record Admissibility of Medical Records.” *Journal of AHIMA* 70, no. 8 (Sept. 1999): 76A–76C.

27. “Building an Enterprise Master Person Index.” *Journal of AHIMA* 75, no.1 (Jan. 2004): 56A–D.

28. “The Complete Medical Record in a Hybrid Electronic Health Record Environment: Part III: Authorship of and Printing the Health Record.” 2003.

29. “The Complete Medical Record in a Hybrid Electronic Health Record Environment: Part II: Managing Access and Disclosure.” 2003.

30. Murphy, Gretchen, Mary Alice Hanken, and Kathleen Waters. *Electronic Health Records: Changing the Vision*. Philadelphia, PA: W.B. Saunders Company, 1999.

31. Welch, JJ. “Correcting and Amending Entries in a Computerized Patient Record Admissibility of Medical Records.” *Journal of AHIMA* 70, no. 8 (Sept. 1999): 76A–76C.

32. Bewley S, Perry H, Fawdry R, Cumming G (2011). NHS IT requires the wisdom of the crowd not the marketplace, retrieved on April 15,2012 from http://www.bmj.com/content/343/bmj.d5317.full/reply#bmj_el_270562

33. AHIMA e-HIM Personal Health Record Work Group (Jul 2005). "Practice brief. The role of the personal health record in the EHR". *Journal of AHIMA / American Health Information Management Association* **76** (7): 64A–64D.

34. American Health Information Management Association; American Medical Informatics Association (Apr 2007). "The value of personal health records. A joint position statement for consumers of healthcare by the American Health Information Management Association and the American Medical Informatics Association".

35. Rahul Shetty: Portable Digital Personal Health Record: To Bridge the Digital gap in Medical Information Storage of Individuals with Personal Health Records in Flash Drives. The Internet Journal of Health. 2007. Volume 5 Number 2.

36. Blobel B. Architecture of Secure Portable and Interoperable Electronic Health Records. Sloot, P. M. A.; Kenneth Tan, J. J.; Dongarra, C. J., and Hoekstra, A. G., Eds. Procs International Conference on Computational Science. Apr 2002; 2:982-994

37. Kalra D. Clinical Foundations and Information Architecture for the Implementation of a Federated Health Record Service. PhD Thesis. University of London, 2003 [Available from http://www.ehr.chime.ucl.ac.uk/docs/Kalra,%20Dipak%20(PhD%202002).pdf]

38. Beale T. Archetypes: Constraint-based Domain Models for Future-proof Information Systems. From http://www.deepthought.com.au/it/archetypes.html.

39. Beale T. Archetypes: Constraint-based Domain Models for Future-proof Information Systems. OOPSLA 2002 workshop on behavioral semantics. Available at http://www.deepthought.com.au.

40. Schloeffel P. (Editor). Requirements for an Electronic Health Record Reference Architecture. International Standards Organization, Australia; Feb 2002; ISO TC 215/SC N; ISO/WD 18308.

41. Rector A L, Nowlan W A, Kay S. Foundations for an Electronic Medical Record. The IMIA Yearbook of Medical Informatics 1992 (Eds. van Bemmel J, McRay A). Stuttgart Schattauer 1994.

42. Elstein AS, Shulman LS, Sprafka SA. Medical problem solving: an analysis of clinical reasoning. Cambridge, MA: Harvard University Press, 1978

43. Patrick Kierkegaard (2011) Electronic health record: Wiring Europe's healthcare, Computer Law & Security Review, Volume 27, Issue 5, September 2011, Pages 503-515, ISSN 0267-3649, 10.1016/j.clsr.2011.07.013. Retrieved Dec 15, 2011

44. Menachemi, N.; Collum (2011). "Benefits and drawbacks of electronic health record systems". Risk Management and Healthcare Policy: 47.

45. Adler-Milstein J., A. McAfee, D.W. Bates, A.K. Jha. "The State of Regional Health Information Organizations in the U.S.: Current Activities and Sources of Funding." Health Affairs, 27(1): w60-9.

46. Patient Privacy Rights Website, Missions and vision, www.patientprivacyrights,corg/site/PageServer?pagename=Mission, viewed June 16, 2009.

