UNIVERSITY OF NAIROBI

SCHOOL OF COMPUTING AND INFORMATICS

PROJECT REPORT

FRAMEWORK FOR THE IMPLEMENTATION OF A PATIENT ELECTRONIC REFERRAL SYSTEM: CASE STUDY OF NAIROBI PROVINCE.

BY

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Submitted in partial fulfillment of the requirements of the Master of Science in Information Systems.

DECLARATION

The project, as presented in this report is my original work unless where specified in form of referencing and has not been presented for any other University award.

Sign:.....Date:29th/08/2011

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This project has been submitted in partial fulfillment of the requirements of the Master of Science in Information Systems of the University of Nairobi with my approval as the University supervisor.

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DEDICATION

This project is dedicated to my sons – Daniel Thiong'o and Joseph Njogu.

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First, I want to thank my Almighty God for granting me the opportunity and resources to undertake my Masters Degree course.

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God bless you all!

ABSTRACT

A research into the area of usage of ICTs in health with a particular focus on developing a framework for e-referral for exchanging patient information between health institutions in order to provide continuity of patient care is detailed. A background of the structure of health care delivery services in Kenya is first outlined. An initial observation shows that there is an imbalance in the distribution of health care providers particularly in government hospitals and that the operations are manual. Also hospitals are run as single entities with no information to link among them resulting to discontinuity in care delivery thereby leading to very inefficient patient care because of lack of care continuity and high costs in care delivery. Literature in strategic role of ICTs in health care citing the current and emerging technologies in electronic health care delivery is reviewed. It shows that the challenges of cost and quality care can be overcome if the services were delivered electronically. However, health care information systems are tailored based on the results of assessment needs for individual hospitals. The key challenges to electronic health care delivery include standards, privacy, trust, security, costs and lack of ICT skills.

From this study, it was found that majority of public health institutions have not embraced use of ICT tools for handling patient health data and information. In contrast, a few private for profit making hospitals have installed software packages for keeping track of local transactions in administrative activities and resource management flow. In both the case of public and private health institutions, very little medical information is processed and most of the records are still kept manually and archived on papers. To address these challenges, the researcher has proposed a patient e-Referral framework to improve the integration of primary care and specialty care through a common interface. The proposed framework provides a starting point for further work in solving the problem of inefficient referral system.

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List of Acronyms and Abbreviations

ICT	Information and Communications Technology
ANSI	American National Standards Institute
HL7	Health Level Seven
CPR	Computer-based Patient Record
EHR	Electronic Health Record
EMR	Electronic Medical Record
EPR	Electronic Patient Record
NGO	Non-Governmental Organization
KHPF	Kenya Health Policy Framework
WAN	Wide area network
PDA	Portable Digital Assistant
ASTM	American Society for Testing and Materials
HCRN	Health care record number
EPR	Electronic patient record
TCP/IP	Transport control protocol/Internet protocol
EPHI	Electronic public health information system
HMIS	Health management information system
IT	Information Technology
IS	Information system
HIS	Health information system
E-HIMS	Electronic Health Information Management System
MOH	Ministry of health

CHAPTER ONE: INTRODUCTION

1.0. Introduction

This chapter outlines the following: Research background, Motivation, Research main objective and Research questions.

1.1. Research background

The emergent of Information and Telecommunication Technologies (ICTs) has brought about information revolution, leading to the information society we are living in today (Rindfleisch, 1997). It has transformed business functions (Schiefer, 1999) by changing the way they handle and use information that emanate from their day-to-day running or that which is availed to them from other sources. In fact, almost every economic branch is somehow affected by the use of information Technology (Reima, 2002). The accompanying technologies such as the world wide web (www) and growing usage of the internet has led to business trading on-line (e-commerce) as well as e-business in commercial business (Chaffey, 2002), which the health care industry has benefited by removing boundaries of treatment resulting to e-health care (Brown, 1995).

Health care industry, like any other service delivery industry, has undergone changes in its infrastructure and approach to health care. These changes have acted as driving forces to demand for more usage of IT (Grimson, *et al*, 2000). There is a growing need for improved efficiency and reduction of costs in the health sector and ICTs provides the solution to availability of reliable, consistent and timely data since the sector is an information intensive business (Anderson, 1997). Patients are demanding for better services and are more aware of their rights such as right to their clinical data (Feschi marius, 2002). In addition, the health care providers are faced with very high competition and are therefore exploring IT opportunities to gain competitive advantage through differentiation and cost reduction (Yiannis *et al*, 2002).

This thesis describes the research into the area of Electronic Health Care Delivery (eHCD). The research is particularly focused on assessing the feasibility of development of a framework for the implementation of a patient e-referral system that allows for electronic use and exchange of patient information between health institutions.

1.2. Motivation

Health care industry is an important part of our society as it provides services that are required by everyone. Almost all the services provided in health care industry are centered on the patient. Other service industries such as banking and online retail industries have used ICT technologies to provide convenient, efficient, and customer-centered services. In contrast, uptake of ICTs in the health care industry has been minimal and has stubbornly lagged behind for many years.

In the banking industry, automatic teller machines and online Web sites provide customers with ways to conduct their banking when and where they choose and with confidence that their personal information is protected. Banks also provide alerts to customers about sensitive activity in their accounts and reminders about payment deadlines. These easy-to-use tools depend on a secure, seamless information infrastructure that enables data to cross organizational and national lines. In the online retail industry, companies such

as Amazon.com not only offer convenience in shopping but also provide personalized shopping recommendations based on past purchases or selections made by other customers who have shown similar interests. This feature depends on the ability to capture and analyze data on individual and population levels. Amazon also provides a mechanism for used-book sellers to offer their products via its Web site—a process that is possible, in part, because there is a shared format (technically, interoperability standards) for the information presented to customers.

An initial visit to Thika District hospital revealed that the hospital is divided into seven service sections which include records and information, consultation, wards & treatment, VCT, pharmacy, laboratory and finance sections. All the sections depend on one another in terms of information sharing.

The demand for health information in the hospital is high. The consumers of this information include the following;

- Ministry of public health and Sanitation and Ministry of Medical services.
- Donors and partners like ICAP, Afya2, and Red Cross among others. They support the hospital by providing professional support as well as employing staff for the hospital.
- The General public must be informed especially when there is an outbreak of a disease. It is a two way process.
- The hospital administration needs data for management purposes.

The Department of health records & information renders several services such as enquiries, registration of outpatient & issuance of cards, retrieval of cards, retrieval of files, registration of an admission file, registration of a death, booking of an appointment, opening of consultation file, verification of medical records and verification of births/deaths.

The initial stage of capturing data involves recording data manually on admission and patient registers, outpatient cards, and inpatient files. Face-to-face is also used as a method for receiving information. Occasionally E-mails are used when sending reports or receiving feedback. There exists a computerized register which stores part of the patient data such as name, sex, age, residence and patient unique number. The rest of the patient data is kept and maintained on physical files. There exist an electronic Health Information Management System (E-HIMS) used for managing health records for instance in the delivery of patient records to sections such as laboratory. After laboratory tests are carried out the results are delivered back to the system for storage. However some sections such as consultation, treatment, pharmacy are not activated yet on the system. The system is also used for managing hospital operations such as the receipting system.

The initial observation shows that health record keeping is done mainly on physical files rather than on electronic media. It also shows that health information analysis and reporting is partly computerized and limited to some services rendered in the hospital. In view of this, overall service delivery is hindered mainly due to delay in availing patient information as files are moved from one point of care to another; misplacement of files; shortage of staff; loss of records and bureaucracy.

ICT support in service delivery is minimal in the hospital. The most commonly used ICT tool is the telephone and mobile communication for queries as well as clarification on patients information received from other sections of the hospital.

This chapter outlines the potential of ICTs in health care in section 1.3. The actual research to be undertaken is summarized in sections 1.4 and 1.5, followed by how the thesis is structured in section 1.6.

1.3. Problem statement

Access to medical specialists is a challenge, in particular in resource constrained settings. The problem is exacerbated by poor manual referral process that is cumbersome, confusing and inefficient. It is not uncommon for patients to be referred to a specialist without sufficient information about their conditions, prior work-up, or clear questions for the specialist consultant. Such poorly planned and prepared referrals result in wasted or ineffective specialty visits that further worsen access to specialized care and threaten quality of care.

1.4. Justification

Among its limitations of the bureaucratic, paper-based referral process are: lack of tracking of referrals and outcomes, limited standardization, extensive paper-based rework by staff, inadequate information for specialists and lack of specialty feedback to referring providers. For patients, the referral process is long and cumbersome.

1.5. ICT and health Care

A revolution is taking place in the health care industry with information and communication technologies (ICTs) playing an increasingly important role in its delivery (Raghupathi, 1997 & Daly, 2003). The capabilities of ICTs are being demanded of health care institutions today than ever before (Haux et al 2002). ICTs are being used in many developing countries and communities to facilitate remote consultation, diagnosis and treatment, collaboration among physicians themselves, medical research, and administrative efficiency of public health systems (Johan, 2002). Besides these benefits, Albert (2002) feels that the health care delivery and ICT partnership is must, especially in addressing the shortage of health care professionals through telemedicine technology. ICT also provides an effective and cost-effective channel for the distribution of health care and disease prevention information to general public and enables new ways of involvement between health care professionals and patients. Extending health care service delivery through the internet and the web result in e-care, which is rapidly becoming the norm for quality health care (Ryan et al, 2001).

Compared to other sectors such as banking, airlines and manufacturing, uptake of ICT in the health care industry lagged behind by 10-15 years (Raghupathi, 1997) but that is rapidly changing due to its unmatched benefits. The uptake of ICT in health care delivery is at different stages in different countries. While the industry spent between $12 and $16 billion in 1996 in implementation of ICT in health care in other states (Raghupathi, 1997), Kenya government is yet to do so. Kenya's government spending on health care is 6% of GDP (NHSSP 1999-2004) of which 70% of that goes to health care service provider's salaries and other benefits, leaving a meagre 30% to finance direct health care services. Due to this financial constraint, the uptake of ICTs in the care delivery in Kenya might take time. However, privately run hospitals are capitalizing on this disability of government run hospitals to have an edge over them (Raghupathi and Tan, 2002) and this applies to both developed and developing countries.

Haux *et al*, 2002) prognosis is that by the year 2013 the health care will be in the information society fully because they argue that, without ICT, physicians practice cannot provide adequate patient care. However, according to World Health Organization (WHO) document, , implementation of ICTs in e-health care delivery (e-HCD) does not automatically provide the benefits of efficiency and effectiveness. Instead, the adoption should be a response to genuine need for ICT support in the health care delivery.

Also according to an e-health Blueprint, success of ICTs in moving health care to an e-health system must be coupled with managed changes to support all major functions of health care delivery. Therefore the concerned health institution should conduct a thorough needs assessment before embarking into such project.

1.6. Research objective:

To develop a framework for the implementation of a patient electronic referral system.

1.7. Research questions:

1. What are the current and emerging ICT technologies and implementations available for managing patient health data and information in health institutions in Kenya?
2. What is the perception of health care service providers towards use of ICT tools in handling patient health data and information in health institutions in Kenya?
3. What is the level of readiness for the implementation of electronic healthcare delivery system in health institutions in Kenya?
4. What are the existing models for managing patient health data and information, suitable for Kenyan health institutions?

Upon analysis of the survey results, the research aims to identify the challenges facing clinical data recording and information flows among the health care service providers, and the opportunities of developing framework for the implementation of a patient e-referral system suitable for Kenyan based health institutions.

1.8. Structure of the thesis

This thesis is divided into six chapters. The first chapter gives an introduction of the research work. Chapter 2 discusses health care delivery services in primary health care system as well as private health care system. Policy and regulation issues governing delivery of these services are also outlined. The chapter also reviews the literature on current practices in computerized health care delivery, identifies the best practices and key challenges. It also outlines Historical background of HMIS in Kenya and recent developments within HMIS. Chapter 3 outline the research methodology followed by evaluation of the research findings in chapter 4. Chapter 5 covers the proposed system model. This is followed by recommendations and conclusions in chapter 6.

CHAPTER TWO: LITERATURE REVIEW

2.0. Introduction

This chapter presents the research theories and concepts derived from various works in relevant literature.

2.1. Health Care Service Delivery

2.1.1. Introduction

The health care industry is an important part of our society as it provides services that are required by everyone. In fact, it had become difficult for anyone to imagine that someone has never been inside a physician's practice or a pharmacy (Haux et al, 2002). Almost all the services provided in health care industry are centered on the patient (Smits and Pijl, 1999). One of the duties of any state is to ensure good health to its citizens and therefore in most countries, majority of the health care services are offered by legislation through public health care though the private sector has gained substantial shares by offering special treatments and improved service (Reima and Jarmo, 2002). The organizational structures of health care services are relatively similar in private and public sector. The main difference between them is how these services are delivered and the resources used to deliver them. It is important for any service industry to strike a balance between demand and supply of the services (Michael et al. 1997). In the health care sector, this worked out as service providers to patient ratio.

This section outlines the structures and functions of health care centres i/n Kenya in section 2.1.2. Classification of health care services is described in section 2.1.3. Health care services regulation is outlined in section 2.1.4 followed by a critical evaluation of service delivery function in section 2.1.5 and a conclusion in section 2.1.6.

2.1.2. Structure and Functions of Health Care Centres

Generally, the state and local government structure plays an essential role in organizing the health care system (Reima and Jarmo, 2002). In Kenya, the health sector comprises of the public health system with the major player being the Ministry of Health (MOH). Other players are Non Governmental Organizations (NGOs), Mission and Private Sector. Health care services are delivered through a network of 4200 health facilities with the public health system accounting for 51% of the total (NHSSP 1999 – 2004).

The health care services system structure takes the form of a tree with the Kenyatta National Hospital at the top (Kenya Health Policy Framework). It acts as the key referral, medical research and teaching facility. Provincials follow the National Hospital and are located in the seven provinces in the country. This is often closely followed by district hospitals. Both provincial and district hospitals provide referral as well as outpatient services. Meanwhile, the health centres and dispensaries form the lowest level of health care delivery providing first level contact with the community. To supplement the public health system are non-governmental and private health care providers. The public health care services are financed by Ministry of Health, individuals through cost sharing initiative and mandatory National Health Insurance Fund (NHIF).

2.1.3. Health Care Services

The health care services in Kenya are classified in two major categories; Curative and Preventive Health Services. Curative services are provided by the government and private/NGO sectors. Preventive services are provided through government, NGO, Mission and to a lesser extent private initiatives.

2.1.3.1. Primary Care Services

The primary medical care services are available at municipality level first in the health centres or private clinics run by self – employed general practitioners or government employed professionals who also practice privately. These private clinics act as gatekeepers to special health care or to the hospitals. Patients first consult the general practitioner who referrals them to the hospital or special health care. The health facilities in Kenya are not linked together by any form of information system to share patient information. Hence in cases of referrals, the process of treatment is started all over again in the secondary or tertiary health facility, leading to delays which have at times lead to "pre-mature" deaths (NHSSP, 1999 – 2004).

2.1.3.2. Private Care Services

According to Reima and Jarmo (2002), private health care is seen to mostly complement the public health care sector in most developed countries. In Kenya, the private care services are offered by NGOs, Mission hospitals and other private health facilities. The market for the private sector have established slowly mainly due to the extensive role of public services leading to congestion and poor services. In fact, according to Kenya Health Policy Framework (KHPF), the private sector is providing more than 40% of health care demand in the country. Health insurance companies and employers opt for private sector services for their workers because of quality of service as well as efficiency further boost this percentage. The other reason why private sector is giving the public sector competition is their effective business management and up-to-date management models, mostly resource-based approach (Reima, 2000).
The care services mostly sort in private sector are specialist doctors, dentists and physiotherapists and employee health services.

2.1.3.3. Distribution of Health Service Providers

According to KHPF, the current distribution of health personnel is not equitable. There is a concentration of key health personnel in urban areas which is not commensurate to the population distribution. The major urban areas of Kenya which include about 12% of the population have 375 key health personnel while the rural areas which include about 88% of the population have less than 90. As a result the service providers at the rural are overworked and at the expense of quality. However, this is not the case in private hospitals as their salary is better than in public sector.

2.1.4. Health Services Regulation

According to NHSSP, the overall mandate for health services promotion is vested with the Ministry of Health under the Public Health Act Cap. 242 of the laws of Kenya under various subsidiary legislations dealing with specific areas of health services provision. The ministry is assisted to administer health services by various Boards and Councils, which regulate the performance of service institutions and of the health workers in general. The Ministry has the responsibility to formulate policies, establish and

enforce standards and mobilize resources for health services development. The provincial and district levels have the important role to implement health programs and deliver health services.

Health care policy stated in Kenya Health Policy Framework document which states that the overall goal of health sector policy until 2010 will be to improve the health of all Kenyans through the deliberate restructuring of the health sector to make all health services more effective, accessible and affordable.

2.1.5. Critical Evaluation of the Health Care Delivery Functions

The health care delivery functions are critically evaluated against organization of the services and efficiency of the delivery process, availability of services and regulation of service delivery.

2.1.5.1. Organization of services and delivery efficiency

The hierarchical distribution of the health facilities makes then accessible to all though this is hampered by the imbalance in service provider to service demand ratio. The efficiency of service delivery is affected by the delays introduced as the patient file is moved from point of care to another.

2.1.5.2. Regulation of Health Services

Although the government is doing all within its machinery to provide quality health for all Kenyans, many public health facilities are in the state of disrepair, whereas many of the private facilities do not comply with the expected standards. There has been no system of assessing the quality of health services. As a result the well being of the general public is likely to be threatened.

2.1.6. Conclusion

The government through public health sector has the dominant role in providing care services to its citizens. Although NGO, Mission and private health care sector are said to supplement public health care services, their contribution is 50% of the total care demands. While the MOH try to deliver health care services in most effective and efficient manner, there are areas that provide potential for improvement, particularly with respect to electronic public health information system. A suitable system model may be utilized to capture, store, retrieve, transmit and provide manipulation of patient-specific health care related data including clinical, administrative and biographical details. This will provide efficiency in service delivery costs.

In the next section, strategic role of ICTs in health care delivery is reviewed.

2.2. Strategic Role of ICT in Health Care Delivery

2.2.1. Introduction

Over the past several years, there has been increasing use of Information and Communication Technologies (ICTs) to support improvements in the quality of health care within developed and developing countries (Smith and Preston, 2000). It has also been established that health care delivery has shifted responsibility from one practitioner to shared-care paradigm where a patient pass through several health care service providers within one visit (Fieschi, 2002 & Bernd and Francis, 2001). Therefore the systems in place should facilitate information flows both vertically and horizontally in efficient and timely manner (Grimson et al, 2000). According to Fieschi (2002), the amount of patient data acquired and stored per day is enormous and complex. In addition, Haux *et al* (2002) estimates that more than

1000 archived medical records are accessed each day in university hospital scenario. Therefore ICT can be used in a strategic and innovative manner to support patient data capture and flow of information among the service providers in health care delivery (Raghupathi and Tan, 2002) resulting to e-health care. The World Health Organization (WHO) strategy 2004 – 2007 defines e-health as the use of digital data that is transmitted, stored and retrieved electronically in support of health care, both at the local site and at a distance. The opportunities provided by ICTs in health care delivery are clinical, decision and administrative support, in an efficient, timely and cost-effective manner. The adoption of ICTs in the private health care sector is for competitive advantage, which may be in terms of differentiation and low cost (Yiannis et al, 2002). However, there are also challenges to be dealt with as well, as a result of application of ICTs in health care (Ammenwerth et al, 2004).

Current technologies, which play a critical role in health care delivery by enhancing sharing and integration of patient's information, are discussed in this section. Section 2.2.2 discusses the opportunities of ICT in health care in terms of the health care tools currently in use in hospitals.

Section 2.2.3 highlights recommendations for the right model of patient health information management. Section 2.2.4 highlights standards for ICT adoption in health care. The key issues and challenges are discussed in section 2.2.5, acceptability of electronic service delivery is discussed in section 2.2.6, risk analysis is discussed in section 2.2.7, followed by legal issues in section 2.2.8 and ending with a conclusion in section 2.2.9.

2.2.2. ICT Health Care Tools

The ICT tools used in health care delivery are a combination of software and hardware resulting to the systems supporting managed health care. On the hardware side, one of the commonly used tools in e-health is the personal computer. According to Haux *et al's* (2002) observation, there are more computers being sold today across the globe than automobiles. The usage of ICT tools in health care is varied depending on who is using and where they are being used. Individual practitioners use cell phones, answering machines, and pagers. Primary care facilities buy computers, and link to the internet. Hospitals buy diagnostic imaging devices and laboratory equipment with embedded digital processors. Public health organizations computerize to utilize the technology to improve administrative functions.

E-health care delivery applications that support prevention, patient diagnosis and patient management and care as listed by WHO include tele-consultations, tele-referrals, forward-storage concepts such as tele-radiology and tele-prescriptions, and electronic patient records (EPR). The current technologies behind these applications are discussed in the subsequent sections.

2.2.2.1. Health Care Information Systems

The information systems introduced in health care decades ago were not directly involved with health care delivery but were mainly used for administrative purposes such as billing (Anderson, 1997). The health care providers handled the clinical data on paper while sharing of such data amongst them was through sneaker net. Ward clerks then transferred the gathered data to the information systems. While in developed countries these information systems have since evolved to clinical information systems (Anderson, 1997) and are being used in care delivery, what is being seen in developing countries today is either information systems that support administrative activities or none at all. In fact, Inan *et al*, (2001) observation is that most of the HIS packages in developing countries just keep track of internal hospital

transactions in administrative activities, financial and material flow as opposed to storing and archiving information regarding the physician-patient relationship which improve diagnosis and treatment.

A modern hospital information system consisting of several modules such as a financial management system, a laboratory information system, a pharmacy system, scheduling and registration, and admission/discharge transfer system (Raghupathi, 1997). The service providers share this information through intranets. In fact, hospital information systems are portal through which patient medical records enter into health care networks (Fiechi M., 2002). The information stored in HIS results to electronic medical records, which play a great role in the delivery of health care. This acted a catalyst causing Institute of Medicine (IOM) to call for the development and implementation of computer-based patient records (CPRs) also coined to as Electronics Patient Record (EPR) (Anderson, 1997).

2.2.2.1.1. Electronics Patient Record (EPR)

There has been a growing concern on how to organize the captured health data along individual patient cases instead of dividing lines of health care organizations (WInthereik and Vikkelso, 2005). Moreover, according to Smith and Eloff (1999), there is a difference between electronic medical records and electronic patient record (EPR). While electronic medical record contains medically related information for a patient for a specific enterprise such as hospitals, an EPR contains all the health care related information on one person from disparate enterprises and uniquely identifies each record (Raghupathi et al, 2002). An integrated EPR system involves capturing, storing, retrieving, transmitting and manipulating patient-specific health care-related data and whilst an integrated EPR system includes clinical, administrative and biographical data of the patient reducing the cost of maintaining multiple databases (Raghupathi, 2002). All the health care providers are allowed controlled access to the database thereby eliminating the need for duplication of data and security and privacy of patients' data is ensured (Smith and Eloff, 1999). Another feature of EPR cited by Berg and Goorman (1999) is that it can take active form whereby calculations of the data collected are possible and also triggering alarms or reminders.

Many authors' view is that once patient data is stored in electronic databases, insurance companies, researchers, care managers and others can utilize these data for their own purposes (Raghupathi, 1999). But Berg and Goorman (1999) argue that medical information is best fit for the primary context of its production although he comments that it can be disentangled if it has to be used for secondary purposes. In other words, with clear understanding of the purpose, information context translation is possible to avoid medical errors.

Building the electronic patient record requires integration of health information across diverse and disparate systems (Smith and Eloff, 1999).

Implementation of EPR systems in hospitals have changed the paradigm of care delivery in the health sector with paperless handling of patient data and timely sharing through intranets and wide area networks (WANS) (Espinosa, 1998). Practitioners now have access to vast amounts of patient-related information and are using this to enhance clinical decisions in their practice.

The design of an EPR system varies from designer to designer but contents of the records are essentially the same.

EPR systems run on a client/server environment with varied software. Typical examples of hospitals that have taken EPR initiative since the last decade as listed by Raghupathi et al (2002) are Cabarrus Family

Medicine in Concord, West Palm Beach Veteran's Administration Medical Center in West Palm Beach, San Jose Medical Center in San Jose, St. Vincent's Hospitals in Birmingham, Johnson Medical Center in Johnson City, US Department of defence among others. The sharing of computerized medical records is possible through Local Area Networks linking document management software, relational databases, imaging equipment, laboratory and pharmacy systems, thereby forming a comprehensive EPR system (Raghupathi et al, 2002). The view of those in charge of health care in developed countries today is adopting a national electronic patients record and it is either adopt 'now' or 'die' situation. In fact the chairperson of the Canadian Healthcare Association and a trustee with the Alexandria Marine and General Hospital in Goderich recent comments regarding adopting a national electronic patient record are:

"If we don't get to it pretty soon, it is just going to be a disaster"

"I think we have just missed the boat for so long,"

(John Miner, 2005)

A national EPR system means that patients will have a single health record that will be transferable from one health care provider to another and thereby providing continuity of health care and eliminating duplication of health records. The major benefits of EPR system that most hospitals are boasting about as a result of the initiative in health care delivery are efficiency, effectiveness, and cost saving.

2.2.2.1.2. Patient Smart Cards

A patient smart card is like 'mobile' record for an individual patient because it stores updated information about a patient as an EPR system does (Smith and Eloff, 1999). The centerpiece about this application of technology is that the patient can carry their clinical information wherever they go for medical care thereby providing continuity of treatment. This prevents medical errors and meets the needs of the highly mobile patients (Rindfleish, 1997). The information in the cards is updated periodically (Raghupathi and Tan, 2002). Although the developers of patient smart cards initially intended it to support insurance related procedures, the cards are widely being used today for health care delivery (Treek *et al*, 2001). The technology is mainly in use in developed countries and a lot of research in the area is still in progress.

2.2.2.1.3. Portable Digital Assistant

Reliable patient care is ensured if their data is available whenever clinicians need it. Point-of-care systems such as PDAs are the solutions to such need (Jinwook et al, 2004), which enable a nurse to gather and record patient's data electronically from their bedside (Bryne and Sahay, ud). The PDA is then linked to the hospital's information system.

2.2.2.2. Telemedicine

Telemedicine is a promising mode of health care delivery that supplements the existing quality health care. Telemedicine has provided borderless health care delivery by sharing some of the scarce resources such as expert professionals (Brown, 1995 and Konditi, 2004) and equipments. This is made possible by linking geographically dispersed health care facilities through interactive video and telecommunication technologies. Doctors in one location can now administer remote clinical diagnosis and treatment after receiving or accessing patient's tele-imaged records or films (Kyriacou et al, 2003). According to Lin (1999), the volume of patients that received telemedicine health care services initially was low and the

applications that were in use then were radiology, pathology, cardiology and medical education. However, this has since changed with more patients receiving treatment and the technology being used for all medical specialties, mainly in developed countries (Kyriacou et al, 2003). Moreover, the attitude of physicians and patients towards telemedicine has been favorable from its inception. Preliminary findings in US in 1996 and Hong Kong showed that a number of practitioners and clinicians were making use of the technology for health care delivery (Lin, 1999). But compared to other health care delivery mediums currently in use, the field still serves few patients (Wilson, 2003).

Some of the early initiatives of telemedicine as cited by Brown (1995) are Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC) whose goal was to deliver medical care to astronauts in space and at the Papago Indian Reservation in Arizona from 1972 – 1975. The implementation was through use of a van equipped with a variety of medical instruments including electrocardiograph and X-ray and two paramedics. A two-way microwave telemedicine and audio transmission was then used to link the van to the public health service hospital with specialists. Nebraska Medical Center used closed-circuit television technology as early as 1955. Among other implementations are Massachusetts General Hospital/Logan International Airport Medical station, Alaska ATS-6 Satellite Biomedical Demonstration and the North-West Telemedicine Project. One the latest implementations are the Asahikawa Medical College hospital telemedicine center in Japan (Asahikawa-med, 1999). The centre was set to address, the distribution of medical facilities between rural and urban health centres, the climatic conditions and the aged. According to the estimates in the report Asahikawa-med (1999), approximately one of four people will be 65 years in Hokkaido or older in the rural areas by the year 2020. This facility not only provides clinical support but also latest medical research findings to practitioners.

Initial set-up costs for telemedicine facility is quite enormous because of the specialized equipment involved, although the benefits are enormous (Brown, 1997). Since little research has been carried out on the effectiveness of telemedicine, Lin (1999) assumes that it has been medically effective while its cost effectiveness has been undoubtedly been demonstrated by the unnecessary transfer of patients. The figure 2.1 shows typical telemed session.

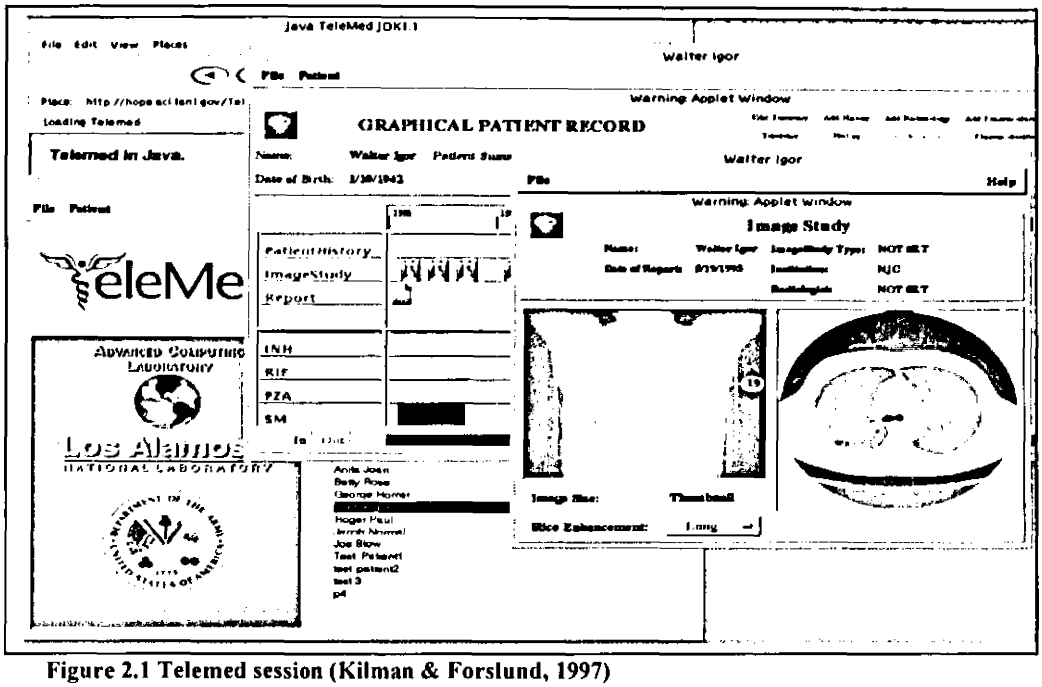

Figure 2.1 Telemed session (Kilman & Forslund, 1997)

Some of the research challenges in telemedicine cited by Lin (1999) include flexible bandwidth allocation, efficient compression algorithms for data and imaging, intelligent interface, uniform data transmission standards, and system and transmission medium reliability and security. The obstacles to the future of telemedicine as cited by (winter2002.htm, 2002) are administrative structures of medical care, changing laws and regulations, attitudes of some practitioners and financial reimbursement to physicians.

2.2.2.3. The Web/Internet Technology

With today's information intensive society (Jane and William Grimson, 2002), the internet is playing a crucial role in providing a lot of information on health care ranging from preventive to curative advice (Raghupathi, 1997). This is in response to the demands of today's informed consumers of health care services so that they can make informed choices on their health. Wilson, 2003 observed that due to the shift in health care market and increasing patients' demand, the communication between providers and patients via the internet would soon be a lifestyle. Figure 2.2 shows results of a healthcare satisfaction study carried out in the year 2000 (Harris, 2000).

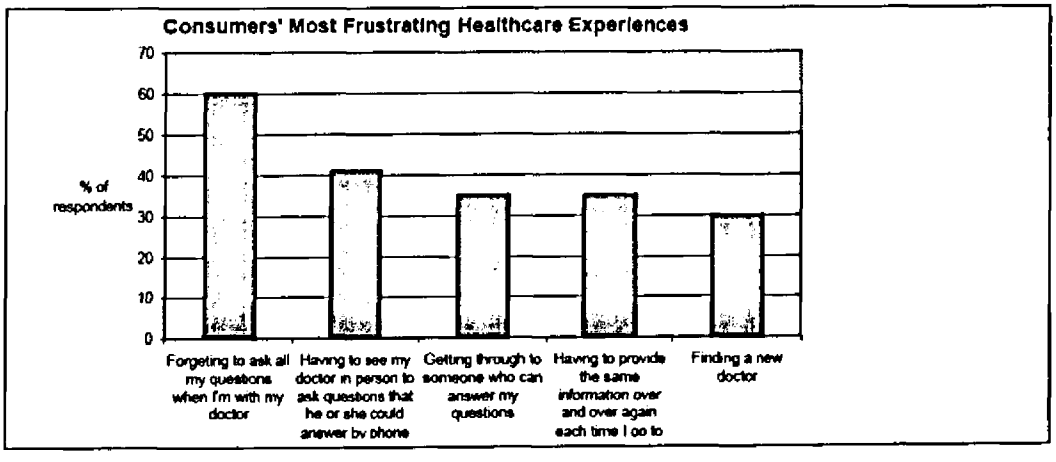

Figure 2.2 Results of online health care satisfactory study (Harris, 2000)

According to Smith and Eloff (1999) the health care service providers also make use of the internet for varied health care activities such as transmission of health care data via e-mail though Wilson (2003) describes the uptake as slow. He also notes that most of the health care web sites offer free content and commerce but one has to subscribe for clinical care. A typical example of health care website is illustrated in figure 2.3. There are a few health websites for community service but a few meant for-profit provide access communication between users and clinical personnel for free (Wilson, 2003).

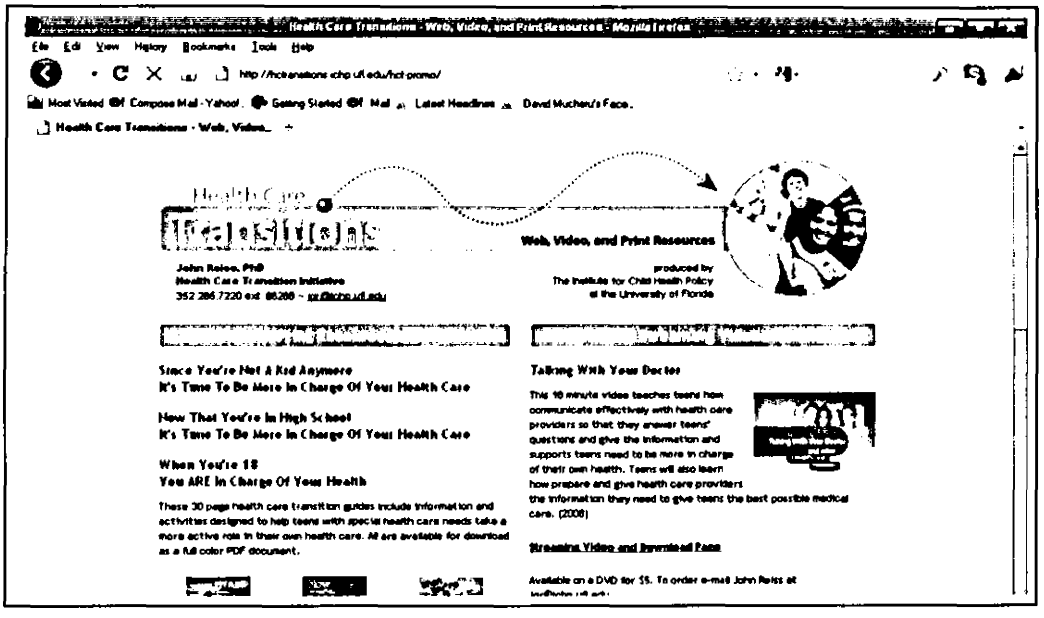

Figure 2.3 A typical health care web site.

2.3. Information Technology (IT) and Information Systems (IS)

2.3.1. Introduction

The terms IT and IS have been used by various researchers over the years. Heeks (1998) defines IT and IS as follows: "***Information technology (IT)*** is computing and telecommunications technologies that provide automatic means of handling information.

IT is therefore taken here to represent equipment: both the tangible hardware and the intangible software. ***Information systems (IS)*** are systems of human and technical components that accept, store, process, output, and transmit information. Information systems may be based on any combination of human endeavours, paper-based methods and IT" (Heeks 1998, p.5). This emphasizes that IS are just not technical systems, but represent also a larger network of people, practices, and organizations.

In health information systems, when discussing information technologies (IT), usually the discussion is about the use of computers in health information systems. Wilson and Smith

(1991 cited Wilson 2000) suggest that, "the creative use of microcomputer technology is one of the most promising means of improving the quality, timeliness, clarity, presentation, and use of relevant information for primary health care" (Wilson, 2000, p.

199). Recent experience (Braa and C. Hedberg 2002; Wilson 2000; Wilson *et al.* 2001) attests to the potential for using computers in health information systems. However,

Wilson (2000) gives a warning that, "it is important to ensure that, computerisation of health information systems does not dominate the health information system reform improvement process" (Wilson 2000, p.199). This is because the majority of health information users in developing countries have no access to computer technology, thus the development and improvement of manual systems for collection, analysis, and use of data should be the primary focus.

While developing countries were reluctant to accept information and communication technologies (ICT) in 1960s and 1970s, in recent years they have come to realize that

"ICT has come to constitute the basis of economic development both at the macro and micro levels, and hence those actors that fail to participate in such developments risk increasing marginalization" (Spanos *et al.* 2002, p.659). As a result, many developing countries are attempting to deploy IT in various facets of governance, and health is a key focus area. It could be argued, however that, even as IT in business organisations around the world converge, the impact of their use may well depend on national culture and the specific idiosyncrasies of the economic and organizational environments in which they are embedded. Because of the differences of the use and the capacity of developing countries to absorb IT, specific studies are important.

This section starts with the discussion of IT in developing countries in section 2.3.2 Section 2.3.3 gives a background on why old and large information systems (legacy information systems) do exist in many information systems despite the existence of new powerful technologies. A proposal on how to develop a new system in order to relinquish the legacy systems is discussed. As an expansion of the proposal on how to relinquish the legacy systems, approaches to information systems developments are described (section 2.3.4) as one of the strategies towards health information systems reform. Section 2.3.5 describes the efforts made to Reform Health Information Systems.

2.3.2. IT in Developing Countries

IT in developing countries is typically characterized by poor infrastructure, inadequate human resources, and lack of an information culture. However, there are indications that these conditions may be gradually changing, and many developing countries have in recent years observed a strong increase of adoption of various ICT applications. Some developing countries like India and Pakistan are more advanced in their IT use. One of the most promising and clearly demonstrated applications for IT in developing countries is in the improvement of health care delivery systems (Mujahid 2002). In Pakistan, for example, Muhajid (2002) reports examples in the use of IT in the health sector as reported to facilitate remote consultation, diagnosis, treatment, and collaboration among physicians.

2.3.3. Legacy Information Systems

Many of today's computer systems, used in applications ranging from corporate accounting to air traffic control, were created decades ago and over the years were patched and fine-tuned to perform their jobs. Sommerville (2001), argues that,

"Many computer software in large information systems remain in use for more than

10 years and are still business-critical, that is, the business relies on the services provided by the software and any failure of these services would have a serious effect on the day-to-day running of the business" (Sommerville 2001, p.582).

Sommerville describes legacy information systems as "socio-technical computer-based systems that include software, hardware, data, and business processes" (Sommerville 2001, p.583).

Legacy information systems are typically too slow, unreliable, and inflexible for handling new, more diverse and demanding tasks. Unfortunately, the functions of these systems are very difficult to understand, and their replacement with a new and efficient designed system seems virtually impossible. Replacing a legacy information system is a risky business strategy for a number of reasons (Sommervile 2001):

1. There is rarely a complete specification of the legacy information system. The original specification may have been lost. Therefore, there is no straightforward way of specifying a new system, which is functionally identical to the system that is in use.
2. Business processes and the ways in which legacy information systems operate have been designed to take advantage of the software services and to avoid its weaknesses. If the system is replaced, these processes will also have to change, with potentially unpredictable costs and consequences.
3. Important business rules may be embedded in the software and may not be documented elsewhere.
4. New software development is itself risky, so that there may be unexpected problems with new system. It may not be delivered on time and for the price expected. In describing problems of running legacy information systems, Sommerville (2001, p.583) points to the following expenses in changing legacy information systems:

Different teams have implemented different parts of the systems. There is, therefore, no consistent programming style across the whole system.

- Part or all of the system may be implemented using an obsolete programming language. It may be difficult to find staff who have knowledge of these languages and expensive outsourcing of system maintenance may be required.
- System documentation is often inadequate and out of date. In some cases, the only documentation is the system source code. Sometimes the source code has been lost and only the executable version of the system is available.
- Many years of maintenance have usually corrupted the system structure, making it increasingly difficult to understand.
- The data processed by the system may be maintained in different files, which have incompatible structures. There may be data duplication and the data itself may be out of date, inaccurate, and incomplete.

2.3.3.1. Leveraging legacy systems

Thinking about taking action to leverage legacy systems, Chislenko (1995, pp. 2-3) has advised five techniques:

1. *Parallelism and Specialization* where the increased responsibilities of a legacy information system are divided among a number of old systems. The work is substantially improved as individual systems are optimised for performing particular tasks and relieved from other duties.
2. *Redundancy* where several systems work in parallel then the result is compared to make the output more reliable.
3. *Wrapping* where the layers of the system that cannot be understood are left alone while the others are replaced.

4. External aids technique deals with providing the legacy system with necessary resources, pre-processing them for the input, and performing some tasks the old system is not good at.
5. Finally, *replacement* of parts technique in those cases where the structure and function of some of the part of the system is well understood. The part can then be directly replaced with its improved equipment (Chislenko 1995, pp.2-3).

Although the above approaches by Chislenko (1995) proved useful in updating many computer systems, these have proved to be a temporary solution and sometimes magnify the problem. In his paper labeled *Reengineering work: do not automate, obliterate*, Hammer (1990) argues,

> It is time to stop paving the cow paths. Instead of embedding outdated processes in silicon and software, we should obliterate them and start over ... use the power of modern information technology to radically redesign our business processes in order to achieve dramatic improvements in their performance (Hammer 1990, p.104).

The best option is to replace the legacy information systems with new systems. This is because it is risky to run legacy systems as outlined in the earlier discussion and because since legacy systems were developed in old technologies, as time goes, the hardware and software will fail. However, replacing the legacy systems is also a risky activity as it was presented in the earlier discussion, but this will ensure the sustainability of the organization, as the new systems are implemented in modern technologies. While developing a new system to replace the legacy one, the most risky aspect is to loose organization data collected for several years. The question is how the vast amounts of data locked in legacy systems can be secured and migrated to the new system.

2.3.3.2. Migrating data from legacy information systems to a new information system

Instead of adding patches to the old system as discussed in section 2.3.3.1, a guaranteed solution is to implement a new system and migrate all the data from the legacy system to the new system. This is common practice in building data warehouse systems as these systems aim at creating an enterprise reservoir of data, that is, integrate all operational systems and store their data in one place, the data warehouse. The process of migrating data from one system to another has a known technical terminology *Extraction, Transformation and Loading (ETL)* (Microsoft 2000).

While ETL can be done manually through "copy and paste" for a simple problem, it is impossible to migrate data from one database to another manually. The alternative is to automate the ETL processes by developing an application software system. Microsoft (2000, p.2) outlines four distinct functional elements of an ETL system: extraction, transformation, loading and Meta data whereas;

- The ETL extraction element: is responsible for extracting data from the source system. During extraction, data may be removed from the source or a copy made and the original data retained in the source system.
- The ETL transformation element: is responsible for data validation, data accuracy, data type conversion, and business rule application. It is the most complicated of the ETL elements.
- The ETL loading element: is responsible for loading transformed data in the target system, and
- The ETL Meta data element: is responsible for maintaining information (meta data) about the movement and transformation of data. It also documents the data mapping used during the transformations. Developing an ETL system seems to be the most feasible solution for leveraging

legacy database because it gives users an opportunity to implement new technologies, without worrying of losing their data. The next section discusses approaches to Information Systems development in order to give an insight on how to develop the new systems that will replace the legacy information systems and to develop the ETL application systems.

2.3.4. Approaches to information systems development

Computer based information systems development approach is concerned with all aspects of the development and evolution of complex systems where software plays a major role.

These aspects include hardware procurements, policy and process design and system deployment as well as the software engineering. Software engineering is an engineering discipline, which is concerned with all aspects of software production from the early stages of specification through to maintaining the system after it has gone into use. To develop software, there are known processes that need to be executed. A software process is a set of activities and associated results, which produce a software product. Software processes have four common fundamental process activities. These activities are (Sommerville 2001, p.8):

1. *Software specification*: The functionality of the software and constraints on its operation must be defined.
2. *Software development*: The software that meets the specification must be produced.
3. *Software Validation*: The software must be validated to ensure that it does what the customer wants.
4. *Software evolution*: The software must evolve to meet changing customer needs.

Different software processes organize these activities in different ways. A software process model is a simplified description of a software process, which presents a particular perspective, an abstraction of the actual process being described. There are a number of different general models or paradigms of software development; Sommerville (2001, p.9) outlines the following models:

1. The waterfall approach: This takes the software process activities and represents them as separate process phases such as requirements specification, software design, implementation, testing and so on. After each stage is defined, it is 'signed off' and development goes on to the following stage.
2. Evolutionary development: This approach interleaves the activities of specification, development, and validation. An initial system is rapidly developed from very abstract specifications. This then refined with customer input to produce a system, which satisfies the customer's needs.
3. Formal transformation: This approach is based on producing a formal mathematical system specification and transforming this specification, using mathematical methods, to a program.

4. *System assembly from reusable components:* This technique assumes that parts of the system already exist. The system development focuses on integrating these parts rather than developing them from scratch.

It is not possible to elicit all user requirements at one phase of software development thus the *waterfall approach* is not appropriate for developing health information systems. The problem with the waterfall model is its inflexible partitioning of the project into these distinct stages; implying that it should only be used when the requirements are well understood. The *formal transformation* approach has something in common with the waterfall model but the development process is based on formal mathematical transformation of a system specification to an executable program.