47. Wang, S.; Middleton, B.; Prosser, L. A.; Bardon, C. G.; Spurr, C. D.; Carchidi, P. J.; Kittler, A. F.; Goldszer, R. C. et al. (2003). "A cost-benefit analysis of electronic medical records in primary care". *The American Journal of Medicine* **114** (5): 397.

48. K. K. Guilherme Del Fiol, Robert Jenders and H. Strasberg, “Hl7 version 3 domain analysis model: Virtual medical record for clinical decision support,” tech. rep., Clinical Decision Support Work Group, 2012.

49. C. for Medicare and M. Services, “Medicare and medicaid programs; electronic health record incentive program stage 2,” tech. rep., Department of Health and Human Services, 2012.

50. O. of the Secretary, “Health information technology: Standards, implementation specifications, and certification criteria for electronic health record technology, 2014 edition; revisions to permanent certification program for health information technology,” tech. rep., Department of Health and Human Services, 2012.

51. C. Inc and Sextant, “A ‘conceptual’ privacy impact assessment (pia) on canada’s electronic health record solution (ehrs) blueprint version 2,” tech. rep., Canada Health Infoway, 2008.

52. S. Ratajczak, “Electronic health record infostructure (ehri) privacy and security conceptual architecture,” tech. rep., Canada Health Infoway, 2005.

53. C. H. Infoway, “Ehrs blueprint: An interoperable ehr framework executive overview,” tech. rep., Canada Health Infoway, 2006.

54. Tavenner, M. (2010). "The "Meaningful Use" Regulation for Electronic Health Records". *New England Journal of Medicine* 363 (6): 501–504.

55. Beaver K and Herold R, The Practical Guide to HIPAA Privacy and Security Compliance. 2004: Auerbach Publications.

56. NHS, The Use Of Computers In Health Care Can Reduce Errors, Improve Patient Safety, And Enhance The Quality Of Service - There Is Evidence. 2005 National Health Service, UK http:// www.connectingforhealth.nhs.uk/worldview/ protti2/.

57. Silverstein, Scot (2009). "2009 a pivotal year in healthcare IT". Drexel University. http://www.ischool.drexel.edu/faculty/ssilverstein/cases/?loc=cases&sloc=2009. Retrieved 2012-01-05.

58. http://www.dama.org/files/public/DL_DAMA_DMBOK_Guide_presentation_2007.pdf

59. Silverstein, Scot (2009). "2009 a pivotal year in healthcare IT". Drexel University. http://www.ischool.drexel.edu/faculty/ssilverstein/cases/?loc=cases&sloc=2009. Retrieved 2012-01-05.

60. Castro, D. (2009) Explaning Intertional IT Leadership: Health IT. The Information Technology and Innovation Foundation. http://www.itif.org/files/2009-leadership-healthit.pdf (9/03/2010).

61. Connected Digital Health in Denmark (2007). National Strategy for Digitalisation of the Danish Healthcare Service (2008-2012). Copenhagen.

62. Deloitte (2007) Strategiske udviklingsveje for epj. - Eksternt review af det hidtidige epj-arbejde, Bestyrelsen for den nationale epj-organisation [Strategic development paths for EPR – External review of previous clinical information work, Board of Directors of the National EPR organization]. http://www.im.dk/artikler_im_dk/Files/Fil1/4256.pdf (14/6/2010).

63. Baltic eHealth. "Information." Retrieved 1/03, 2010, from http://www.baltic-ehealth.org/

64. Dumortier, J. (2009). Overview of the Legal Status in the EU Member States. Telemedicine Legal Workshop. Prague.

65. Europe's Information Society. (2009). "Telemedicine works." From http://ec.europa.eu/information_society/activities/health/policy/telemedicine/index_en.htm.

66. Appel, M. (2005) Evaluation of the implementation of EPRs. Health Policy Monitor. http://www.hpm.org/survey/dk/a6/1 (14/6/2010).