The formal transformation approach requires that the problem is well defined so that a mathematical representation of the operation of the software is specified in advance. This is not always the case in building software for health information systems because it is unlikely to have health delivery practitioners who know the system very well and have a competitive knowledge in software development. The other approach, *system assembly from reusable components,* is also not a good choice for developing software for HIS because usually there are no existing systems in the field. Even if there are existing systems, usually these are legacy systems developed using obsolete technologies. Thus, the feasible choice is the *evolutionary development* approach; because the assumption is that, a software process can be developed incrementally. "As users develop a better understanding of their problems, this can be reflected in the software system" (Sommerville 2001, p.47). The evolutionary development approach is based on the idea of developing an initial implementation, exposing this to user comment and feedback, and refining this through many versions until an adequate system has been developed. Figure 2.4 presents evolutionary systems development process activities.

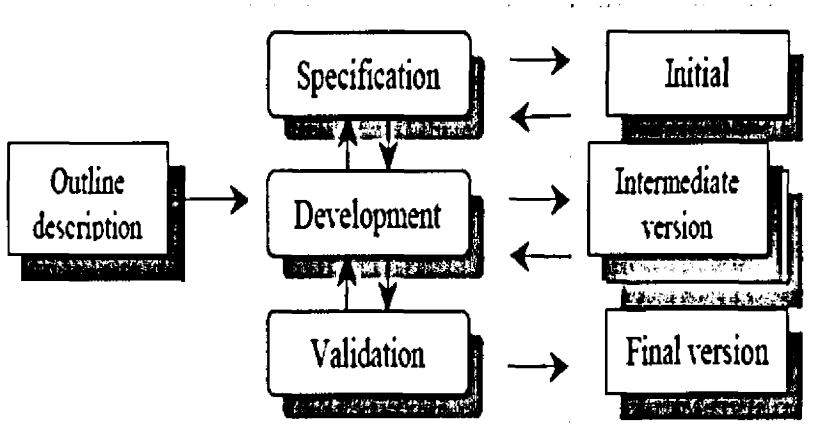

Figure 2.4: Evolutionary development (Source: Adapted from Sommerville 2001, p.47)

Evolutionary development approach introduces *system prototypes* in order to allow users to experiment to see how the system supports their work. A prototype is an initial version of a software system which is used to demonstrate concepts, try out different design options and, generally, to find out more about the problem and its possible solutions. A software prototype supports two requirements engineering process activities "requirement elicitation and requirements validations" (Sommerville 2001, p.172). Experiments have shown (Boehm and Gray 1984) that prototyping reduces the number of problems with the requirements specifications. Furthermore, the overall development costs may be lowered if a prototype will be developed. Once a prototype is available, it can also be used for other purposes (Ince and Hekmatpour 1987) such as:

- *User training.* A prototype system can be used for training users before the final version of the system has been delivered.
- *System testing.* Prototype can run 'back-to-back' tests. The same cases are submitted to the prototype and to the system under test. If both systems give the same result, the test case has not detected a fault, otherwise it may mean that there is a fault and the reason for the different should be investigated.

Prototyping in evolutionary systems development allows and depends on user participation (involvement). User participation in information system development is recommended to systems analysts as a technique of successful system development. Newman and Noble (1990) defined user involvement as "a process of interaction between systems specialists and users or their representatives where they discussed four process models of user involvement - learning, conflict, political and garbage-can" (p. 89). From a study of the literature, the four process models of user involvement in systems development abstracted by Newman and Noble are now described.

The Learning model: The "simplest variation" of the learning model sees user involvement as "an opportunity for designers to educate users about the system" (Newman and Noble 1990, p.90). As discussed above, prototypes allow user involvement by providing early training of users. As a result, users' expectations become more realistic, and their resistance to change is reduced (Bjørn-Anderson and B. Hedberg 1977 cited Newman and Noble 1990). "Success" is user satisfaction with the system, and use of it as the designers intended. The "simplest variation" of the *learning model* falls short in that learning is one-sided; designers have little to learn except details of user requirements.

Another variation of the learning model is the "mutual learning model" (Boland 1978) in which users and software engineers recognise each other's distinctive capabilities and views, and cooperate in order to produce a joint solution to a common problem. Each side learns from the other in the course of development.

Conflict Model: Conflict models have been developed to explain situations where there are complex problems, incompatible goals, and multiple criteria of success (Robey and Farrow 1982). A test of the model (Robey *et al.* 1989 cited Newman and Noble 1990) showed that user participation led to conflict if it was accompanied by user influence. At the same time that it created conflict, participation coupled with influence created opportunities for conflict resolutions. Here, user involvement is conceptualised as a process through which users and designers discover and resolve their differences. The conflict model appears to be superior to the learning model in that it recognizes the potential, which user involvement has for producing conflict and it sees the amount of influence users have as instrumental in conflict resolution.

Political Model: The organisations into which information systems are introduced are seen as political orders, with established distributions of power, which may be disrupted or confirmed by the design of the technology (Pettigrew 1973 cited Newman and Noble 1990). Kling (1987, p.312) explicitly includes a political model as part of the assumptions for his "web" model of computing in organizations.

Political models take account of conflict but are concerned with the way in which conflict is structured by the existing organisation, and the role of power in conflict resolutions. "Political tactics such as bargaining and negotiations are relevant to conflict resolution" (Newman and Noble 1990, p.93). The HISP implementation in South Africa was not without criticism from HISP partners, which had its roots in conflicts between different levels of the administration. However, the financial and organisational independence of HISP allowed the programme to undertake developments and provide solutions (Braa *et al.* 1999).

The Garbage-Can Model: This model was intended to apply to a particular type of organization, or decision situation, described as "organized anarchy" (Newman and Noble 1990, p.94) such as universities. In this model, to paraphrase Newman and Nomble (1990), actors are seen as having limited rationality in that they are not sure what their interests are and pursue them only intermittently. Key

players leave the scene, the composition of the team changes constantly as do the goals. HISs are not structured as organization anarchy, and thus, the model is not applicable in HIS

The discussion of the process models for user involvement in systems development suggests that health information systems practitioners to understand the roles that users can play during the implementation of health information systems. In my study, the political model is the most relevant process model of user involvement followed by conflict model. This is because health information systems are structured as a hierarchy of administrative levels. Many health information systems reform efforts like the case of HISP aims at empowering the lower levels such as the district which has little or no say in the current systems. Now neglecting to involve the higher administration levels (National and Provincial) would create strong resistance from the higher authority levels in changing the HIS structure. Some personnel from the national and provincial levels should be directly involved in order to negotiate with the lower levels and other stakeholders to accept a new system.

2.3.5. Efforts to Reform Health Information Systems

There have been many problems reported on the performance of health information system in developing countries (see e.g. Braa *et al.* 2001; Lippeveld *et al.* 2000; McLaughlin 2001; Simwanza and Church 2001). In recent years, many developing countries are restructuring their health information system mostly by decentralizing the systems in order to empower the lower levels with focus on the district levels. The process of restructuring the health information systems is commonly known as health information systems reform. In many developing countries, health information systems reform has been one of the national strategic plans. While some countries have undergone comprehensive restructuring of the health information systems as on integrated approach, in others, health information systems reform was done using a more gradual approach on subsystems, such as epidemic disease surveillance or routine services reporting (Wilson 2000). Health information systems reforms have been reported from South Africa, Zambia, Uganda, Malawi, India, and Pakistan (see e.g. Braa and C. Hedberg 2002; Simwanzaand Church 2001; Mursalin and Haque 2001; Wabwire- Mangan *et al.* 2001).

2.3.5.1. Using computers in health information systems

There is a long list of reasons for using computers in health information systems in the literature. Some of the reasons are as follows:

- To improve health system efficiency by processing and analyzing large amounts of data quickly.
- To produce a wide variety of outputs and feedback reports targeted for many levels of the health system from a single data set or by combining data set.
- To reduce the duplication of work, this is typically seen in many hierarchical data collection systems.
- To improve the quality of data collection through automatic validation during data entry and automatic preparation of immediate feedback reports on errors for individual health facilities.
- To improve analysis and information presentation to facilitate data interpretation and use for decision-making.
- To train health personnel through computer-based interactive tutorials for self instruction and continuing education.
- To improve data dissemination by providing online public access to data through Internet World Wide Web pages.

In addition to the direct reasons for using computer technology in health information systems, the process of computerization itself can serve as an opportunity to review and improve dysfunctional manual systems and procedures (Auxila and Rohde 1988).

However, the manner in which IT is implemented in HIS in developing countries has been questioned by many studies, as they are typically featured by large-scale projects. McLaughlin (2001, p.72) criticizes that, "Traditionally HIS efforts have been couched within project components for building health systems, efforts that have produced notorious white elephants and countless reams of paper forms that were hardly used to inform decision-making".

In addition, Lippeveld and Sapirie (2000) argue that, one of the main objectives of many typical health information systems development projects is the computerization of important data to be managed, monitored, and analyzed. However, whenever computerization becomes the primary objective of health information systems development efforts, the more important purpose of serving the data needs of the care providers tend to get lost.

McLaughlin describes the strategic approaches used by some developing countries to reform their health information systems, as it was to respond to donor requirements (McLaughlin 2001). Lippeveld and Sapirie (2000) argue that donor driven health information system restructuring is likely to fail.

Although sometimes these projects succeed in getting a new recording and reporting system up and running with a two-year period. However, once the project is terminated, the situation rapidly deteriorates with accumulation of software and hardware maintenance problems, incomplete and delayed reporting, and the lack of continuity of national staff for managing the system (Lippeveld and Sapirie 2000. pp.247-248).

2.3.5.2. Health information systems reform, the focus is the districts

While restructuring health information systems, many countries focus on decentralizing their systems to empower the lower levels in the HIS hierarchy. According to Muquingue *et al.* (2002), national health information systems are built up from the informational activity carried out in multiple, minuscule, often hierarchically insignificant points in the geographical structure of a country; these points are generally districts. The administration structure of many developing countries includes the community (village), district, provincial and national levels. The national health information systems in many developing countries have been strongly based on Primary Health Care (PHC) and the district becomes the most appropriate level for co-coordinating top-down and bottom-up planning, for organizing community involvement in planning and implementation, and for improving the co-ordination of government and private health care (WHO 1987). Being the information and physical hub between the community and the national health information system, the district consists of a large variety of interrelated elements that support the health system in a specific geographical area. A district includes the health care workers and facilities, up to and including first and second referral hospital levels (Amonoo-Lartson *et al.* 1984).

2.4. Standards

The standardization bodies in health care should define standards that address all aspects of data manipulations such as data storage, encryption, compression, transmission etc. (Espinosa, 1998). There are numerous applications of ICT in health care delivery currently based on their standard. For example, in the case of medical records or EPR, medical standards are used to support the creation of presentations

(Adelhard K. *et al*, 1995). Standards for medical programming languages as specified by ASTM E1460-92 while standard specification for defining and sharing modular health knowledge basis are described by ASTM 1992. According to Grimson et al (2000) and Raghupathi (1997), the reason why uptake of ICT in health care sector has been slow compared to other information intensive industries is general lack of standards and in other cases slow adoption where they do exist. Standardization committees include HL7, CENTC251 and Object Oriented Group among others.

2.5. Key Issues and Challenges

The shared-care paradigm of health care delivery has not been without challenges. The specific challenges relating to application of ICT in health care delivery as cited by Grimson (2000) are complexity of medical data and data entry problems, security, confidentiality, privacy, absence of unique national identifier, and general lack of awareness of benefits and risks of information technology. These challenges are independent of the adopted ICT tool to provide electronic care delivery.

According to Bakker (2002), there is need for more investments in health care software development to improve on functionality and thereby overcome the complexities in data entry in electronic medical records. New functionalities must be developed in partnership between health care professionals and ICT professionals. Raghupathi (1997) projects a move toward a universal electronic health management information system thereby eliminating data duplication nationally. However, this calls for a national unique patient identifier and patient index. This need can be addressed by software developers guided by a state's health care CIOs.

Threat of privacy of patient data in digital form stored in a database and in the process of transmission (Obrien, 2001) than in paper-based form is very real. In addition medical data is very sensitive and lack of privacy can result to patients avoiding the much needed health care services. Also it can lead to physicians' failure to enter all information into patient records (Rindfleisch, 1997 & Tachakra *et al*, 1996). Therefore all the benefits of electronic health care delivery cannot be enjoyed unless patient privacy and confidentiality is guaranteed (Smith and Eloff, 1999). The security concerns that must be addressed as a result of electronic medical records include confidentiality, integrity and availability (Grimson *et al*, 2000). According to Rindfleisch (1997), confidentiality of patient data is threatened within a health institution through accidental disclosures, insider curiosity and insider insubordination while external threats are mainly through unauthorized access.

Security issues surrounding health care information systems is an international concern and has thus resulted to formation of security bodies to address these issues. International Federation for Information Processing Technical Committee 11 (TC11) focuses on general information security while the International Medical Informatics Association (IMIA) is concerned with security in the area of medical informatics (Smith and Eloff).

According to Smith and Eloff (1999), a more current security measure for electronic patient data and information is de-personalizing and disintegrating patient information and storing it in various locations in coded pseudonyms assigned by Identifier Control Facility (ICF). This result to disintegrated virtual record and hence eliminating the risk to data confidentiality threatened through use of patients' name. ICF keeps track of the location of all the patient data and information.

The access authorization security application solutions vary depending on complexity, cost and efficiency of each method. Public Key Infrastructure (PKI) combined with digital signatures, passwords, biometric

devices and firewalls are being promoted to ensure secure transmission of health care information over the internet (Raghupathi *et al*, 2002 & Chadwick *et al*, 2003). Secure networks protocols such as Secure Sockets Layer (SSL) and Secure HTTP (S-HTTP) are widely used in transmitting patient data securely over the World Wide Web.

According to Smith and Eloff (1999) patient smart cards are optimized for security by their design because the chip holding the information is embedded within a plastic, which makes it difficult to be probed as in the case of magnetic striped cards. However, security of the memory part of the card is zoned with different levels of user access.

2.6. Acceptability of Electronic Health Care Delivery

Despite the numerous benefits of electronic health care delivery technologies, most health care service providers have not embraced its introduction because of change in workflow processes and lack of training (Guler and Muldur, 2001 & Goosen *et al*, 1997). The solution has been offering short training to the end-users to get familiar with the new system while the system software developers come up with simple windows to prevent the users from getting lost between menus and user-friendly screens to easily adapt the users to the new system.

2.7. Risk Analysis

Risks in health care systems cannot be tolerated as they can cause harm to patients or at times lead to death (Ammenwerth et al, 2004). Typical risks to a health-care information system are mainly unauthorized access or power failure, which prohibit the availability of patients' data (Epinosa, 1998 & Smith and Eloff, 1999). Other hazards as listed by Ammenwerth *et al*, 2004 include functional errors of the system, unreliability, user-friendliness, environment not prepared adequately to changes in working processes, and ill functions among others. Implementation of information systems to replace an old system can be nightmare for the implementers. However support from top management and future users almost guarantee successful implementation of health care systems (Berg 2001).

2.8. Legal Issues

Legislators internationally have recognized the need for data protection legislation against misuse of electronic data processing (Grimson et al, 2000 & Benedict, 2001). However, only a few regulations of the existing data protection act involve health care services and thus Smith and Eloff (1999) feels that more legal issues in health care needs to be addressed. The current health care legislation covers use of health care records as evidence in legal proceedings and collection of personal health data for other purposes than provision of health care services.

Europe has introduced Data protection Legislation and Freedom of Information Legislation (Grimson et al 2000).

2.9. Patient e-referral models reviewed:

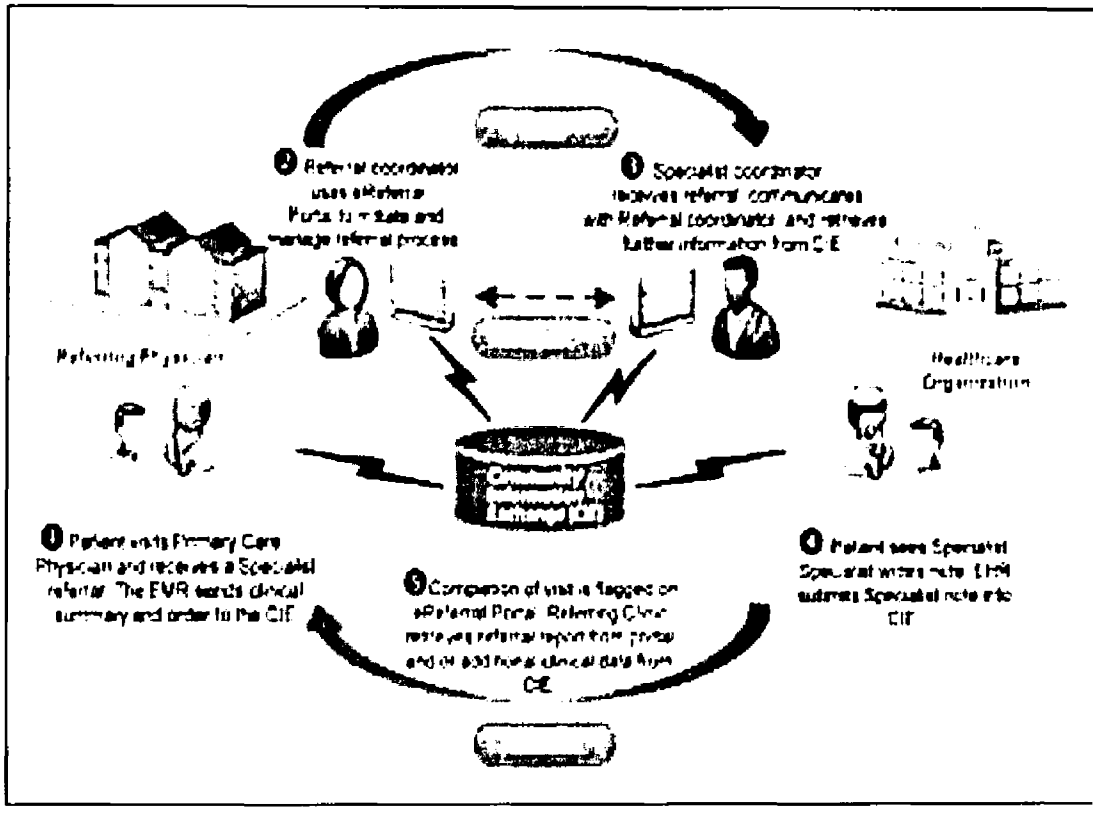

Figure 2.5 BMC's newly re-engineered referral process.

1. Boston Medical Center BMC's re-engineered referral.

1. The patient visits a primary care physician (PCP) at a CHC and receives a specialist referral. The EMR sends a clinical summary and order to the CIE.
2. The referral coordinator uses the eReferral portal to initiate and manage the referral process.
3. The specialist coordinator (SC) receives a referral, communicates with the RC and retrieves additional information from the CIE.
4. The patient sees a specialist who writes a note into the system, which the EMR submits to the CIE.
5. Visit completion is flagged in the eReferral Portal while the Referring Clinic accesses a referral report from the portal and additional data from the CIE.

By implementing eReferral, BMC is able to offer its 1,500 clinicians composite views of relevant patient information housed in varied systems and applications across the community. Clinicians and referral coordinators can find specialists, book appointments online, transmit clinical data and track referrals from beginning to end. Among eReferral's key results:

- Facilitation of clinical information exchange through tracking of referrals from initiation through completion

- Streamlined referral coordinator and clinician workflows
- Improved alignment with community health centers
- Centralized referral coordination
- Enhanced communication between PCPs and specialists.

"BMC's electronic referral management system integrates with physicians' current workflow and optimizes the effectiveness of referral coordinators," said Rich Kalish, M.D., medical director of Boston HealthNet. "By sending referrals via an electronic format, BMC ensures that clinicians will receive timely feedback and relevant information on referral outcomes."

2. San Francisco General Hospital: Connectivity through Electronic Referral

San Francisco General Hospital & Trauma Center (SFGH) is the city's only public hospital and Level 1 Trauma Center for the residents of San Francisco and northern San Mateo counties. The hospital is owned and operated by the City and County of San Francisco's Department of Public Health and serves as the hub of the county's safety net delivery system, which includes 35 community health centers, clinics and affiliated partners. The hospital serves as a teaching hospital for the University of California, San Francisco, and this entire system benefits from shared access to patients' SFGH electronic medical records.

- The system's key components include the following:
- There is a centralized, electronic queue for each participating specialty service.
- All referring clinics must use the eReferral system to refer to participating specialty services.
- Each participating specialty service has a designated specialist clinician reviewer with dedicated time to review and respond to referral requests. The reviewer can use the system to schedule appointments, triage patients, request clarification of the consultative question and provide guidance for pre-visit evaluation.
- The referring provider and specialist reviewer can communicate in an iterative fashion using the eReferral system until the patient's clinical issue has been addressed, with or without an appointment.
- The eReferral system is tightly integrated with the hospital EMR so that all information exchange is documented in the patient's chart in real time.
- The system is limited to initial referrals (rather than referral for follow-up care) because these were decided to be the best use of the reviewer's time.

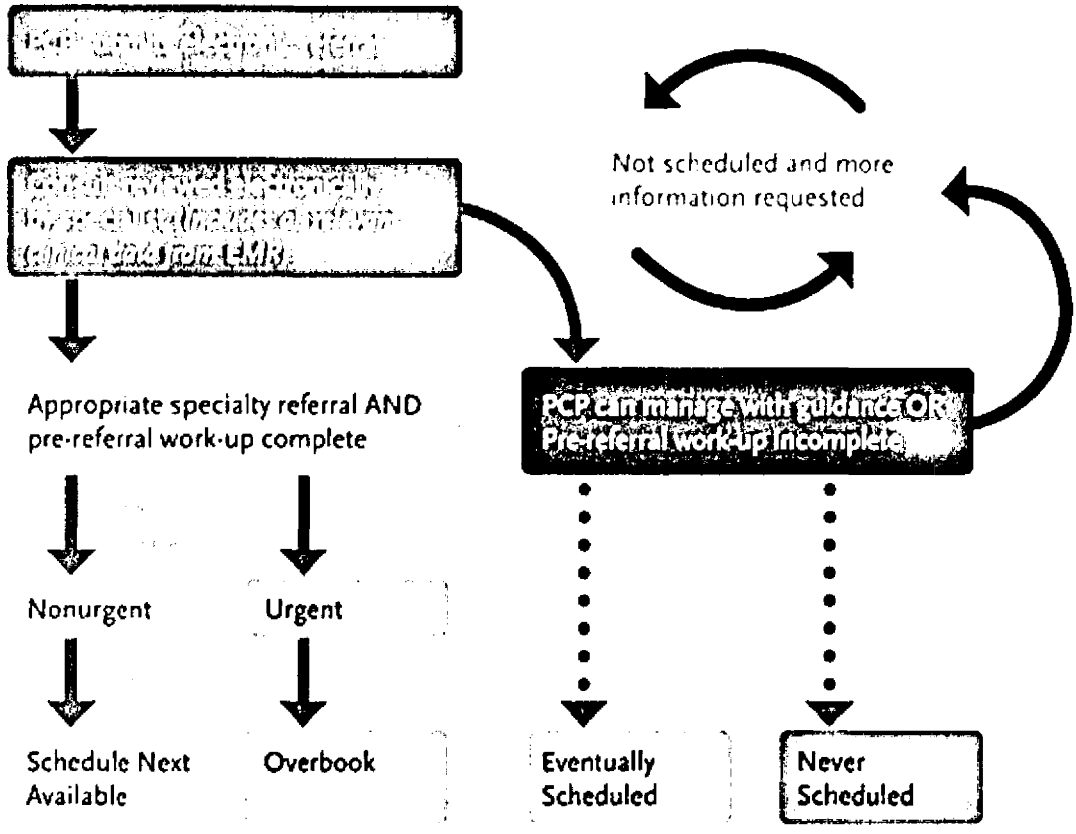

Figure 2.6 San Francisco General Hospital & Trauma Center eReferral system process

Drs. Yee and Chen believe that one of the primary values of the eReferral system is facilitation of communication between primary care and specialist providers. It is important to note that implementation of these consultations may be difficult because of legal, medical and logistical reasons. Nonetheless, primary care providers now receive guidance on evaluation and management in a timely fashion, while specialists who see patients in clinic receive clear consultative questions.

This information connectivity not only reduces unnecessary specialist appointments, but gives (Primary Care Providers) PCPs more opportunity to learn and treat their own patients' clinical issues.

Local PCPs are satisfied with the eReferral system, especially clinics with good Internet access. Clinics that only have intermittent internet access are less able to fully benefit from the system. In these practices, referrals tend to be entered by clerical staff yielding a less informative clinical referral and less opportunity for back-and-forth communication between providers.

2.10. ELECTRONIC HEALTH RECORD PROJECTS IN AUSTRALIA, EUROPE AND CANADA

2.10.1. Overview

Electronic health records have been developed for a range of purposes. Most of the established EHR schemes are used for purposes such as electronic billing and are designed for individual institutions or for a limited network of health services.

EHR projects are now being developed at the national and state level in Australia, Canada and Europe to provide a lifetime summary of patient's records, linking information about their health care across the whole health system. The primary objective of these EHR schemes is to improve the quality of health care services.

They offer health care providers access to a more complete medical history of a patient, with the patient's consent. They also promise consumers more complete information to assist them to better manage their own health care.

EHRs promise a more integrated approach to health care, so that services are more patient focused. In Canada, England and Ireland EHRs have been explicitly linked to reforms in health care delivery, particularly primary care, rather than relying on EHRs to achieve change in themselves.

Australia is well advanced in developing EHR projects, with trials of proposed schemes commencing in late 2002 and 2003. The National Health Information

Advisory Council was established in 1998 to bring together state, territory and federal government health information technology initiatives.

In England, the government has made a long-term commitment to testing, developing and evaluating EHR proposals to learn from the best and worst of local initiatives. The Canadian Government has also adopted a collaborative approach to EHR development. It has established a number of organizations to foster cooperation and build on provincial government EHR projects.

2.10.2. Definition of EHR

In its most general usage, the phrase 'electronic health record' is used to describe any digital representation of health information with little or no concern about how this information is stored or retrieved. The term is often used synonymously with other related phrases such as 'electronic medical record' and 'electronic patient record'.

This indiscriminate use of 'electronic health record' and other apparent synonyms is sometimes causing considerable confusion among stakeholders.

As tempting as it can be to dismiss the lack of uniformity in terminology as semantics, one must recognize that each term has independently evolved for good reason – to address a specific underlying context and agenda.

Confusion arises from the indiscriminate blurring of these contexts and agenda, which can hamper fruitful discussion among the key health care policy stakeholders who exert significant influence over funding and direction. As a result, progress towards implementing systems that put the right information in the hands of health care providers, where they need it and when they need it, is impeded.

Many credible sources have adopted terminology to describe local EHR systems that collect data and support the care delivery processes during an encounter. Such examples include HIMSS' preference for

electronic medical record (EMR) (Davis, Garets, 2006); Gartner's use of the term computer-based patient record (CPR) for systems in care delivery organizations and electronic medical record (EMR) in ambulatory (Edwards, Handler, Rishel 2006); and Canada Health Infoway's nomenclature for health care facility systems as electronic patient record (EPR) and physician office systems as EMRs (Canada Health Infoway, 2006).

Use of the term electronic health record (EHR) seems to be more broadly used in describing jurisdictional information sharing systems. HIMSS describes EHR as a 'subset of each CDO's [care delivery organization's] EMR, presently assumed to include summaries, such as ASTM's Continuity of Care Record (CCR) and HL7's Care Record Summary (CRS)' (Davis, Garets, 2006) while Canada Health Infoway describes the HER as a 'secure and private lifetime record of their key health history and care within the health system...available electronically to authorized health providers and the individual anywhere, anytime in support of high quality care' (Canada Health Infoway, 2006). The Certification Commission for Healthcare IT, however, uses EHR to describe both inpatient and ambulatory local systems (CCHIT, 2007).

Despite the interrelationships and common interests in the industry, we have not yet achieved a common language to describe the systems and data in the broader context of jurisdictional information sharing that is critical to supporting the coordinated care we seek to provide. Hence the challenge and alphabet soup of confusion that are sometimes present in the private and public sector health care discussions. As patients, why do we really care about what we call each system and the data it manages? As recipients of health care, it should not matter whether our surgical care is recorded on an EMR or CPR or where our lab result physically resides in a region. What we do care about is that our caregiver has the information needed to make safe and effective clinical decisions.

There is no universal answer on what terminology is correct, however for the purposes of this discussion, it is useful to de-emphasize the focus on what systems are required in a given care context (e.g., physician office, hospital ward). Rather, it is helpful to look generically at patient health information, regardless of the systems that contains it, and to generically view the systems in the context of jurisdictional information sharing.

One of the best candidates to describe the pieces needed to achieve success in the e-Health agenda is the nomenclature proposed by the International Standards Organization in its technical report, ISO/TR 20514:2005. This document defines an electronic health record as a 'repository of information regarding the health status of a subject of care, in computer processable form.' It further defines an EHR with a 'commonly agreed logical information model' as a 'shared EHR', that when supporting integrated care across and between health care organizations in a jurisdiction becomes an integrated care EHR (ICEHR).

The ISO definition also distinguishes between clinical information and the systems that support its provision. It refers to systems where data is collected during an encounter by a care provider as 'local EHR systems', and systems that support an ICEHR as 'shared EHR systems'. It is all too easy to forget to separate the notions of a) the information upon which clinicians make decisions and b) the physical data, and manual and automated systems that generate that information.

This distinction between the data and the systems that process that data is crucial to maintaining a clear image of the EHR environment in which clinicians are operating. It is rare that the set of data upon which clinicians will make care decisions will originate from one place only. Local EHRs will almost always contain some form of paper records and clinicians will often also have to contend with multiple systems

to find the information they require. Some organizations have achieved varying degrees of success in integrating this information through technologies such as single sign-on or through clinical data repositories. Less fortunate clinicians might have to interact with separate registration, laboratory, radiology, pharmacy and other departmental systems in addition to the day-to-day stream of hard-copy information.

2.10.3. Review of EHR projects in Australia, , Canada and Europe

2.10.3.1. EHR projects in Australia

The major national EHR initiative planned in Australia is Health*Connect* - an Internet based network providing for the collection, storage and exchange of summary patient information over a patient's lifetime. A related initiative is the Better Medication Management System (BMMS), which will provide a central record of patient medications information held by doctors, pharmacists and hospitals, with the patient's consent. Regional and state EHRs are also well advanced and many of these will provide pilot sites for Health*Connect*. Pilots and evaluation will be completed, by the end of 2003, before national implementation.

2.10.3.2. EHR projects in Canada

The major EHR schemes being developed by provincial governments in Canada include:

- . the Pharma*Net* system in British Columbia, Canada. Established in 1995 to provide online processing of pharmaceutical benefits, it gives pharmacists a province-wide patient medication history and offers them comprehensive drug information and automatic checks such as drug interactions. It is available in hospital emergency rooms and will be extended it to doctors in future;
- the Pharmaceutical Information Network in Alberta, Canada. It provides a complete record of patient medications held by doctors, hospitals and pharmacists and drug information and automatic checks. Pilot implementation commenced in 2002. It is part of Alberta's Wellnet scheme, which aims to provide an umbrella for provincial and regional initiatives to build an integrated health information network;
- Smart Systems for Health, an initiative of the Ontario Ministry of Health and Long Term Care. It commenced four years ago to provide the infrastructure for secure communication of patient information among healthcare providers across the province.

2.10.3.3. EHR projects in Europe

The EHR schemes being developed in Europe include:

- . a patient centred EHR, electronic booking of appointments, electronic prescribing and a patient held record promised across the English National Health Service by 2005. The English are world leaders in setting a national agenda for health information technology and integrating the information strategy to changes in how health services are delivered. A feature of the English approach is a desire to learn from success and failures, with funding for long term development and evaluation;

- the Department of Health in Germany is planning an electronic health smart card to process health insurance claims and provide electronic prescriptions, with the option of also storing other clinical information. Pilots will commence in late 2002-2003, which will be evaluated before implementation;
- phased introduction of electronic patient records proposed in Ireland as part of a yet to be released National Health Information Strategy.

2.10.3.4. Issues

The EHR schemes in the countries reviewed in this study demonstrate that there are many common challenges to be met and some important lessons for Australia.

The pilots of EHR schemes in England and Canada demonstrate the benefits of a long term commitment to research and evaluation of different EHR models.

The HealthConnect and BMMS trials and evaluations in Australia in 2003 may need longer than planned to provide useful results.

In Australia public policy debates about the privacy and security requirements of EHRs have not yet commenced. As a result there is a lack of understanding and consensus about the issues among stakeholders.

The Canadian Government and the European Union have advanced these discussions by incorporating privacy and security issues into the health information technology agenda. The privacy requirements of EHRs should be explicitly part of the funded work program of National Health Information Management Advisory Council or its successor.

The lessons from Europe and Canada in particular show the need for patient consent processes to be simple and easy to use for consumers and doctors. Processes need to be developed that are responsive to peoples' desire to control how their personal health information is shared with others.

EHR schemes in Australia would benefit from privacy commissioners taking an active and public role in providing advice on privacy issues. Their Canadian and European counterparts have done so very successfully.

In Europe and Canada government agencies and health informatics experts have highlighted the shortcomings of PKI and favour the use of Public Key Infrastructure (PKI) in combination with other security measures. Australian governments should consider the use of Trust Management system, biometric devices and smart cards in combination with the PKI provided by the eHealth Signature Authority.

2.10.4. DEVELOPING A FRAMEWORK FOR BUILDING A SHARED EHR

2.10.4.1. Introduction

To make effective decisions in the most cost-efficient manner, health care professionals need timely and accurate access to an ever-increasing amount of patient information. While many people might think of the patient chart as the repository of all their health care information, in reality, it is scattered across a myriad of different electronic and paper-based systems, often spread across multiple organizations and sometimes even regions and jurisdictions. The inability to quickly access an aggregated view of health care information on a patient's previous and current episodes of care has the potential to hinder diagnosis,

prompt the unnecessary repeat of tests, jeopardize safety, and generally increase the cost of health care delivery.

As society has become increasingly mobile and health care has become further specialized, patients are more likely to interact with multiple health care institutions, particularly when specialized care is required. This movement of patients among health care providers is driving a need to share their health information so that care can be coordinated and integrated across the various care environments, a process that is very expensive and time-consuming when paper-based.

Putting the right information in the hands of health care providers – where they need it and when they need it – has become a strategic imperative for many health care institutions and the organizations that fund them. By employing information and communication technology to facilitate the capture and transfer of patient information, these organizations believe that they can:

- enhance patient safety by eliminating errors attributable to incorrect or incomplete patient information,
- improve access to health care services by streamlining processes, and
- Reduce the cost of delivering care through productivity gains.

This framework views health information and the system architecture that supports an aggregated view of health information to be organized in two tiers: one tier comprises of point-of-care systems whose data are integrated by a second tier, which shares health data with other providers. The simplicity of this framework avoids the confusion of differing terminologies, yet provides the flexibility to adapt to the unique requirements of each jurisdiction that will drive the balance in investment needed between these two tiers.

2.10.4.2. E-HEALTH REQUIREMENTS

So what factors are driving e-Health requirements in various jurisdictions? Although the majority of regional e-Health projects are in the early stages, it is clear that many different approaches to sharing patient information electronically are emerging. There are, however, two key elements that are common across all jurisdictions. First, each jurisdiction has its unique set of governance structures that will drive both local and jurisdictional health care system requirements. Second, clinicians require two distinct, highly interdependent classes of health information to care for their patients. Each of these factors is describe in further detail in the following sections.

Governance

The electronic sharing of patient information across organizational boundaries will be heavily influenced by the governance structures in place within and across the organizations involved. Each organization, at the local, regional, or jurisdictional level in a health care system will have its own agenda and priorities whose history is reflected in its legacy of technology investment. Even in the most centralized of governance models, there will be a broad base of care delivery organizations, each with a distinct history and local agenda that will influence their information and communication technology decisions.

Systems that capture and manage local health care data are deployed in the context of the local organization, and each needs to fit into its organization's unique array of legacy applications. Spanning a common set of solutions across governance boundaries can be very challenging, if not unfeasible. Therefore, it is more typical that multiple governance structures yield to multiple systems that store and manage patient information.

In addition, there will always be an over-arching leadership at the jurisdictional level driving health care policy and practice, be it a single governance structure or a funding and policy body that provides the legal and regulatory framework within which health care services are delivered. It will be natural for stakeholders at this level to focus on how to share health care data throughout the jurisdiction. In addition to regulatory constraints such as data stewardship, decision-makers will be driven by local governance factors such as the specific requirements of stakeholder organizations, legacy technology, and the preferences of key influencers throughout the jurisdiction.

What is common across each jurisdiction is that their respective attributes, needs and preferences, which are reflective of their governance structures, will drive a relatively unique set of requirements and solutions that each fit on a continuum of deployment models from highly centralized to highly de-centralized.

Local vs. Shared

The second major factor that drives e-Health requirements in all jurisdictions is that there are two distinct and highly interdependent classes of patient health information that are needed to build an aggregated view for clinicians:

- Local Data is collected by the provider during the episode of care. Some of this information is more focused on the care processes and is of primary value to the provider of that encounter.
- Shared Data is collected by other health care providers that is of value in the current episode of care and is usually a subset of local data. Examples of shared data typically include allergies, medication history and current medications, previous surgeries, medical history, diagnosis and problem list, health habits, previous treatments and test results.

In a jurisdiction with a highly integrated information sharing architecture, shared data may be exchanged by abstracting the desired subset and migrating it to the point-of-care systems of other care delivery organizations. In less integrated environments, health information may be shared through access to multiple systems. There are many ways to successfully share information and deliver the aggregate view of local and shared patient data the clinician needs.

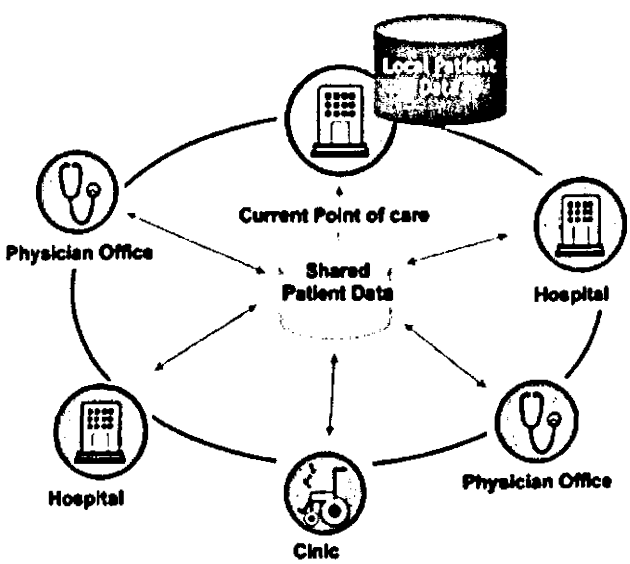

Figure 2.7 - Local vs. Shared Patient Information Structure: Source - www.emergis.com

Access to both local and shared data is critical to enhancing patient safety, productivity and quality of care.

Consider a physician ordering a medication for a patient. Many health care organizations use some form of drug interaction checking to alert the physician to potential medication conflicts. Without a complete medication history assembled from multiple care organizations, this decision support will be of little use when a previously prescribed medication has a serious interaction with that being ordered.

The commonalities of governance issues and the distinct sets of data needed by clinicians add up to a 'domino effect' that drives e-Health requirements. Governance drives the local legacy architecture and system requirements, which drive the data being collected, which drives the practical options available for governance. This domino effect suggests that:

1. A two-tiered approach will best accommodate the delivery of aggregate health information within and across jurisdictions; and
2. Balanced investment in both tiers will ensure that the unique attributes, needs and preferences of each environment will be addressed.

The two statements above may give cause for some to point out numerous examples of a common set of systems being deployed across a jurisdiction.

Such an architecture does not mitigate the need to design and invest in the data it contains, so that clinicians have the accessible information they need to make safe, effective clinical decisions.

2.10.4.3. FLEXIBILITY IN THE FRAMEWORK

While the distinction between local and shared data and systems may seem simple, the needs of the specific jurisdiction may drive some practical level of overlap in functionality between local and shared EHR systems. Because a shared EHR has local EHR functionality does not mean it is a local EHR. It is the high-level function that defines the data and system.

To illustrate, local EHR systems typically have very detailed information on the episode of care with viewing, clinical documentation, and computerized provider order entry (CPOE) functionality. Jurisdictional shared EHR systems will typically populate user interfaces with view-only data, but may also provide extended functionality such as CPOE for those health care providers without the benefit of such functionality in their local EHR.

As a further example, there are many exceptions where a local EHR system is implemented across an entire jurisdiction. Although it continues to have all the attributes of a local system, it defacto becomes a shared HER system by the very breadth of its implementation.

As previously stated, both local and shared EHR systems must have the flexibility to meet the differing needs of each environment. We can see the tremendous clarity that is possible if e-Health stakeholders maintain a high-level, disciplined distinction between local and shared EHRs as well as a distinction between the information and the systems that provide this information. As discussed in the next section, there is a wide variety of deployment models that readily accommodate specific jurisdictional needs and constraints for implementing a shared EHR.

2.10.4.4. DEPLOYMENT MODELS

Although the term "shared electronic health record" may seem to imply a single, centralized database, there are actually multiple approaches to creating a shared EHR. These different options address the

specific needs of the organizations involved and take into consideration possible constraints regarding data stewardship, technological differences, and organizational boundaries.

There are many architectural options for implementing a shared EHR system. Each lies on a continuum with the following models at each end:

1. Centralized model. Shown in Figure 2.8, this model is based on a single, central data repository in which shared patient information is stored. Local EHR systems use this central data repository to store and retrieve an agreed upon subset of information about each patient. The shared EHR system includes components to authenticate the parties involved in each transaction, to authorize the transaction based on the credentials of these parties, and to record information about the transaction for audit and reporting purposes. Providers without a local EHR can access the central data repository with a web browser through a clinical portal.

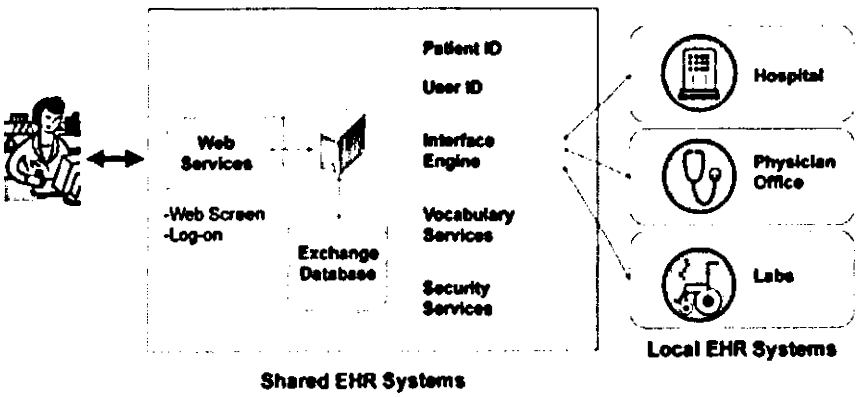

Figure 2.8 - Centralized Model: Source - www.emergis.com

2. De-centralized or federated model. With this model, patient data is retrieved, at the time it is needed, from the system in which it is stored as shown in Figure 2.9. The local EHR systems are each responsible for maintaining all the information about the patients who visited the facilities at which these systems are located and for sharing selected patient information. The shared HER system may include a mechanism to determine where all the shared information related to a specific patient is stored as well as some form of electronic messaging system for transmitting shared patient data and for conducting transactions between local EHR systems.

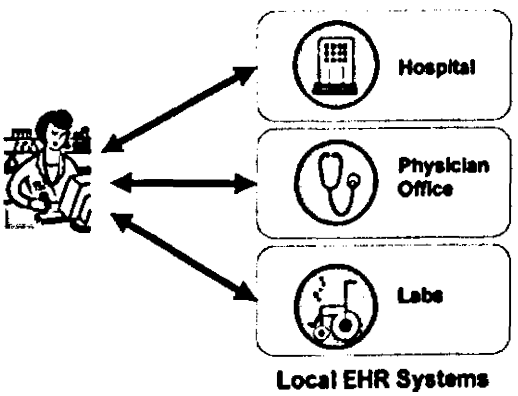

Figure 2.9 - Simple Federated Model - Source - www.emergis.com

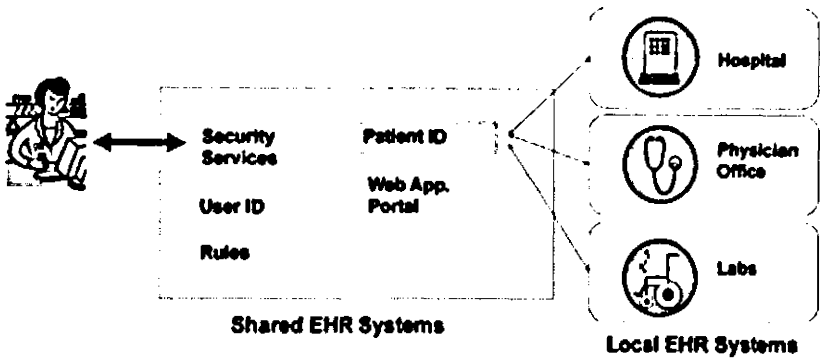

Figure 2.10 - Federated Model with Shared EHR System - Source - www.emergis.com

The main difference between the centralized and federated model is the location in which the shared patient information is stored. In the federated model, shared patient data is stored and maintained in the local HER systems in which it was created while in the centralized model, shared patient data is stored in a central repository.

Setting up the infrastructure needed for the centralized model can make it more expensive and more complicated than the federated model to implement. However, when user convenience and overall performance are taken into consideration, there are a number of implementation options for the federated model that can make this model more complex and costly to implement. These options include:

- **Data push vs. data pull.** In the centralized model, shared patient data is pushed from the local EHR to a single, central repository. In the federated model, shared patient data can either be pushed from the source local EHR system, or pulled by the shared EHR system. In the simplest case, the user is left to connect with each local EHR and to search for and retrieve (pull) relevant patient data. More complex implementations include shared EHR system components that help locate patient information and that support the movement of patient data. A federated model can even have data pushed from the local EHR systems in which the patient data is stored to other local EHR systems that also store information about the patient.
- **Automatic vs. manual user intervention.** In the centralized model, shared patient data is automatically placed in the central repository when it is created and is therefore available whenever it is needed. In the federated model, user intervention may or may not be required to retrieve the shared patient information. If data has been pushed to the local EHR systems then user intervention is generally not required. However, if shared patient data must be pulled from a local EHR system, the shared EHR system may automate this process or leave it to the user to retrieve the shared patient data from each local EHR system.
- **Local EHR system interaction.** In the centralized model, the user does not interact with any of the local EHR systems on which shared patient data is stored. In the federated model, on the other hand, users may need to interact with and have working knowledge of each local EHR system on which shared patient data is stored in order to retrieve this data. This process can be greatly simplified if the shared EHR system uses techniques such as single sign-on and patient

context sharing to automatically connect to the local EHR systems and display the data associated with a specific patient.

2.10.4.5. CENTRALIZED MODEL

Following are three examples of deployment models that fall more to the centralized end of the continuum.