67. Jon's F.Meyes. "research methods www toutorial." Research methods. 2008.Meerj@camden.rutgers.edu.15 April.2008 http://sociology.camden.rutgers.edu/jfm/toutorial/main.htm#list accessed on 10 march 2012

68. <http://newagepublishers.com/samlechapter/000896.pdf> accessed on 11 march 2012

69. <http://newagepublishers.com/samlechapter/000896.pdf> accessed on 11 march 2012

70. Rangit Kumar, A step by step guide for beginners: Resarch methododlogy.Addis Ababa.http://www.blurtit.com/q41726.html

71. Dr.Catherine dawson (2002) practical research methods: A user friendly guide to mastering research (pp14-15) Magdalen road, oxford ox41re.united kingdom: how to books limited, 3 newtec place.

72. Alley, Michael (2008) The craft of scientific presentations: Critical steps to succeed and critical errors to avoid. New York, Springer- Verlag, LLC.

73. Alley, Michael (2008) The craft of scientific writing, 3rd Ed. New York, Springer-Verlag, LLC.

74. Jackson, Sherri (2007) Research methods: A modular approach. Cengage Learning.

75. Dellarocas, C. (2003). The digitization of word of mouth: Promise and challenges of online feedback mechanisms. Management Science, 49(10),1407-1424.

76. Jarvenpaa, S., Tractinsky, N., & Vitale, M (2000). Consumer trust in an Internet store. Information Technology and Management, 1(1-2), 45-71.

77. Seale, C., Gobo, G., Gubrium, J. and Silverman, D. (eds) (2004) Qualitative Research Practice. London: Sage.

78. Reichardt, C.S. and Rallis, S.F. (1994) Qualitative and quantitative inquiries are not incompatible: a call for a new partnership, in C.S. Reichardt and S.F. Rallis (ed.) The

Qualitative-Quantitative Debate: New Perspectives. San Francisco, CA: Jossey-Bass, pp 85 - 92

79. Mann, C. and Stewart, F. (2000) *Internet Communication and Qualitative Research: A Handbook for Researching Online.* London: Sage.

80. Krippendorf, K. (2004) Content Analysis: An Introduction to its Methodology, 2nd edn. Thousand Oaks, CA: Sage.

81. Festinger, L., Reicken, H. and Schachter, S. (1956) When Prophecy Fails. Minneapolis: University of Minnesota Press (republished London: Harper & Row, 1964).

82. Becker, H. and Geer, B. (1957) Participant observation and interviewing: a comparison, Human Organization, 16(3): 28–35.

83. Boutilier, M., Mason, R. and Rootman, U. (1997) Community action and reflective practice in health promotion research, Health Promotion International, 12(1): 69–78.

84. Cline, R.J.W. and Haynes, K.M. (2001) Consumer health information seeking on the Internet: the state of the art, Health Education Research, 16(6): 91–92.

85. Creswell, J.W. (2003) Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Thousand Oaks, CA: Sage.

86. Halfpenny, P. (1997) The relation between quantitative and qualitative social research, Bulletin de Méthodologie Sociologique, 57: 49–52.

87. Fdre. ministry of Ethiopia. Health and health related expansions program. Policy plan directorate monitoring and evaluation case team. 2001.

88. Letters to the editor, “odds ratio or relative risk for cross sectional data”, fromjames lee, international journal of epidemiology, international epidemiological association 1994, vol.23,no1.

89. Cherry, Kendra. “What is longitudinal research?” experiments. About.com guide retrieved 15 march 2012

90. Manketelow c, bigatello Lm, hess D, hurford WE. Physcology determinants of the response to inhaled nitric oxide in patients with acute respiratory distress syndrome. Anesthesiology 1997:87 (2):297 -300

91. Http://www.experiment_resource.com/research_population. html # ixzz1pp5im3ht. accessed on 17 march 2012

92. Http://www.experiment_resource.com/research_population. html # ixzz1pp5im3ht. accessed on 17 march 2012

93. Walsham, Geoff and Sundeep Sahay. (2005).Research on Information Systems in Developing Countries: Current Landscape and Future Prospects. Wiley Periodicals, inc.

94. Fdre. Ministry of Ethiopia. Health and health related expansions program. Policy plan directorate monitoring and evaluation case team. 2001.