1. National Programme for Information Technology (NPfIT)

A highly publicized example of the centralized shared health record model is the National Programme for Information Technology (NPfIT) in the United Kingdom.

The NPfIT is a comprehensive, fully integrated system consisting of shared and local electronic health records that will give health care professionals secure access to patient information whenever and wherever it is needed.

The NPfIT consists of a national, shared EHR system operated by the National Health System (NHS) Connecting for Health Agency and local EHR systems operated by hospital and primary care trusts.

A major NPfIT component supporting the exchange of patient information is the NHS Care Records Service (NHS CRS). The core of the CRS is the 'Spine', a national, centralized database of key information about patients' health that includes a summary of care encounters and clinical events. Summary patient information available through the spine includes:

- Personal health information such as drug allergies, lab results, and medication history is provided by the Personal Spine Information Service (PSIS).
- Demographic data such as address details is held nationally but is accessible through local EHR systems. This data is provided by the Personal Demographics Service (PDS).

As shown in Figure 2.9, the NPfIT consists of national applications common to all users and local systems which address the needs of specific institutions or communities. National applications are the responsibility of a national application services provider who provides software and support for the summary patient record along with the infrastructure services that supports a consistent set of patient confidentiality and security principles.

NPfIT

Year Initiated:	2002
Area Served:	England
Governance:	Delivered by the Connecting for Health Agency, established in April 2005 as the single national IT provider for the National Health Service.

Services:

- Care Records Service (CRS) – Enable clinicians to access patients' records securely, when and where they are needed.

- Electronic Booking Service (eBooking) - Enables general practitioners (GP) and other primary care staff to make appointments for patients with clinicians or other health care professionals.

- E lectronic Transmission of Prescriptions (eTP) - Allows prescribers working in GP practices to generate and transmit electronic prescriptions using their computer system.

- National Network (N3) - Connects all NHS organizations and provides the IT infrastructure, network, and voice services and broadband connectivity to meet NHS IT needs.
- Email and Directory Service (NHSMail) - Provides a central, secure, email service that enables sensitive info to be exchanged securely between NHSMail accounts.

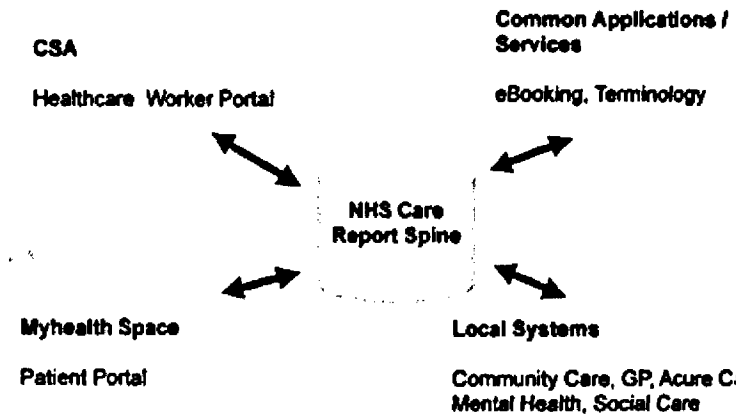

Figure 2.11 - Relationship between local systems and NPfIT Spine - Source - www.emergis.com

Applications at the local level are the responsibility of the five local service providers (LSP). These LSPs ensure that existing local EHR systems are compliant with national standards and these systems facilitate data flow between local and national systems.

2. Electronic Child Health Information Network (eCHN)

A Canadian example of the centralized model is the electronic Child Health Information Network (eCHN), a not-for-profit, government funded organization dedicated to providing electronic solutions that permit the sharing of patient information across multiple health care organizations in the province of Ontario. Initially created in 1997 to facilitate the sharing of paediatric information among hospitals in and around Toronto, the provincial capital, eCHN now connects a growing number of hospitals and other health care organizations across the province.

The basis for eCHN's centralized shared electronic health record is HiNet, (Health Information Network) a secure system in which a child's medical records are available electronically to a health care provider when and where they are required. As shown in Figure 2.10, patient information from participating health care organizations stored in this central repository includes laboratory results, doctor's notes, x-rays, visit information, and personal demographic information. HiNet has proven to be so successful in actual operation that the Ontario Ministry of Health and Long Term Care is now considering this same technology as the basis for a pan-provincial, population-wide shared electronic health record system for all Ontarians.

Echn

1997	A conglomerate of all the organizations providing paediatric care in the GreaterToronto Area (GTA) form the Child Health Network of Toronto to share health information and practices in paediatric care.
1999	HiNET is deployed and health care providers have access to records generated at any one of five sites in the GTA. Toronto area physicians can also access patient information from their office computers.
2002	eCHN begins expansion beyond the GTA with the addition of two new members.
2003	eCHN expands to northern Ontario and the Ottawa area. The Children's Hospital of Eastern Ontario as well as many new community hospitals, more doctor's offices and northern Community Care Access Centres are added.
2006	Growth of eCHN continues as three more tertiary paediatric centres are added. In addition, the remaining Community Care Access Centres, Children's Treatment Centres, more physicians and many more community and teaching hospitals join eCHN.

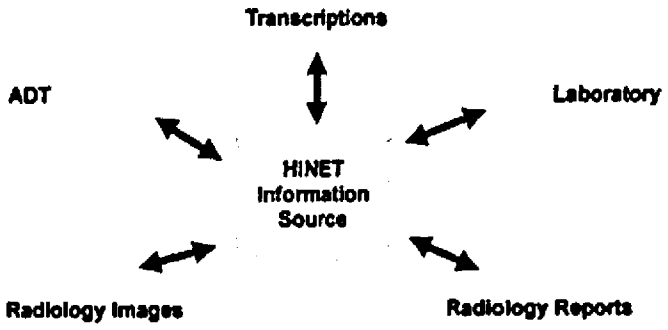

Figure 2.12 - HiNET Information Sources: Source - www.emergis.com

3. Careconnect.sa

In cases where a number of organizations are governed by the same entity, a centralized shared electronic health record can be used to store all patient information, thereby eliminating the distinction between a local and shared EHR. A good example of this approach is the Careconnect.sa program in South Australia. Since all publicly funded organizations are governed by the state Department of Health, a single EHR system has been deployed and will, over time, be used by all health care organizations in South Australia.

The careconnect.sa EHR system integrates with disparate clinical systems in each health care organization and stores the patient data generated by these systems in a single repository. Data stored in

this repository includes patient demographics, encounters, outpatient appointments, medications, laboratory results and radiology reports. The careconnect.sa

Clinical Display application provides a single point of access to this integrated on-line patient record. To date, South Australia has integrated the centralized HER with the clinical systems in the eight largest hospitals serving approximately 80% of the state's residents.

Careconnect.sa

Year Initiated:	1997 for an initial pilot in renal units of four urban hospitals in Australia
Area Served:	South Australia with a population of 1.5M people, 1.1M of whom live in Adelaide
Governance:	A program of the Government of South Australia Department of Health

Functionality:

- Clinical Display
- Order Entry
- Separation Summary
- Nursing Discharge Letter

Utilization Statistics:

- 6,125 active users
- Patient record reviewed every 9 seconds
- Electronic order placed every 53 seconds
- Separation summarized every 5 minutes

2.10.4.6. FEDERATED MODEL

Following is an example of a deployment model that falls more to the de-centralized end of the continuum.

HealthBridge

An example of a federated shared electronic health record model in which data is pushed to the local EHR systems is HealthBridge. Created to streamline the distribution of clinical documents from member hospitals to physicians whose patients go to these hospitals for outpatient services (such as lab tests and diagnostic imaging), Health-Bridge collects and delivers the clinical documentation associated with these services to the "physician of record" for each patient.

When HealthBridge was initially conceived, the member hospitals did not want to store their patient data in a centralized repository nor did they want to deal with the data stewardship issues associated with a centralized model. Hence, HealthBridge is based on a clinical messaging architecture that "pushes" patient information to physicians.

A critical element of this federated architecture is the local HealthBridge server that resides at each member hospital site. The local EHR systems at each hospital send a copy of relevant clinical information for each patient to the local HealthBridge server which in turn transforms this information as necessary to conform to standard data formats. The local HealthBridge server periodically uploads aggregated patient

data to a central distribution server which collates the information from all member hospitals to create patient specific reports.

Each report is distributed electronically to the "physician of record" for the specified patient.

HealthBridge

Year Initiated:	1997
Area Served:	Southwest Ohio, northern Kentucky, and southeastern Indiana
Governance:	Not-for profit organization whose members include hospital corporations in and around the Cincinnati, Ohio area
Services:	Distribution of clinical documents to area physicians, physician access to member IT systems, physician transcription, and Internet connectivity

In addition to transmitting patient clinical data, HealthBridge also provides a portal through which physicians can access numerous databases and applications housed and controlled by the member hospitals. The portal does not enable single sign-on to these applications. Instead, each member hospital maintains security over its own internal applications that are accessed through HealthBridge. Physicians must therefore enter several passwords, a process that does prove cumbersome at times.

Prior to the advent of HealthBridge, a physician would not know when a test had been completed or even to which hospital a patient went to have the test performed. Physicians and hospital staff routinely exchanged phone calls to locate test results. Today, patient data is automatically delivered to the physician in various formats (electronic, fax, and paper), some of which can be consumed by the local EHR systems in the physician's office.

2.10.4.7. HYBRID MODEL

A shared EHR generally contains data from multiple domains including but not limited to laboratory results, medication history, encounter history, diagnostic imaging reports and images, and patient demographic data. The data associated with each of these domains can be shared using either a centralized or federated model. Shared EHR systems that use both models – the centralized model for some domains and the federated model for the remaining domains – are classified as using a hybrid model.

CareConnect

A good example of a hybrid model is CareConnect, the shared EHR for Vancouver Coastal Health (VCH) and Providence Health Care (PCH). Created through the amalgamation of several small health authorities in the lower mainland of British Columbia, VCH delivers a wide range of acute, continuing, and community care in urban and rural settings. PHC, a Catholic health community serving residents of Vancouver, British Columbia, receives funding from and works in partnership with VCH.

When VCH was created, the health authority inherited a diverse suite of clinical, financial, and administrative systems. Consolidating these systems, while appealing, was considered impractical in the short term. Yet, clinicians working at the different sites had a pressing need to access patient data stored across these multiple systems. Taking a very pragmatic approach to this problem, VCH decided to forego the time-consuming and difficult task of integrating the data across the various systems. Instead, VCH

opted to implement what they call "visual integration" and provide easy access to each system. The clinician, instead of the system, is responsible for integrating the data from the various systems to get a composite picture of the patient's health status.

As shown in Figure 2.11, the CareConnect clinical portal is the main tool that health care professionals use to access patient information. This tool controls access to patient information and allows professionals to search for a particular patient. For each selected patient, the portal displays demographics, encounter history, and other key clinical data. Having selected the patient of interest, health care professionals can use the portal to access other clinical systems. They are automatically logged on to each of these systems, with information on the selected patient stored in that system automatically retrieved and displayed. Professionals still need to know how to use each system and may have to access several of these systems in order to gather a complete set of patient information.

Several of the systems that health care providers can access, notably PathNet (laboratory results) and PharmaNet (medication history), are provincial systems based on a centralized model for the specific domain in which they operate. Hence, CareConnect uses both a federated and a centralized model for shared health information.

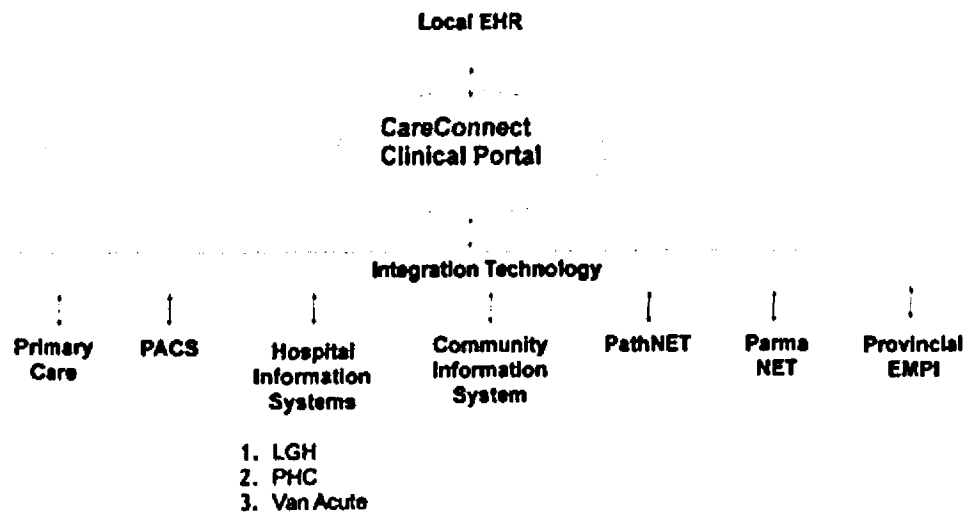

Figure 2.13 - Care Connect: Source - www.emergis.com

2.10.4.8. POINTS ON A CONTINUM

As the examples cited in this review illustrate, there are considerable variations in the architectural approaches used to implement a shared EHR. These variations are driven by a number of factors including:

- Governance model, which drove the choice of a federated model for HealthBridge vs. a centralized model for South Australia.
- Technical constraints, which led to the choice of a simple federated model for the clinical domain at Vancouver Coastal Health vs. a centralized model for eCHN.

The classification of a shared health record system as either centralized or federated is not always clear. There is a continuum of architectural choices, with points along this continuum having more in common with one model than the other. Perhaps the most notable example is the highly successful and much publicized Indiana Health Information Exchange (IHIE) which has been classified in published literature as federated, centralized, and federated centralized. As shown in Figure 2.12, the IHIE shared EHR architecture is not based on a single repository in which all patient data is stored. Instead, patient data is converted from the format in which it is stored in each local EHR and stored in a separate repository (Edge Proxy) at a central location. Information for each specific patient is gathered from the separate repositories using information stored in a central master patient index (MPI) to cross-reference patients across all participating organizations.

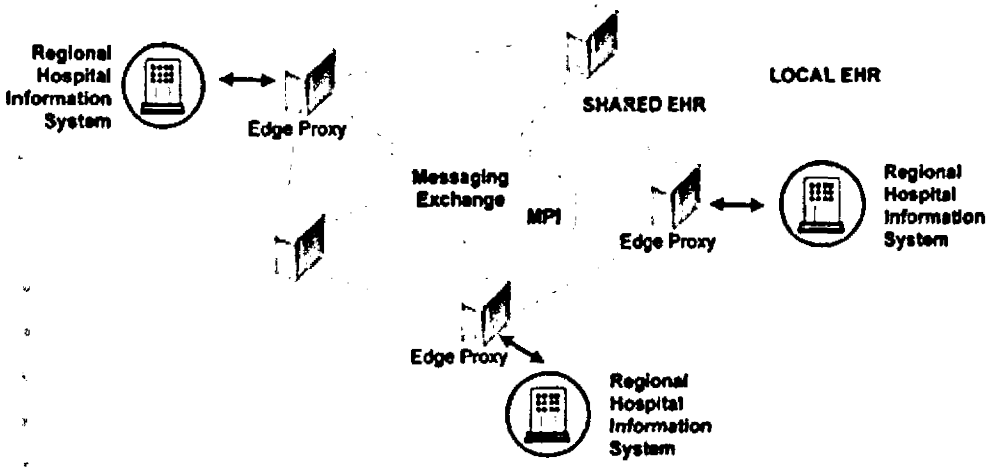

Figure 2.14 - IHIE Architecture: Source - www.emergis.com

Like the use of terms such as EMR, EHR, and EPR, the architectural classification is of less importance than the understanding that shared EHR architectures can be designed to meet the specific needs of the participating organizations. Further, there is no absolute "best" or "right" architecture. Rather, it is a matter of what is the "best" fit for the organizations involved that will lead to clinical use and long-term financial sustainability.

2.10.4.9. Historical background of health information system in Kenya

2.10.4.9.1. Development to Current Status

The design of a Health Information System for Kenya was conceived in 1972 by a committee that included representatives from the Ministry of Health, World Health Organization, Central Bureau of Statistics (now Kenya National Bureau of Statistics) and the Attorney General Chambers. Thereafter, a pilot project was designed and tested in three Districts, and was completed in 1976 and suggestions and recommendations were adopted.

Following the policy change towards the district as the focus for rural development in 1984, the Ministry of Health decentralized its reporting activities by establishing Health Information Systems offices in all districts where all Heath data from all health facilities would be processed.

Other events have followed since then. This include the National Health Sector Strategic Plan (1999 – 2004), that articulated the ministry's strategy to strengthen its co-ordination function with the private sector and non-governmental organizations in health care delivery, proper design and implementation of integrated health information systems was critical.

The then Ministry of Health continued to have fragmented data-based information systems. These included stand-alone information systems at the central level, vertical reporting systems and software. This continued to make integration very difficult. Very little information was able to find its way up from the facilities and through to the Provinces. This essential health information was found to be largely unavailable for effective planning, monitoring and evaluation at all levels.

The drive towards enhancing the HMIS function can be elicited from the following initiatives and programmes:

- the Kenya Health Policy Framework Paper (KHPF) 1994 - 2010, and subsequent implementation plans (1996)
- HMIS Needs assessment report (2003)
- the National Health Sector Strategic Plan II (NHSSPII) 2005 – 2010 dubbed "Reversing the current trends"

All these have outlined the areas that require immediate attention. These areas include:

- the integration of data collection and reporting tools
- the improvement of data flow mechanisms
- support for the districts' supervision role
- provision of clear policy guidelines on HIS
- the improvement of feedback mechanisms at all levels

In a nutshell, greater investment in the development of effective health information systems would have multiple benefits and would enable decision-makers at all levels within the health sector.

2.10.4.9.2. New Role of Donors

Donors have been instrumental in the development of the HMIS division by supplementing government efforts. This has supported HMIS in the restructuring process, training of personnel and provision of equipment and other resources at various levels. It is worthy to note that in recent times, under the sector wide approach (SWAP) there is a visible donors and implementing partners working group who have signed a Code of Conduct (COC) bringing then together. As a consequence of this, they now have enhanced their collective participation rather than individual participation. This has been achieved through the joint programme of work and funding. MOH development partners include World Bank, USAID, DFID, SIDA, DANIDA, JICA, GTZ, CDC, UNICEF, UNFPA and WHO.

2.10.4.9.3. Document Review – Planned Interventions

There have been several initiatives within HMIS over the last couple of years. Some of the previous recommendations include:

- Design of new data and information systems and tools to be determined by the type and range of indicators selected.

- Review and re-organization of the Health Management Information System (HMIS) at all levels to generate comprehensive, appropriate, accurate, timely and accessible information to support decision making, policy-making, technical, coordination and regulatory functions of the Ministry of health and health sector in general.
- Development of effective and nationally enforceable data/information standards and protocols for information management.
- Development of data/information flow and feedback policy.
- Computerization of the data management and processing system including introduction of new, more powerful computers at various levels of the health management information system.
- Construction of a technical data dictionary accompanied with 'Guidelines for Use'.
- Definition of Reporting Guidelines for various levels and stakeholders of the health management information system.
- Development of dissemination strategy and enabling institutional mechanism to enable the users of the information system to operate effectively at all levels.

2.10.4.10. Recent developments within HMIS

Harmonization of Data Collection Tools

Last year (2008), HMIS successfully finalized on the process of the harmonizing and rationalizing the health indicators to be collected within the health sector through a sector-wide process. Following this, new forms that were developed and agreed upon and are now available in the facilities for data capture and reporting.

Master Facility List

In January 2009, a stakeholder's consensus workshop for the Kenya Health Sector was carried out. In line with one important objective of integration of data in the health sector, the goal of this workshop was to achieve a comprehensive list of all health facilities in the health sector and assigning a unique code for each health facility. This was achieved. These unique codes would then form the basis of standardizing data elements in databases, sharing data and as a reference for all health facilities. It was noted that prior to this initiative, there existed multiple uncoordinated lists.

This standardization alone opens up the possibility of data integration across institutions and organization generating and using health facility related data.

2.10.4.10.1. Health management softwares

There exist some application softwares for the Health Sector around the world that are in use across many countries. Some of these are proprietary while others are open source. For proprietary software's, technical information is not easily available as opposed to open source where such information is in public domain. It is important to add that in Kenya there are a few initiatives on open source-based applications for the health sector.

A sample of the vendors and application softwares available in other countries include the following:

(a) District Health Information Software (DHIS) - developed by the Health Information Systems Programme (HISP). This software is largely used for aggregating data.

(b) Open Medical Record System (OpenMRS) - is an open source medical record system framework for developing countries. This system is used for managing electronic patient medical records.

(c) EpiSurveyor – an application for collecting data, developed by DataDyne

(d) eIIMIS

(e) OpenClinic - a fully-integrated hospital information system, created by Medical Exchange Solutions (MXS)

(f) VoXiva/Phones4Health – a company developing multi-channel applications for healthcare providers

(g) iHRIS SUITE - a human resource information system

(h) AMPATH Records Management System (ARMS) – A system used for HIV/AIDS electronic patient records implemented in Western Kenya by Moi University and Indiana University. Its implementation includes that use of electric power packs, a solution for areas with no electricity power or unreliable electricity supply.

(i) Zambia Electronic Perinatal Record System (ZEPRS) is an Electronic Medical Record (EMR) system that is in use by public obstetric clinics and a hospital (the University Teaching Hospital) in Lusaka, Zambia.

2.10.4.11. HMIS model

This integrated HMIS conceptual model is modular in nature. The HIS module would include mortality and morbidity, disease surveillance, patient management (in and out patient), laboratory management, pharmacy management, programs such as TB, Malaria, HIV AIDS, immunization, child health, nutrition, reproductive health, mental health, Ophthalmic services etc.

Management information is captured by other modules such as logistics & supplies, Human Resource, inventory of equipment and Finance and Accounting functions.

Other modules are external but integral to this HMIS. These include vital registration, census, demographic surveys, weather and environment. Powerful tools for modeling such as Geographical Information Systems (GIS) and Decision Support Systems (DSS) utilize the data from the integrated modules, enhancing decision making and planning, with little effort.

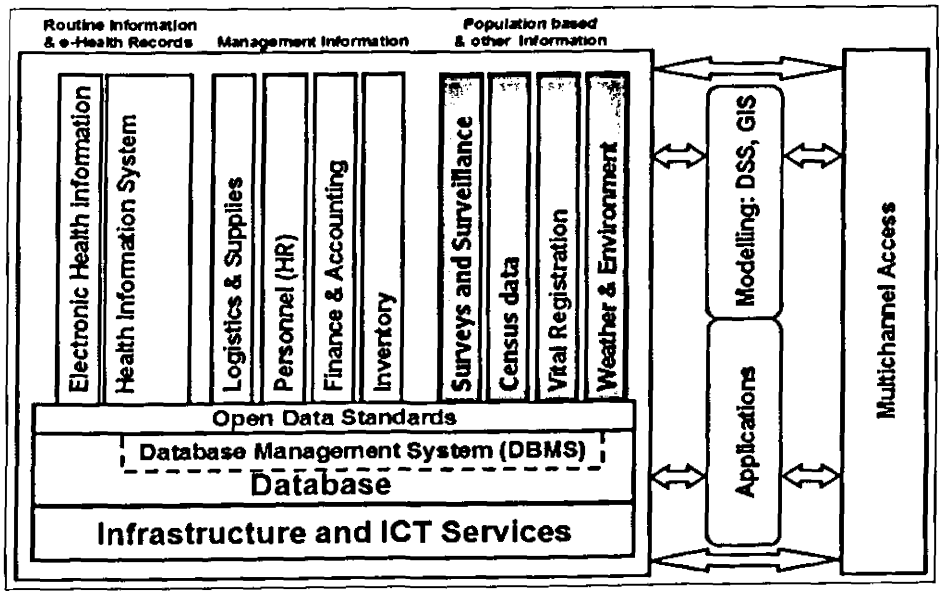

Figure 2.15: Conceptual Model of Integrated HMIS. Source: Final HMIS software report, UNES (2009)

Integration and interoperability is achieved by the use of open data standards on the Database. Table 2.1 shows the open standards. The table also includes information from where they can be obtained.

Open Standard	Custodians (Source)
1. Patient registry (patient health card)	KEBS/ISO (Health informatics committee)
2. Master facility list (Facility Codes)	HMIS (Phones4Health)
3. Facility Department codes	HMIS
4. Drug codes	KEMSA and MEDS
5. District and Province codes	KNBS
6.Constituency, Division, Location, Sub-location codes	KNBS
Reporting tools indicators (Indicator Registry)	HMIS
International Statistical Classification of Diseases and medical procedures (ICD) (Disease Codes)	WHO – ICD
Human Resource database (ILO Codes)	ILO
Reporting guidelines and time-lines	HMIS
Data security	KEBS /ISO (Health informatics committee)
Data collection, dissemination and management protocols	HMIS
Medical data dictionary	HMIS

Table 2.1: Open Standards and sources

All systems in the health sector must use the same standard codes.

The multi-channel access refers to the use of appropriate interfaces to the Integrated HMIS. This includes mobile phones, WAP, web, PDA, IVR, PC client, Smart phones, SMS etc. Though the software development incorporating different channels of access introduces a small overhead, the principle should be retained as different access channels will be suitable for different groups of users as dictated by their environments.

Figure 16 illustrates the flow of data and feedback between community, facility, district, province, and national levels with integration with external databases.

At the community level, transfer of data is manual to the facility, from facility to the district level; the transfer is either manual or electronic. The transfer between the districts to the national level is electronic. The province is able to access the data from the national level electronically.

At the facility, the data collected includes: HIS, Workload, FIS, and Inventory. At the district the data collected includes logistics and supplies, human resources, inventory, data reporting from facilities. At the province the data collected includes GIS and inventory.

2.10.4.11.1. Conclusion

Electronic health care delivery as a result of ICT adoption in health care is the way forward for any hospital that is committed to quality, efficient and cost effective health care services. ICT tools in health care have an ever-growing impact on the capture and how information flows across all domains in the health care sector. The catalyst to further benefits is coming up with more applications that will further

enhance sharebility of patients' health data and information because what moves the health sector is efficiency in information flows.

Several challenges to electronic health care delivery have been identified. Lack of trust as a result of absence of security, privacy and confidentiality is prevalent on the side of the patient while service providers are challenged by lack of skills in the technology and change of work processes. The implementers of the systems and service providers have to contend with lack of uniform policies and standards, legislation as well as set standards and guidelines.

The next chapter outlines research methodology used to survey and study the current usage of ICTs in handling of patient's data and information, perceptions of health care provider towards adoption of ICT tools and the barriers for the adoption of automated health management information system.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0. Introduction

The review on the literature on strategic role of ICTs in health care delivery shows that varied technologies are being applied to provide health care delivery services electronically. Developed countries take the lead in the adopting the opportunities offered by ICT health care delivery. Late uptake of ICTs in health care compared to other service industries has been noted. It also shows that applications of ICTs range from implementation of a simple health care information system within a hospital, to linking geographically dispersed health centres by use of telecommunication technologies. It further highlights key issues that need to be overcome if computerization of health care services would be fully embraced by the concerned stakeholders.

The literature review also reveals that successful implementation of e-health care delivery systems is not based on "one-size-fits-all" solution because of the great variations in needs and infrastructure of heath centres but rather on specific needs to be addressed by the concerned health centre, that are first investigated thereby leading to custom-made heath care information systems. Consequently, the feasibility and effectiveness of health institution delivering health care electronically through an Electronic public health information system needed to be established. This research methodology is described in this chapter.

The ability to share paperless clinical data among the health care service providers in a timely and cost effective manner showed to be the greatest innovation of ICT in health care delivery (Espinosa, 1998). The usage of computer plus accompanying health care software provides the means to capture, store and manipulate patient-specific healthcare related data including clinical, administrative and biographical detail while intranets and extranets common technologies provided means of transmission of the resulting information. The main barrier to electronic health care delivery in hospitals world wide are insufficient investments, security, lack of standards, and shortage of skilled people in the area of the technology.

The research requires the gathering of data on the perceptions of the service providers and opinions with regard to electronic health care delivery. The development and design of the survey is first outlined in Section 3.1, followed by the questionnaire structure in section 3.2. Section 3.3 outlines choosing the sample size followed by procedure in diction 3.4. Section 3.5 highlights consent followed by evaluation of results in section 3.6. Finally, conclusion is discussed in section 3.7.

3.1. Development and design of the survey

There are different categories of primary data collection methods, which include laboratory measurements, field observation, archives, questionnaires and interviews (Royce et al, 1993). For this research however, only questionnaires are suitable to collect the data required, as opinions from large group of health care providers are needed. Questionnaires provided a more structured approach to gathering and recording data and hence the choice for this research. The research entailed a survey of all the sections in selected health institutions in Nairobi province and in particular, staff who are directly involved with the patient care.

3.2. Questionnaire Structure

The questionnaire was designed with a separate section for each survey objective. The first section of the questionnaire asked about general information where respondents were asked to provide general information about the health institution working for (i.e. name, type, owner) and personal information (i.e. job position, department, age, gender and level of formal training)

A structured approach was adopted using a combination of closed formats with response choices and a few open ended formats. The response choices included response formats such as 'yes' or 'no', single response while others will require multiple responses. This method of data collection ensured high response rates and allowed easy elicitation. Closed questions formats produce standardized data that can be analyzed statistically and allow easy coding and recording for computer processing.

3.3. Choosing the sample of recipients and an appropriate Sample size

A convenient sample that consisted of a variety of health practitioners; health data and information officers and patients from the both the public and private health facilities in Nairobi province was selected. The key respondents included: (1) Health records staff (HRIO, MRO, health records clerk/technician); (2) Nurses; (3) Clinical officers; (4) Doctors; (5) Laboratory technologists/technicians; (6) Pharmacists/pharmaceutical technologists; (7) Hospital administrators; and patients. Lack of specific funding for this study did not allow for a more nation-wide survey and this convenience sample was the only feasible approach.

There are a total of 404 health facilities in Nairobi City County (**HIS, PHRIO, DHRIO - MOH 715 Returns of 30th September 2009. Updated: 5th November 2009)**

A convenient number of 70 facilities were selected from across Nairobi province.

Type of facility	Number in the province	Proportion by ratio (1:5.6)	Number of staff to be interviewed (max = 5 per facility)	Number of patients to be interviewed (max = 4 per facility)
Dispensary	131	23	115	92
Health Centre	70	12	60	48
Medical Clinic	107	19	95	76
Other-Nursing home with Maternity	14	2	10	8
Nursing home without Maternity	5	1	5	4
Other Health Facility	4	1	5	4
Other Hospital	39	7	35	28
Primary Hospital	2	1	5	4
Tertiary Hospital	2	1	5	4
VCT Centre (Stand-Alone)	30	5	25	20
Total	**404**	**70**	**360**	**2848**
		Population size	**Staff**	**360**
			Patients	**288**

Table 3.2 Kenya Health Facilities - (Nairobi Province). Facilities by Type.

3.4. Procedure

The questionnaires were delivered to the health institutions through hand delivery to a cross-sectional sample of healthcare providers, health records officers and patients. A preliminary research was conducted in Thika District hospital and Ruiru health centre before the final survey commenced. The intention was to test effectiveness of the research methodology by establishing any difficulties that were not anticipated. A total of 30 respondents participated in the pilot survey. The collected data was coded and then entered on SPSS (Statistical Package for Social Sciences) version 11.5 for processing. This enabled evaluation of the results. Questions that seemed not to be clear were corrected and part that seemed not to be significant were removed. Reliability of the questionnaire was carried out using SPSS (Statistical Package for Social Sciences) version 11.5 on data collected from the final survey.

3.5. Consent

Prior to this study, approval from the Provincial Director of Public Health and sanitation (Nairobi Province) was obtained for support of study. He gave me an introduction letter (attached as Appendix 4) in order to visit the health facilities in Nairobi province.

For the private hospitals, I had to approach the selected health organizations and request the top management staff to participate in the research project.

3.6. Evaluation of results

The survey was hoped to determine the information needed to support the health institution service providers as well as health records officers in carrying out their day to day work. It also hoped to establish the perceptions of health service providers regarding adoption of electronic PHMIS. Therefore the responses were analyzed by measuring the count and frequency of each response and then representing this as number and percentage of the range of responses available. A majority view on each question was thus revealed on analyzing the percentage. Cross tabulation of the responses within the section was carried out to analyze the relationship between some responses. For instance a comparison of percentage of patient's information required directly from the patient and from other sections was done.

Some respondents were not able to provide responses for certain questions such as those resulting to ICT tools and those relating to barriers of adoption of electronic PHMIS. The reason for non response was that the respondents did not understand the question or could not decide on one of the response choice provided. Some chose more than one choices even where they were required to select single choice.

The collected data was coded and then entered on a SPSS (Statistical Package for Social Sciences) version 11.5 for processing this enabled evaluation of the results. The analyzed data has been represented in tables and charts and have been used as the basis for recommendations and for development of a suitable model for electronic public health information system.

3.7. Conclusion

The survey was carried out using a structured questionnaire and face to face interviews. The respondents were drawn from different sections of each of the health institution visited. The response rate was 63% with a total of 228 out of 360 questionnaires received from the survey population. A total of 246 patient questionnaires are distributed and received back. Some patients and guardians declined to fill in the questionnaires for the reason that they did not understand the purpose for which they were requested to

participate in the research. The results of the survey were evaluated to establish the percentage of response choices for each question. The evaluation of these figures helped in achieving the objective of the survey. The results of the survey and their evaluation are described in detail in the next chapter.

CHAPTER: FOUR: SURVEY RESULTS AND EVALUATION

4.0. Introduction

This study was conducted to determine the information needed to support the health care providers in carrying out their day-to-day work, information flows amongst them, and their opinions concerning the development of an electronic public health information system. The sampled population involved a variety of health practitioners, health data and information officers and patients from the both the public and private health facilities in Nairobi province. Data were collected from the sampled population using questionnaires. It was analyzed using Statistical Package for Social Sciences (SPSS version 11.5) computer package. The research findings were presented in graphs, tables, and figures as appropriate.

4.1. General Information of the Sampled Population in this Study

The study targeted the population of health practitioners, health data and information officers and patients from both the public and private health facilities in Nairobi province. The study revealed that 33.8% (n=77) of the health record staff who responded were male while 66.2% (n=151) were female.

4.1.1. Age Distribution of the sampled population

The study established that the staff from these health institutions who responded had varied ages. The age distributions between 18-24 years were 6.6% (n=15), those between 25-34 years were 29.6% (n=67) while majority of the respondents aged between 35-44 years were 58.4% (n=132) and those aged between 45-54 years being 4.9% (n=4) even though one respondent was aged between 55-64 years this being 0.4% of the sampled population.

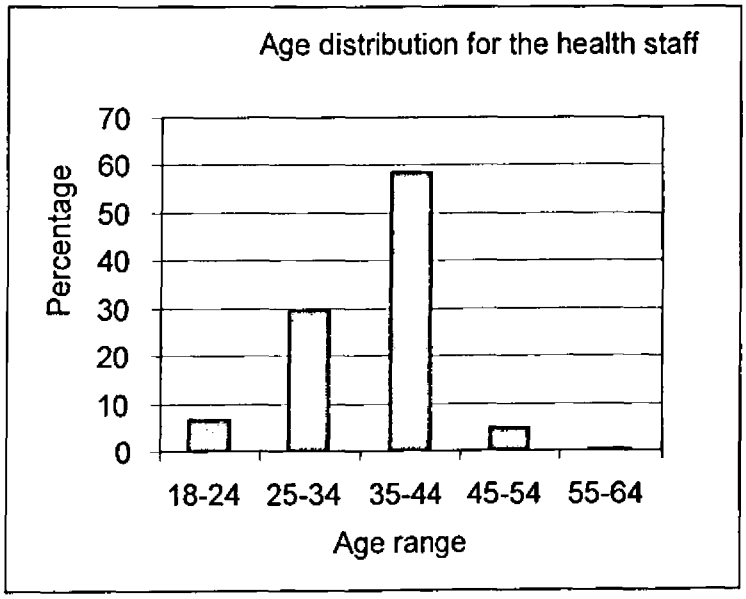

Figure 4.1 showing the Age Distribution of Health institution Staff respondents.

As for the patient age record survey, there was no significant age difference from the staff, even though majority of the patient were young people. The patients' age distribution were as follows; those aged between 18-24 years were 31.3% (n=77), 25-34 years were 23.3% (n=57), while 35-44 years were 28.9%

(n=71), those between 45-54 years were 14.6% (n=36) and those between 55-64 years, 65-74 years were 0.4% (n=1) and 1.6% (n=4) respectively as shown in figures 4.1 and 4.2.

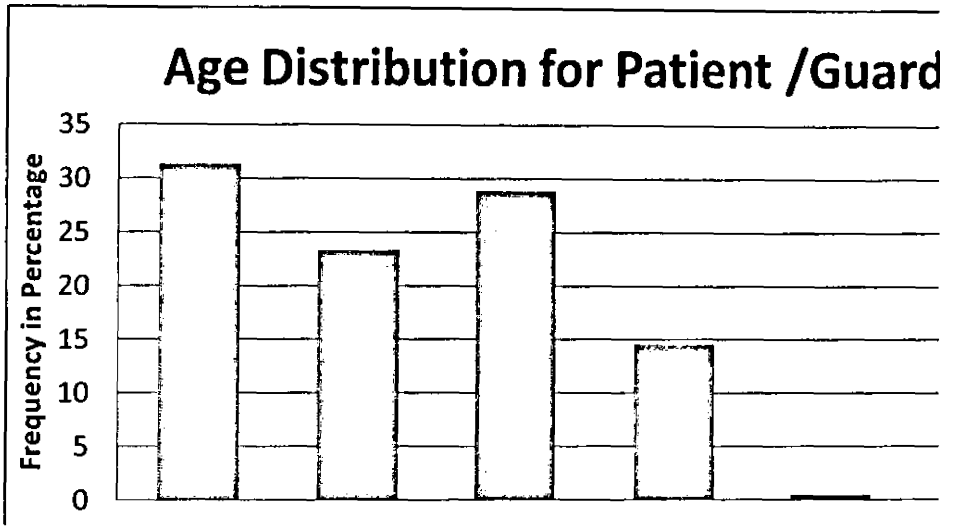

Figure 4.2 showing the Age Distribution of Patient/Guardian respondents.

4.1.2. Highest level of education

In this study, 38.6% (n = 88) of the respondents had Certificate level of education, 51.8% (n = 118) had Diploma education, 6.1% (n = 14) had Higher Diploma education, 0.9% (n = 2) had Bachelors Degree education while 2.2% (n = 5) had Masters Degrees. One Respondent 0.4% had Doctorate Degree level of Education.

4.1.3. Occupation of the sampled population

Majority of the sampled population were health record clerks and quite a big number were Clinical Officers. However, the study established that other professionals were there. The findings were as indicated in the table below:

Table 4.1 showing the job positions of the Sampled Population

Position in the Health Service	Frequency	Percentage
Enrolled Community Nurses	6	2.6
Kenya Registered Nurses	2	0.9
Kenya Registered Nurse/Midwife	1	0.4
Kenya Registered Community Health Nurses	32	14.1
Clinical officers	47	20.7
Doctors	4	1.8
Pharmacists	23	10.1
HRIOs	2	0.9
MROs	1	0.4
Health Record Clerks	58	25.6
Clinical Laboratory Technologists	17	7.5
Clinical Laboratory Technician	32	14.1
Others	2	0.9
Total	**228**	**100**

(N = 228)

4.1.4. The Departments the Researcher interviewed the Staff.

The study was carried out in several departments within these Health institutions in Nairobi Province, which included Pediatrics department, Medicine, Surgery, Obstetrics/Gynecology, Specialized outpatient, General Outpatient. Others included Laboratories, Health Records, and Information, pharmacies, Administrations and Others. The findings of this study indicated that most respondents were from General Outpatient department at 36.8% (n=84), followed by the Health Records and Information department 26.3% (n=60), Laboratories 21.9% (n=50) and pharmacies 10.1% (n=23) respectively as shown in the Table 4.2 below:

Table 4.2 showing the Departments the Researcher interviewed the Staff.

Name of the Department	Frequency	Percentage
Pediatrics	1	0.4
Medicine	1	0.4
Surgery	1	0.4
Obstetrics/Gynecology	3	1.3
Specialized Outpatient	1	0.4
General Outpatient	84	36.8
Laboratory	50	21.9
Health Records and Information	60	26.3
Pharmacy	23	10.1
Administration	1	0.4
Others	3	1.3
Total	**228**	**100**

(N = 228)

4.1.5. The Departments where the Patients met the Researcher

The researcher met the patients in several departments within these Health institutions in Nairobi Province, which included Pediatrics department, Medicine, Surgery, Obstetrics/Gynecology, Specialized outpatient, General Outpatient. Others included Laboratories, Health Records, and Information, pharmacies, Administrations, Radiography, physiotherapy, and Hospital finance. The statistics of the findings is as tabulated in the table 4.3 below:

Table 4.3 showing the Departments where the Patients met the Researcher

Name of the department	Frequency	Percentage
Pediatric	5	2.1
Medicine	6	2.5
Surgery	5	2.1
Obstetrics/Gynecology	5	2.1
Specialized Outpatient	2	0.8
General Outpatient	81	33.9
Physiotherapy	1	0.4
Radiography	10	4.2
Laboratory	38	15.9
Psychiatry	1	0.4
Health Records and Information	29	12.1
Pharmacy	34	14.2
Hospital Finance	6	2.5
Administration	8	3.3
Others	8	3.3
Total	**228**	**100**

The Study generally showed that the Departments of General Outpatient, Laboratories, Health Records and Information, and Pharmacy were the major areas with many respondents.

4.1.6. Type of health facility

The study revealed that different types of health facilities were found in Nairobi province. These facilities included dental clinics, which were 0.4% (n=1), Dispensaries were 31.7% (n=71), Health Centers 26.8% (n=60), Medical Clinics 26.4% (n=55), Nursing Homes with maternity were 5.4% (n=12), Primary Hospitals 6.3% (n=14), Tertiary Hospitals 1.8% (n=4), VCT (stand-alone) 2.7% (n=6). The dispensaries, Health centers, and Medical clinics respectively were the most common health facilities the researcher found; these findings were as indicated in figure 4.3 below:

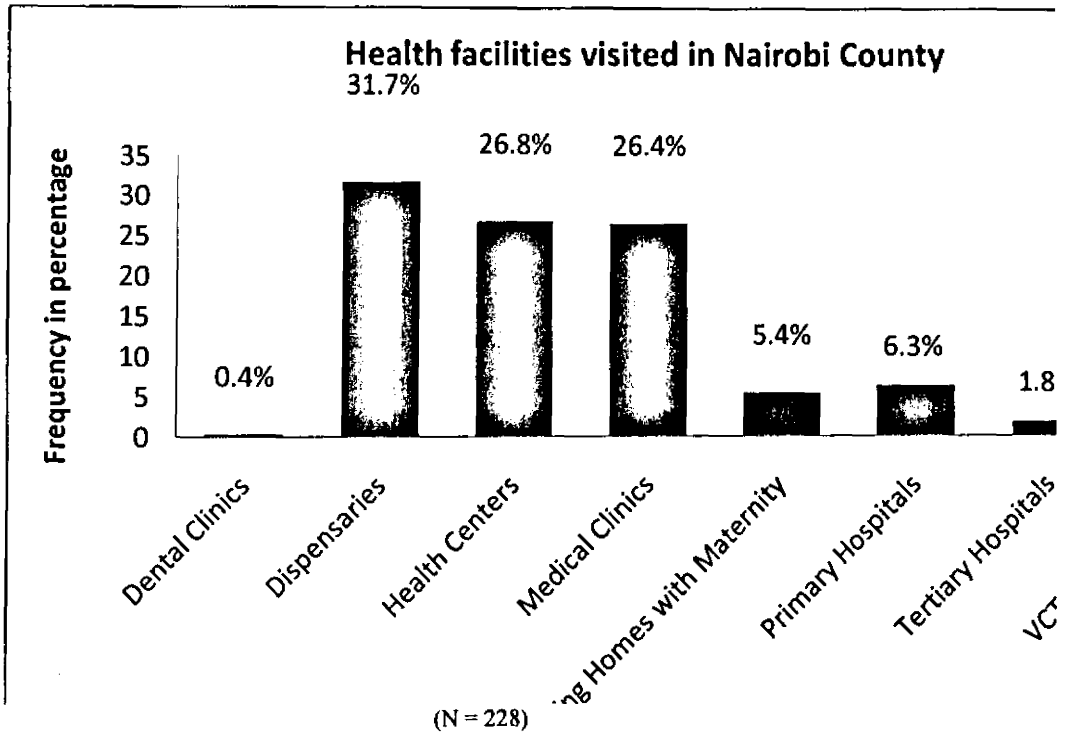

Figure 4.3 Showing health facilities the researcher visited in Nairobi Province

4.1.7. Facility owners

The researcher carried out study on health institutions owned by different entities, which, included; Kenya Episcopal Conference Catholic Secretariat, Other faith-based institutions, Local Authorities Ministry of Health, other public institutions, Non-Governmental Organizations, Private Medical enterprises, other private institutions, and Parastatals health institutions. Majority of the respondents were from Private health Institution at 39.5%, then followed by Local Authority owned institutions 25.4% , Ministry of health had 11.8% of the respondents and other Faith-Based Organizations being 10.5% as shown in table 4.4 below.

Table 4.4 showing the Health facility Ownership Distribution.

Name of the Facility Owner	Frequency	Percentage
Kenya Episcopal Conference Catholic Secretariat	8	3.5
Other Faith-based Organizations	24	10.5
Local Authority	58	25.4
Ministry of Health	27	11.8
Other Public Institutions	3	1.3
Non-Governmental Organizations	10	4.4
Private Medical Enterprises	2	0.9
Other Private Institutions	90	39.5
Parastatals	6	2.6
Total	**228**	**100**

(N = 228)

4.2. Current State of ICT usage

4.2.1. Results

The awareness of Computer Usage by Patients/Guardians

The study revealed that of the 246 respondents who met the researcher in these health facilities apart from the members of staff, 89.0% were patients while 11.0% were guardians. In terms of whether these respondents both patients and guardians were aware of computer usage by these health institutions, only 38.2% (n=94) were aware and 58.5% (n=144) were not aware even though 3.3% (n=8) of the respondents either declined to respond or were non-committal.