95. Robert grove, survey methodology (2010) second edition of the (2004) first edition ISBN 0-471-483448-6

96. David s. Moore and George P. mcCable (February 2005) “introduction to the practice of statistics” (5^{th} edition) W.H. Freeman & company. ISBN 0-7167-6282-X

97. Last jm (Ed.) A dictionary of epidemiology. Oxford: oxford university press, 1995.

98. NAO – national audit office – statistical and technical team. Accessed on march 19,2012

99. Knowledge sharing among professionals: the case of felegehiwot referral hospital. By Adem Agmas june, 2010 – addis ababa.

100. http://people.uwec.edu/pierch/researchmethods/data collection methods.htm, accessed on march 15, 2012

101. http://www.stat.ncsu.edu/info/srms/survpamphlet.html, accessed on march 15, 2012

102. http://search data management.techtarget.com/definition/data.qualify, accessed on martch19, 2012

103. Kim JY, Chae YM. Factors affecting the users' satisfaction on the electronic medical record system. J Korean Soc Med Inform 2002; 8(4):39-53.

104. American Hospital Association. Continued progress: hospital use of information technology. Chicago (IL). 2007

105. Felt-Lisk S. New hospital information technology: is it helping to improve quality? issue brief of timely information from Mathematica (Mathematica Policy Research, Inc.), 2006 May;3:1-4

106. McDonald CJ. The barriers to electronic medical record systems and how to overcome them, Journal of the American Medical Informatics Association. 1997 May;4(3):213-221

107. Kim GH. Study on the Korean model for community-based EHR(Electronic Health Record) system, Graduate School of Public Health, Yonsei University, 2005, June.

108. The Center for Interoperable EHR, General overview. 2010. 3. ttp://ehrkorea.org:8082/about/greeting.aspx (Accessed on April 22, 2010). South Korea.

109. Jha AK, DesRoches CM, Campbell EG, Donelan K, Rao SR, Ferris TG, Shields A, Rosenbaum S, Blumenthal D. Use of electronic health records in U.S. hospitals, NEJM. 2009 April 6;360(16):1628-1638

110. Tang PC, Coye MJ, Bakken S, et al. Key capabilities of an electronic health record system. Institute of Medicine: Committee on Data Standards for Patient Safety· Board on Health Care Services, Washington, D.C., 2003

111. Healthcare Information and Management Systems Society. Interoperability definition and ackground. June 9, 2005. Web site at: http://www.himss.org/ASP/ContentRedirector.asp?ContentID=65063

112. Goodhue DL. Understanding user evaluations of information systems, Management Science. 1995 Dec.;41(12):1827-1844

113. Miller RH, Sim I. Physicians' use of electronic medical records: barriers and solutions. Health Affairs. 2004;23(2):116-126

114. Walker J, Pan E, Johnston D, Adler- Milstein J, Bates DW, Middleton B. The value of health care information exchange and interoperability. Health Affairs. 2005; Suppl Web Exclusives: W5-10-W5-8. Available from: http://www.ncbi.nlm. nih.gov/ entrezquery.fcgi?cmd= Retrieve&db=PubMed&dopt=Citation& list_uids=15659453.

115. Beale T, Heard S. openEHR Release 1.0: Archetype Definitions and Principles. 2006. Available from: http:// svn.openehr.org /specification/TRUNK/ publishing/architecture/am/ archetype_principles.pdf.

116. Institute of Medicine, The Computer- Based Patient Record: An Essential Technology for Health Care, Revised Edition. 1997: National Academy Press.

117. OFPC, Federal Privacy Law. Office of the Federal Privacy Commissioner http:// www.privacy.gov.au/act/index.html

118. Fernando J, Factors that have Contributed to a Lack of Integration in Health Information System Security. The Journal on Information Technology in Healthcare, 2004 Vol. 2 Iss: 5: pp. 313-328.

119 – 123 Amatayakul, M.K. (2004). Electronic health records: a practical guide for professionals and organizations.AMIMA, Chicago

124. Mon DT. Defining the difference between the CPR, EMR and EHR. Journal of AMIMA. October 2004; 75/9, 74

Annex I

Questionnaire

Part I Demographic profile of the respondents:

- Name of the health institution that you are working

_____

Please tick in one of the given boxes which may represent you well or write in the space provided if appropriate.