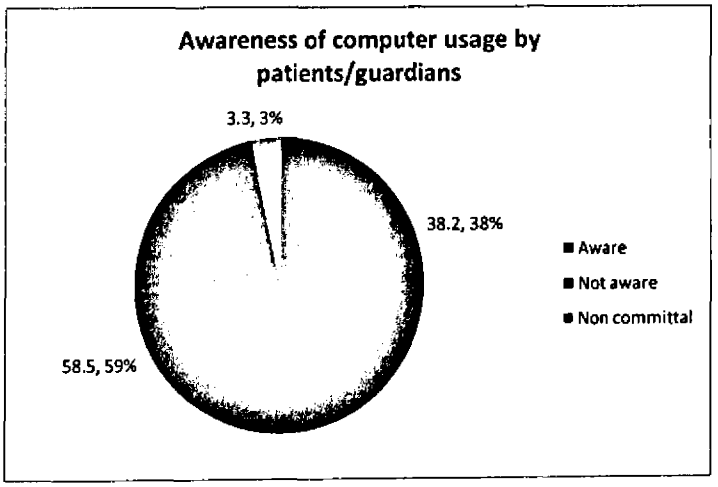

Figure 4.3 showing the awareness of Computer Usage by Patients/Guardians

Awareness of Computer Usage by Hospital Administrators, Heads of Facilities, and Heads of departments

As for the Hospital administrators, Head of the facilities and Head of departments, all the respondents acknowledged awareness of usage of computers in the Health sector, even though only 25% had computers used in their departments while 75% did not have computers in their department.

The patients/guardians, who were aware of usage of computers in various departments, gave their response as tabulated in table 4.5 below.

Table 4.5 showing the percentage of patient/Guardian's awareness level of computer usage in various Departments

Departments Computers are used	Aware	Not Aware	Not Sure
Pediatric	35.7%	16.1%	48.2%
Medicine	48.5%	12.1%	39.4%
Surgery	66.7%	15.0	18.3%
Obstetrics/Gynecology	40.0%	10.9%	49.1%
Specialized Outpatient	43.1%	10.3%	46.6%
General Outpatient	47.5%	18.0%	34.4%
Physiotherapy	35.8%	22.6%	41.5%
Radiography	75.0%	8.9%	16.1%
Laboratory	75.8%	12.1%	12.1%
Psychiatry	30.0%	26.0%	44.0%
Health Records and Information	72.6%	9.7%	17.7%
Pharmacy	71.9%	10.9%	17.2%
Hospital Finance	97.2%	1.4%	1.4%
Administration	79.1%	7.5%	13.4%
General Stores	55.9%	11.9%	32.2%

The study findings revealed that 46.7% of these respondents, who were aware of computer usage in various departments, did visit these health institutions when there were no computers while 53.3% visited when there were computers. In terms of service delivery, 96.7% of the respondents who found computers in these health institutions agreed that computers had improved services in these departments, while only 3.3% disapproved the same.

From the patient/Guardian perspective, computers improved service delivery in various departments as tabulated in table 4.6 below.

Table 4.6 showing the departments, which service delivery improved by Patient/Guardian.

Improved department Service delivery	Frequency	Percentage
Surgery	3	3.1
Specialized Outpatient	2	2.1
General Outpatient	9	9.3
Radiography	2	2.1
Laboratory	11	11.3
Health Records and Information	7	7.2
Pharmacy	13	13.4
Hospital Finance	40	41.2
Administration	10	10.3

The hospital Administrators, Heads of Facilities and Heads of departments indicated the departments where computers were used as Pharmacy, Laboratory, Administration, Radiography and Hospital Finance. Figure 4.4 below illustrates these findings.

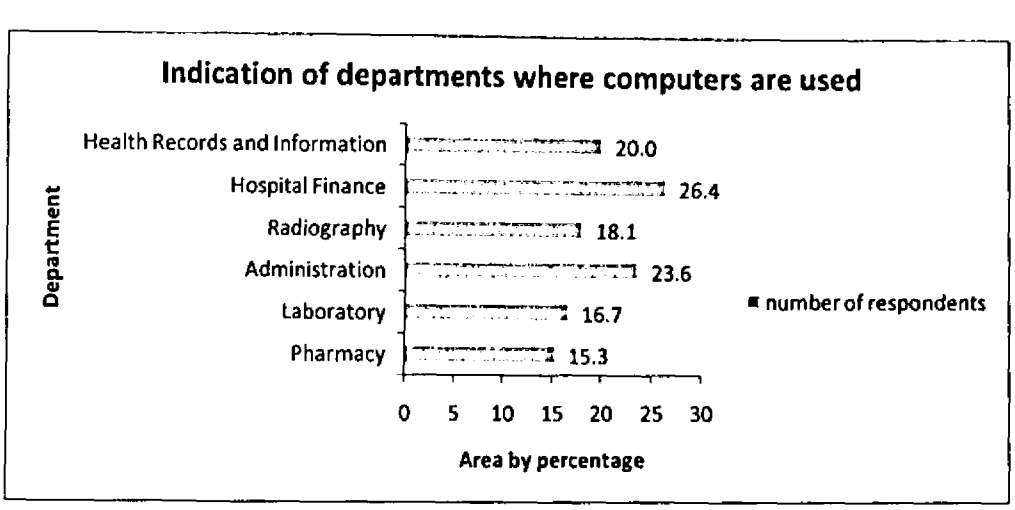

Figure 4.4 showing Hospital Administrators, Heads of Facilities, and Heads of departments indications of the departments where computers were used.

4.2.2. Evaluation

From the patient/Guardian perspective, computers improved service delivery greatest in the hospital finance department followed by pharmacy and laboratory in that order. This indicates that hospital finance is the department where patients/guardians mainly get express service directly from hospital staff through the use of computers. They hardly encounter use of computers in majority of other departments such as Health Records and Information, Surgery, Specialized Outpatient, General Outpatient, Radiography and health data/information departments.

From the Hospital Administrators, Heads of Facilities, and Heads of departments' perspective, areas in the departments where computers were used include data collection, data storage, data retrieval, and data analysis. This is a clear indication that most computer operations in hospitals are done by clerical and administrative staff for financial administrative activities. This further shows that there is a high level of awareness amongst administrative staff on the use of computers and very low level of awareness amongst heath service providers such as doctors, clinical officers and nurses.

4.3. *Current Application of ICT Tools*

4.3.1. Results

The respondents were asked to indicate the form in which they interacted with the patients, record patients' data and the mode in which they shared patient data within a hospital and between hospitals.

In terms of application of ICT tools, the study established that 25.4% of Doctors, Pharmacists, Clinical Officers, Nurses, and Clinical Laboratory Technicians interacted with their patients over the telephone calls, while 99.6% interacted face to face with the patients. This implies that the use of ICT tools is not yet embraced in these health institutions in terms of doctor-patient interaction.

In recording patients' data, 97.3% of the sampled respondents recorded patients' data on Clinical registers as no electronics register was established even though 2.7% declined to respond. From the research findings, 96.1% of both the health service providers and health records staff acknowledged sharing medical information within and between hospitals while only 3.9% did not share. They shared patients' health data due to the following reasons:

- The rules require that patients' medical records are passed to clinical officers, to the laboratory then to the pharmacist for drugs
- To allow fellow workmates to confirm some reports particularly therapeutic reports.
- Through referrals of patients from one service delivery point to the other e.g. from laboratory to clinician.
- They shared particularly reports drawn at the end of the shift.

For those who did not share the patients' medical information, it was because the patients' records should be left to the health professionals, qualified health data/information officers and any other cadre should seek for assistance from health information systems, as patients' information should be confidential. From this study, it was established that there was minimal use of computer application programs. Application programs found to be used include the following; Ms-access, Ms-Excel, Ms-word, FTP, GIS, health CIS, Care2000-ERP, and e- Hospital.

4.3.2. Evaluation

The results from the survey showed that handling of patient information by all respondents and all departments is purely manual, resulting to physical files as the only mode of storage.

Most of the software reported in the survey was available only in rich private institutions where the software are used mainly for financial and administrative activities but not for improving health care delivery. The FTP system that is available at all the district DHRIO offices is used for transmitting health data directly to the ministry of health HMIS. The GIS (Geographical Information System) is also available in all health district DHRIO offices is used for mapping health facilities to the GIS. It is specifically used to capture longitudinal, latitude and distance between facilities. It was piloted in year 2009 in selected health districts in Kenya but is now fully operational in all health districts. The other and more recent application is the Health data management and verification tool whose function is to verify data generated at the health facility kevel and the summarized data at the district level. It is able to generate summarized charts which show discrepancies between the two data sets (i.e. primary and secondary summaries). The tool is not operational yet.

4.4. Existing ICT Infrastructure

4.4.1. Results

From this study, it was established that ICT tools like laptops, Desktops, Servers, Printers, PDAs and Mobiles Phones were in use in the health facilities.

The figure 4.5 below shows the percentage of respondents (Hospital administrators, Heads of Facilities and Heads of Departments) who reported availability of ICT tools in the health institutions.. 24.1% (N=58) of the respondents reported availability pf Desktops and printers equally. Only 1.8% (N=4) of respondents reported availability of laptops and servers in the health institutions. 2.2% (N=5) reported availability of PDAs and mobile phones in the health facilities.

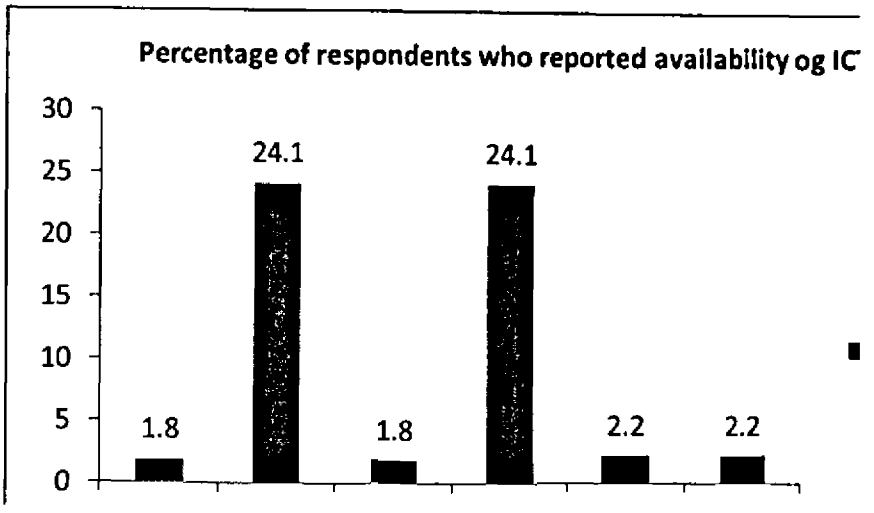

Fig 4.5 Number of respondents who reported availability of ICT tools

97.8% of the Hospital administrators, Heads of Facilities and Heads of Departments admitted that there was no operational LAN in place as only 2.2% agreed to this effect. In that regard, there were no Internet accesses as no respondents had internet connections.

4.4.2. Evaluation

Overall, equipment numbers for Laptops, Servers, PDAs and mobile phones is very low and unevenly distributed. It is revealed that there are very few ICT equipments available for use in the health facilities. Computers available at the district level are used for the HMIS function of collating data at the district level and reporting. PDAs are also available at all health districts and are used by District TB and Lepplosy Coordinators (DTLC) to capture data as it appears in the registers. It was reported that Kenya Extended Programme on Immunization (KEPI) has instituted data transfer mechanism using cell phones to send vaccine stock balances from health districts to its offices in the Ministry. KEPI is supposed to support the sending of data by offering airtime. The current scenario as reported is that sustainability is not guaranteed every month thus prejudicing the reporting process. DHRIOs use their own mobile phones to carry out this exercise.

The current mode of connectivity between the District Records and HMIS headquarters is through wireless telephone equipment provided by HMIS. It was reported that HMIS supplied safaricon modems for use in transferring data and the districts were supposed to sustain the cost of sending data through FTP. In cases where financing not available, DHRIOs resort to using cybercafés to access internet at their own cost.

4.5. Individual staff/respondent satisfaction with the applications

4.5.1. Results

The level of individual satisfaction with the system used to handle patient information was tested in terms of content, accuracy, format, ease of use and timeliness. The ordinal measure used was never, seldom, about half the time, most of the time or always. The findings were as indicated in the tables below:

Table 4.7 showing the level of satisfaction on Content of the application

Content	Seldom	Half of the Time	Most of the time
How often the information content meet their needs.	0%	8.6%	91.4%
How often the system provided reports that seem to exactly they needed	3.4%	50.0%	46.6%
How often the system provided sufficient information	1.7%	12.1%	86.2%

Table 4.8 showing the level of satisfaction on Accuracy of the application

Accuracy	Seldom	Half of the Time	Most of the time
How often the system was accurate	0%	8.6%	91.4%
How often they were satisfied with the accuracy of the system	3.4%	51.7%	44.8%
How often the system was accurate	3.4%	13.8%	82.8%

Table 4.9 showing the level of satisfaction on Format of the application

Format	Seldom	Half of the Time	Most of the time
How often the output was presented in a useful format	8.6%	12.1%	79.3%
How often the information was clear	5.2%	8.1%	79.3%

Table 4.10 showing the level of satisfaction on Easiness to use on the application

Easy to use	Seldom	Half of the Time	Most of the time
How often the system was user-friendly	32.8%	8.6%	58.6%
How often system was easy to use	3.5%	43.9%	52.6%

Table 4.11 showing the level of satisfaction on Timeliness of the application

Timeliness	Never	Seldom	Half of the Time	Most of the time
How often the information needed was got in time	32.8%	3.4%	60.3%	3.4%
How often up to date Information was provided	0.0%	32.8%	60.3%	6.9%

4.5.2. Evaluation

The results of survey in this section generally indicated that use of electronic systems would provide effectiveness and efficiency in health care delivery.

In terms of content, accuracy and format, it was revealed that electronic system met the needs of the users by providing sufficient and accurate information in the correct format. This indicated that electronic systems improved analysis and information presentation to facilitate data interpretation and use for decision-making. This could be for the reason that Graphs, tables, and charts can be created using software applications.

Approximately half of the respondents agreed to ease of use and user friendliness of the system most of the time. This may be attributed to lack of technical skills among the respondents.

In terms of how up to date information needed was got in time, the results of this study indicated half of the respondents were moderately satisfied. This could be as a result of poor maintenance of both hardware and software resulting slowness or breakdown of the system.

4.6. Barriers to ICT adoption and use

4.6.1. Results

The study was carried out to establish the barriers to adoption of electronic health management information system. The findings were in terms of whether the provided options were no barriers, Minor barriers, Major barriers or whether the respondent did not know as indicated below:

Table 4.12 showing barriers to ICT adoption and use

Barriers	Not a barrier	Minor barrier	Major barrier	Do not know
Amount of capital needed to purchase and implement an Electronic Health Management Information System	12.8%	30.1%	54.9%	2.2%
Uncertainty about the return on Investment (ROI) from a Health	27.2%	39.9%	24.6%	8.3%

Information System				
Concerns about the ongoing cost of maintaining a health information System	17.5%	38.6%	32.0%	11.8%
Resistance to implementation From other health care providers (e.g. Nurse, Doctor, Physiotherapists')	14.5%	40.4%	41.7%	3.5%
Lack of capacity to select, contract for, and implement an Electronics Public Health Information System	10.1%	52.6%	35.1%	2.2%
Lack of adequate IT staff	3.1%	42.5%	49.6%	4.8%
Concerns about inappropriate disclosure of Patient Information	6.1%	39.0%	46.1%	8.8%
Concerns about illegal records tampering or hacking	18.4%	33.3%	43.9%	4.4%
Finding an Electronic public health information system system that meets your organization's needs	40.8%	29.8%	26.3%	3.1%
Concerns about a lack of future support vendors for upgrading and maintaining the system	33.2%	16.4%	46.0%	4.4%

4.6.2. Evaluation

From the findings, the report revealed that the three major barriers to overcome in order to implement electronic Patient Health Management Information system are amount of capital needed to purchase and implement an Electronic Health Management Information System, lack of adequate IT staff and concerns about inappropriate disclosure of Patient Information.

4.7. Suggestions for Improvement

From the study most of the respondents gave their suggestions on how there can be improvement in the management of health information system. They gave the following suggestions:

- Provide ICT systems in the departments that need the especially in the Laboratories
- Implement all the Barriers listed above
- Upgrade the existing systems to a suitable one due to expansion and modernizations
- More capital to purchase the equipments, computers, laptops, internet connections and for maintenance of equipments
- Capacity building of the staff members on computer application courses

- Computerization in all the departments to ease data entry, storage and data analysis as well as getting monthly reports in time.
- Provision of telephone line and opening of e-mail accounts.

4.8. Conclusion

The response rate of 63% with a total of 228 out of 360 respondents in health facilities in Nairobi province is a considerable response rate to substantiate the findings of the survey.

The overall findings of the survey show that it is feasible to deliver health care services electronically by implementing electronic public health information system. The level of sharing of patient information among the service providers in the various sections within and between health institutions is high thus justifying the need for a system. Majority of the service providers believe that quality of service was likely to improve through improved efficiency and effectiveness of care delivery while running costs of the service provision were likely to decrease.. it was found that telephone and mobile communication were the most commonly use ICT tools used in health care delivery by most of the health care service providers although a small percentage use E-mail/internet facility. Several issues were identified as most important barriers to overcome in order to achieve electronic health care delivery, amount of capital needed to purchase and implement an Electronic Health Management Information System, lack of adequate IT staff and concerns about inappropriate disclosure of Patient Information being the top most issues.

The next chapter presents the proposed EPHI model to aid care delivery in health institutions.

CHAPTER FIVE: PROPOSED FRAMEWORK

5.0. Introduction

This chapter critically evaluates the completed research project against research questions. A comparison of the final outputs of the project against the research questions of the research is carried out in order to assess how far they have been achieved.

In terms of application of ICT tools, the study established that 25.4% of Doctors, Pharmacists, Clinical Officers, Nurses, and Clinical Laboratory Technicians interacted with their patients over the telephone calls, while 99.6% interacted face to face with the patients. This implies that the use of ICT tools is not yet embraced in these health institutions in terms of doctor-patient interaction.

In recording patients' data, 97.3% of the sampled respondents recorded patients' data on Clinical registers as no electronics register was established even though 2.7% declined to respond. From the research findings, 96.1% of both the health service providers and health records staff acknowledged sharing medical information within and between hospitals while only 3.9% did not share. They shared patients' health data due to the following reasons:

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- To allow fellow workmates to confirm some reports particularly therapeutic reports.
- Through referrals of patients from one service delivery point to the other e.g. from laboratory to clinician.
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For those who did not share the patients' medical information, it was because the patients' records should be left to the health professionals, qualified health data/information officers and any other cadre should seek for assistance from health information systems, as patients' information should be confidential.

From this study, it was established that there was minimal use of computer application programs. Application programs found to be used include the following; Ms-access, Ms-Excel, Ms-word, FTP, GIS, health CIS, Care2000-ERP, and e- Hospital.

The results from the survey showed that handling of patient information by all respondents and all departments is purely manual, resulting to physical files as the only mode of storage.

Most of the software reported in the survey was available only in rich private institutions where the software are used mainly for financial and administrative activities but not for improving health care delivery. The FTP system that is available at all the district DHRIO offices is used for transmitting health data directly to the ministry of health HMIS. The GIS (Geographical Information System) is also available in all health district DHRIO offices is used for mapping health facilities to the GIS. It is specifically used to capture longitudinal, latitude and distance between facilities. It was piloted in year 2009 in selected health districts in Kenya but is now fully operational in all health districts. The other and more recent application is the Health data management and verification tool whose function is to verify data generated at the health facility kevel and the summarized data at the district level. It is able to generate summarized charts which show discrepancies between the two data sets (i.e. primary and secondary summaries). The tool is not operational yet.

As per the results of the survey findings, it was observed that so far, Kenya public healthcare service does not possess an integrated EPR system. Although some healthcare institutions are computerized, the data is

generally only used internally and their electronic accessibility does not cross the boundaries of the healthcare institution where they are generated. The private clinics also have computerized information systems for internal uses.

As can be seen from the above there is need for a lot of movement of patient data from one healthcare institution to another. In view of this, a nation-wide EPR has been proposed whose benefits are far beyond emergency room treatment. Such a system will generally provide one consistent set of data for each patient at whichever hospital the data is being used or updated. In view of the survey results described hereof and the review on the existing models for handling patient health data, the researcher has proposed improvement on the Conceptual Model of Integrated HMIS. Source: Final HMIS software report, UNES (2009) illustrated in Figure 2.15.

Observation made was that users are primarily interested in information processing applications, which they may own or gain access to as end-users via communications networks.

These services are 'enabled' by other underlying, transparent services provided by information and network service providers. In view of this, the researcher suggested improvement of the reviewed conceptual model by including a middleware services component (as shown in the figure 5.1 below) that will enable knowledge discovery. Middleware services that support the development of the Integrated-Electronic Health Records are

- Directory services
- Security services
- Terminology services

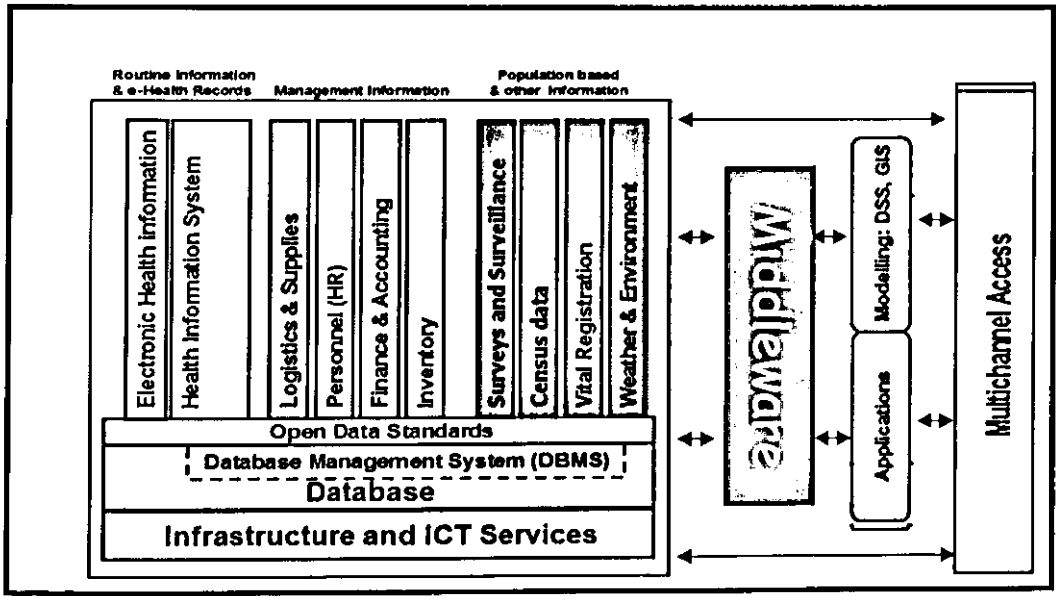

Figure 5.1 Suggested Conceptual Model of Integrated HMIS.

The researcher selected Electronic health information component of the conceptual model of integrated HMIS as the main research area and based on reviews made on the various e-referrals models as depicted in the literature review and the survey carried out in health institutions in Nairobi province, it was found that it is feasible to deliver referrals electronically. If e-referral system is implemented, Quality of service was likely to improve through improved efficiency and effectiveness of care delivery while running costs

of service provision were likely to decrease. In view of this a patient e-referral has been proposed as illustrated in figure 5.2 below.