1. Please indicate your gender

☐ Male ☐ Female

2. Your age group

☐ < 20 years ☐ 41 -50

☐ 21 - 30 ☐ 51 -60

☐ 31 -40 ☐ 61 - 70

3. Please indicate your highest educational achievement

☐ Diploma ☐ Masters Degree

☐ Advanced Diploma ☐ Doctorate Degree

☐ First Degree ☐ Specialist

☐ Other _____

4. Please indicate your educational stream

- ☐ Management/Administration
- ☐ Medical
- ☐ Others _____

5. Profession

- ☐ Medical Doctor
- ☐ Nurse
- ☐ Management
- ☐ Other _____
- ☐ Support/Reception
- ☐ IT expert
- ☐ Human resource administration

6. Working experience in health organization

- ☐ <= 5years
- ☐ 6 -10 years
- ☐ 11 -15
- ☐ 16 -20
- ☐ 20 years and above

7. Your department _____

Part II Electronic Health Record Questions

8. is the health institution

- ☐ Governmental
- ☐ Private
- ☐ Non-governmental
- ☐ other_____

9. in the health institution

- ☐ Hospital
- ☐ Clinic
- ☐ Health post
- ☐ Health center
- ☐ Support provider

10. Overall, how satisfied are you with your most recent health record system?

- ☐ Excellent
- ☐ Very good
- ☐ Average
- ☐ poor
- ☐ Unacceptable

11. How would you rate your most recent activity on the health record documentation for future use?

- ☐ Excellent
- ☐ Very good
- ☐ Average
- ☐ poor
- ☐ Unacceptable

12. Do you have an internet connection in your organization? (Hospital, clinic, health post, health center, research institution)

☐ Yes ☐ No

13. What does the health record system look like in your hospital/ clinic/ health post/health center/research institute?

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14. Do you believe in change?

☐ Yes ☐ No

15. Do you think it will be fine if a system is changed?

- ✓ From the management point of view

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- ✓ From clinical point of view

- ✓ From others point of view

16. Do you think the current system will be improved if an electronic system deployed in the institution?

- ✓ From management point of view

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- ✓ From clinical point of view

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- ✓ From others point of view

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17. What problems do you possibly suppose the institution and its stuffs will face if the health record system changed from manual into computer based?

- ✓ From management point of view

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- ✓ From clinical point of view

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- ✓ From others point of view

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18. What do you feel if all the health institutions (hospitals, clinics, research institutions, etc) are connected to share relevant information?

☐ Very good ☐ unnecessary

19. What advantage you expect if architecture is made for electronic health record system?

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20. What do you have observed about patient health record management in your institution?

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21. What do you suggest for your institution in terms of Electronic Health Record?

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22. If you have any comment please regarding patients data in your institution and any suggestion which can improve health data handling, including electronic health record system

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Part III Technology related questions.

23. Have you ever taken either short term or long term computer courses?

_____

24. If you use computers, what for do you use it?

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25. as how you can describe your knowledge/ understanding about computers and related technology? Ex. Like network?

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26. Have you ever thought about computerized patient health record?

☐ Yes ☐ No

27. What is your attitude towards the help of technology in the health industry?

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- This is the end of the questionnaire. I thank you indeed for your help. For your time as well.

Annex II

Interview Guideline

1. How do you explain the patient health record handling system in Ethiopia?
2. What is your vision for the EHR?
3. What are your goals and expectations for the EHR?
    a. In relation to quality of care
    b. In relation to clinic efficiency and cost savings
    c. Patient safety
    d. Other goals/expectation

4. What skills and resources does your organization have that make you believe the project will be successful?
5. Describe your leadership and communication styles.
6. Describe your understanding of what will be needed for the EHR implementation
    a. How did you gain this understanding?
7. Describe how you communicate with the CEO/Physician/Nurse Practitioner leader
8. Describe your organization's action plan for implementing the EHR. Please include the following:
    a. What milestones you have identified
    b. Plans for addressing challenges that may arise

Annex III

Declaration

I, the undersigned, declare that this is my original work and has never been presented in this or any other Universities.

Name: _____

Signature: _____

Place: _____

Date of submission: _____

This thesis has been submitted for examination with our approval as University advisors.

Name: _____

Signature: _____

Date: _____

Name: _____

Signature: _____

Date: _____

Dedication

To the successful caretaker, Selamawit Aklilu. ሴላ እወድሻለሁ!!!