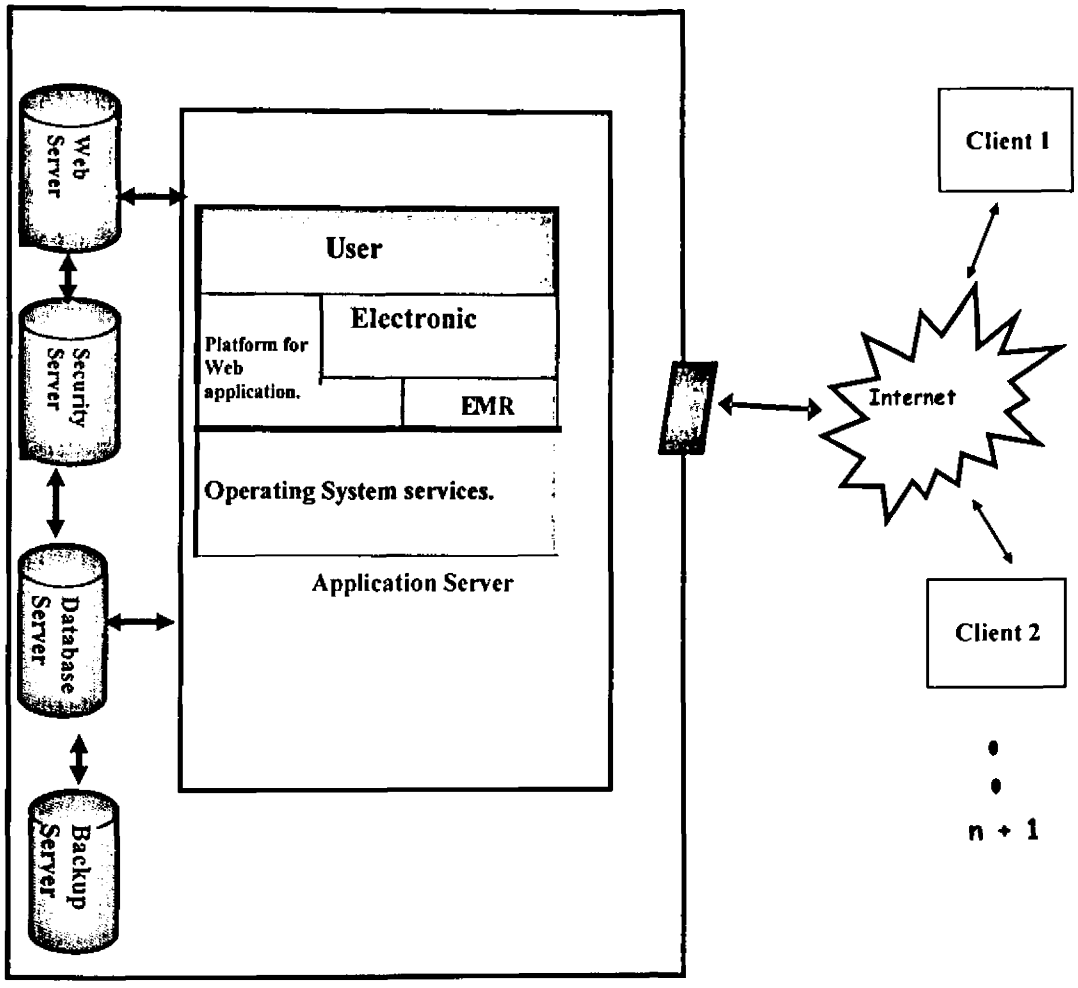

Figure 5.2: proposed ereferral framework.

5.1. e-referral framework components

The proposed system is a web application. The application is divided into 3 layers: user interface, components, and operating system. In the components layer, EMR is the foundation on which e-referral and a user interface is built. EMR manage user accounts, messaging, auditing, and patient data. e-referral component manages the referral process. A referral can be in one of the following states: in the process of being created by a health facility, waiting for action by a specialist, referred, or directed to alternative treatment. The user interface layer is based on a platform for web applications through which specialists can log in and be authenticated in EMR and ereferral components. The web application platform accesses the database, collects the requested data, forms the response in a suitable format and forwards it back to user

5.2. Patient application to different hospitals.

In the proposed model, the client is introduced to the system with a unique patient key. Unique patient key is distributed by a central system in response to patient's application. It is assumed that the patient always applies with this given key. If the patient has never been registered before, then an online registration process is initiated at the health facility where he/she first visits. Upon successful registration a unique patient key is given, and the corresponding demographic information is stored in the central server. It is assumed that all referring health facilities must be registered to use the online ereferral system to refer their patient for specialized services. The patient will not be able to get any specialized service unless his/her application is entered into the online system. This will help prevent cases of self referrals.

5.3. e-referral transaction sequences.

1. The specialist clinician at the referring health facility logs in to the web-based referral system, fills in a referral form and submits it to the health institution offering specialized services.
2. Each participating health institution offering specialized services has a designated specialist clinician with dedicated time to review and respond to all referral requests. The clinician reviews patients' referrals and sorts the referrals according to the type of problem, severity, geography, and other attributes. The reviewer can send messages using the online system to ask for additional information and to schedule an appointment with a specialist, or forward the referral request to another specialist in another health facility offering specialized services .
3. The electronic referral system is tightly integrated with the specialized health facility EMR so that all information exchange is documented in the patient's chart in real time. With an EMR in place, connections can be made to remote health facilities in different locations over a high sped wide area network (WAN), so that the detailed information of the patient such as the treatments undergone, medicines, analyses and radiology images are obtained. The information in the remote health facilities is read-only to the outside. No changes are allowed to be made to the records of the accessed patient data in the remote health facilities offering specialized services .

eReferral system connectivity

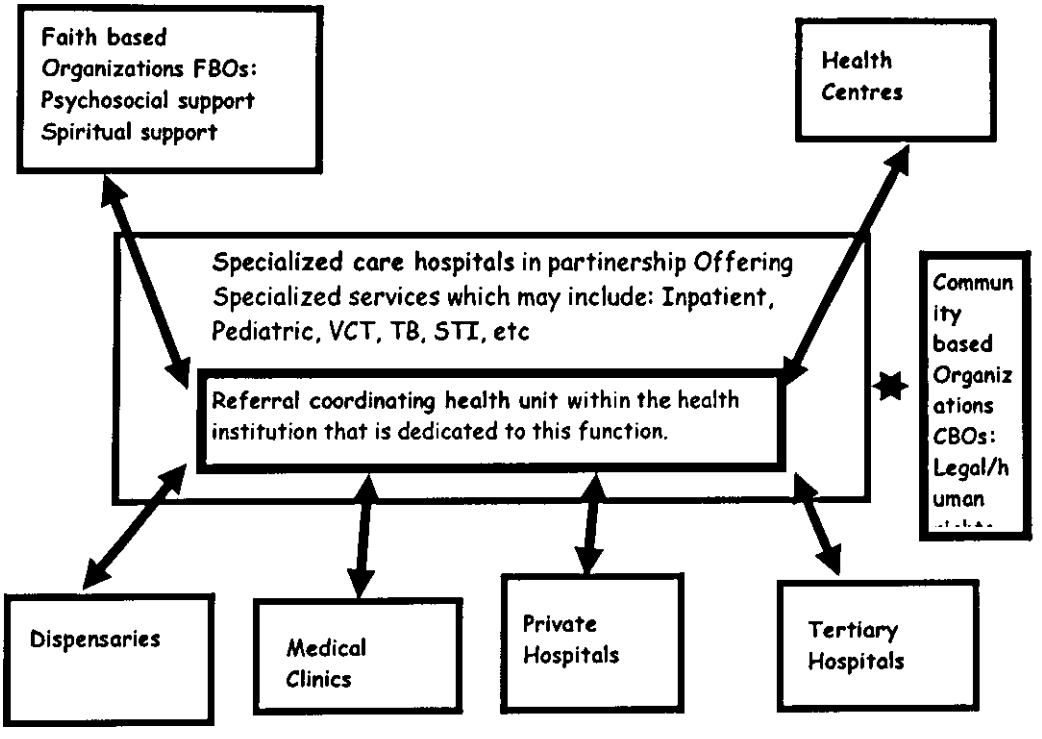

Figure 5.3: proposed eReferral system connectivity.

5.4. Building blocks of an Electronic Referral system

1. **A group of health institutions that, in the aggregate, provide specialized services to meet the needs of patients within a defined geographic area e.g. Nairobi Province.**

The needs of clients span the continuum of care, encompassing the medical/nursing, psychosocial, economic, legal and spiritual domains. To effectively address these needs, the ereferral system must include as broad a range of services as possible.

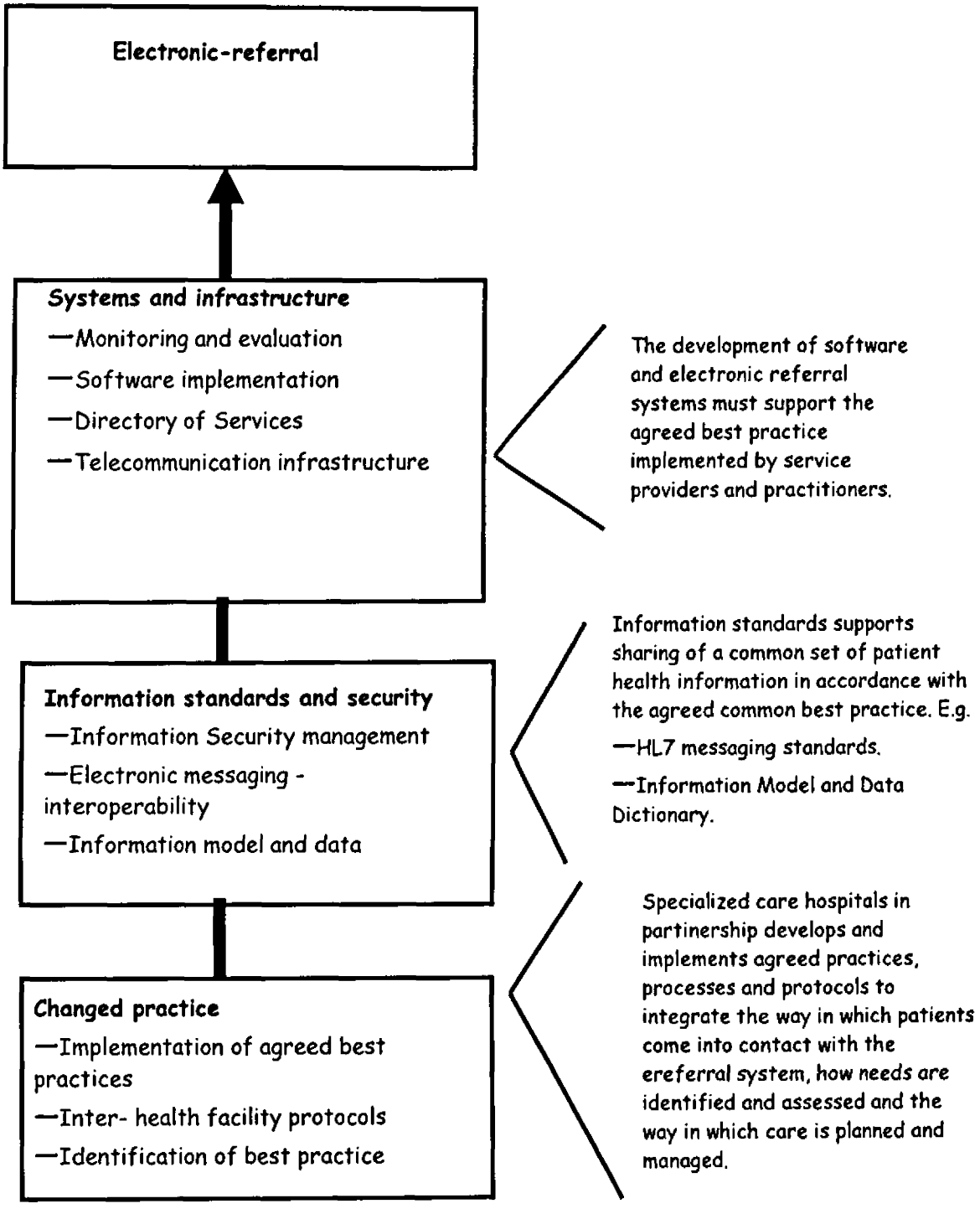

Figure 5.4: Proposed ereferral building blocks.

2. **A health unit that coordinates and oversees the whole ereferral system.**

A specific health facility in the system serves as the locus of responsibility for the system and its performance (in addition to its regular duties). This coordinating function is performed by a health institution, preferably a coordinating unit within the health institution that is dedicated to this function. The primary functions of the coordinating unit include convening regular meetings of providers of specialized services, working with providers to address gaps and other inefficiencies in the system, updating the directory, providing standardized forms, and performing quality assurance for the referral system. At the coordinating unit, there is a specific person designated to fulfill the task of coordination.

3. **Periodic meetings of specialized care providers.**

Regular meetings of health institutions in the network provide a venue for ongoing communication, exchange of information about the referral process, discussion of challenges and gaps in service, and updating the service network directory. The coordinating organization/unit convenes these meetings.The regular meetings promote collaboration and commitment to the referral process as an essential component of service delivery

4. **Designated referral person(s) at each health institution offering specialized service.**

This designated person has responsibility for processing ereferrals efficiently and expeditiously. He/she is also responsible for managing core ereferral activities, such as tracking and documenting ereferrals.This designated person helps patients gain access to needed services. This designated person could be a health specialist.

5. **A directory of services.**

A directory provides an inventory of services available within a geographical area, including the name of the health institution, the type of service provided, the referral contact person(s) and the location of the service. A directory of services facilitates referrals by making it easy to get information on available services in the geographic area. A directory needs to be constantly updated to ensure that information on service providers is current and accurate, new providers are included and providers no longer offering a service are deleted. The directory is managed by the coordinating health unit.

6. **A standardized electronic referral form.**

An electronic referral form that is standardized throughout the system ensures that the same essential information is provided whenever a referral is initiated and that this information is received by the receiving health facility fulfilling the referral. An electronic referral form is filled in and electronically transmitted to the receiving health facility. It introduces the person being referred to the organization fulfilling the referral and identifies the health facility and person initiating the request. It also indicates which services the patient needs.

7. **A feedback loop to track referrals.**

A system to track a referral from point of initiation to point of delivery and, as a feedback loop, from point of service delivery back to point of initiation will be needed to ensure that the patient used the service (s) needed. This feedback provides evidence that the electronic referral process was completed and the service was delivered, and it can note whether there were problems. This information flow is shown in figure 6 below.

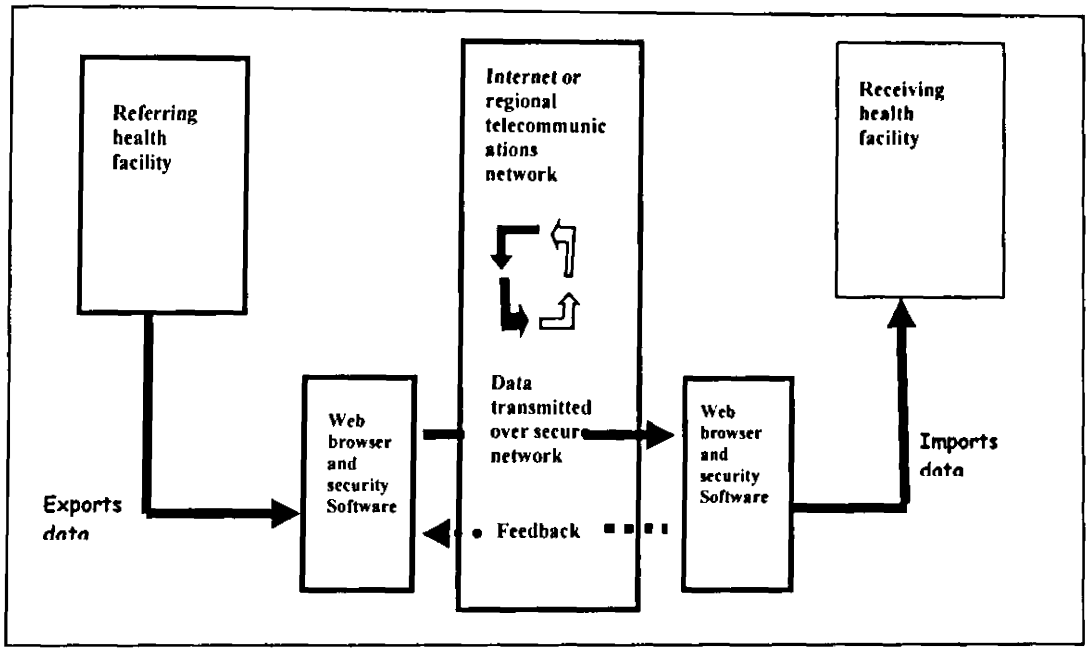

Figure 5.5: Information flow

8. Documentation of referral.

At both ends of the referral (referring health facility and receiving health facility), a record of the referral is needed to document their respective roles in the referral process. A standardized ereferral register is one way to document referrals.

9. Tools to facilitate the electronic Referral Process

Different electronic forms and tools such as: A directory of services, ereferral forms, e-tracking forms and ereferral registers should be standardized to promote accuracy, efficiency and consistency.

10. Health information Security management

Have access control functions that limit access to health data to selected individuals, based on defined and document roles Maintain detailed audit trails of all events within the EMR system, Follow defined standard practices on logins and passwords , Ensure data protection by meeting requirements regarding data backup, recovery and documentation of systems, Incorporate technical security functions in line with requirements regarding encryption and data transmission. The ereferral system must have in-built security controls including: Access Control, Audit Trails, Back up procedures and Data Validation

Access Control

This is a system of controlling entry and use of the ereferral system, in part or in its entirety. Depending on one's assigned roles and responsibilities, access can be limited to specific areas such as reports or the performance of specific functions such as viewing, editing or deleting patient data. ereferral systems must provide a means to authenticate user identity using a user name and password before enabling the user to perform any functions. The length of the password shall be enforced by the system. The system shall automatically enforce the regular changing of passwords.

Audit trails

The ereferral system must log audit trails as evidence of user transactions within the system. Audit trail records should be captured for all levels of access. These records, at a minimum, must include the

following: Date and time of the event, User ID or name, Type of event and the success or failure of that event, Defined significant security events must be logged and include: Multiple failed logons; Access at unusual times or from unusual locations, Sudden unexpected increases in volume, Significant computer system events (e.g., configuration updates, system crashes), Audit logs will be reviewed frequently to allow detection of unauthorized events before a significant loss has occurred.

Back up procedures

Backup is the procedure for making extra copies of data that can be called on in the event that the original data is either lost or damaged. Backup of ereferral data should be automated within the system wherever possible to ensure consistency.

Data Validation

Ereferral systems must have in-built data validation functions to ensure accurate and reliable data.

11. Monitoring and Evaluation of electronic Referral Networks

Monitoring and evaluation activities provide essential information for assessing the extent to which the system is achieving its intended objectives, provides feedback for quality assurance and for informing the planning, design and implementation of future services. Some illustrative indicators for monitoring and evaluating referral systems are as follows:

- Total number of electronic referrals made.
- Number of follow-up referrals made.
- Number of electronic referrals made to which services.
- Number or percent of electronic referral services completed.
- Number or percent of clients who report their needs were met.
- Number or percent of clients who report satisfaction with electronic referral process.

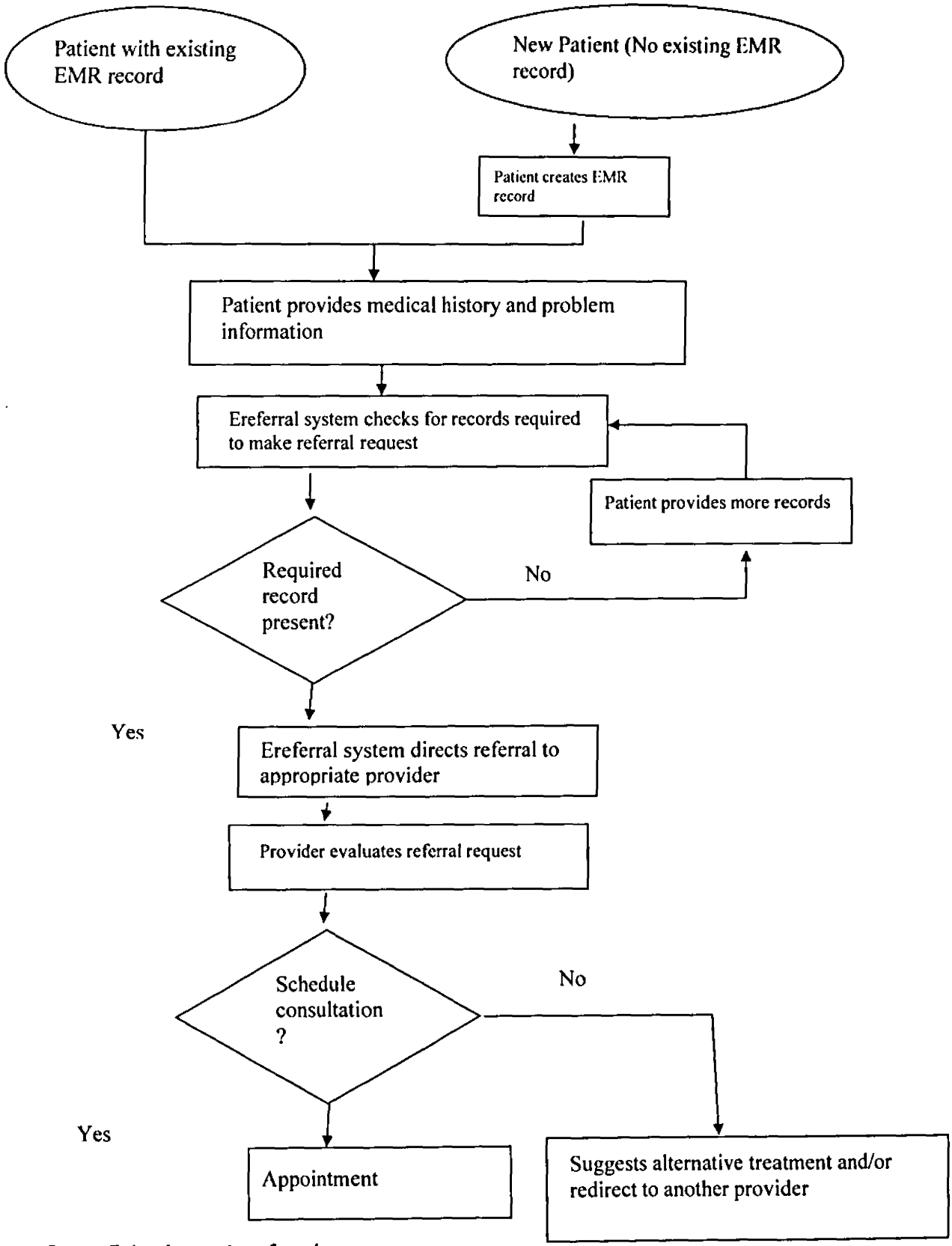

Figure 5.6. electronic referral process.

CHAPTER SIX: RECOMMENDATIONS AND CONCLUSION

6.0. Introduction

This final chapter of the thesis summarizes the research carried out, the key findings and their implications. It also gives recommendations for further research in the area of electronic health care delivery. The research wad carried out in the area of utilization of ICTs in the health care industry, with particular focus on the development of a framework for electronic public health management information system. Health care industry offers a variety of services ranging from preventive to curative services. These service areas include consultation, Laboratory, Pharmacy, Wards, and radiology among others. Review of literature showed that varied ICT tools provide seamless health care services within and between health institutions. The main issues identified as the main barriers to adoption of electronic health care delivery are privacy, security, legistration, authentication and standards.

A survey of health institutions in Nairobi province was carried out to establish the current state of ICT use, needs and gaps in handling patient health data and information. Perception of healthcare providers towards adoption of ICT tools was also established. This survey was carried out using a structured questionnaire.

Section 6.1 of this chapter highlights the key findings from the research and their implications as well as recommendations from the research. Areas for further research are given in section 6.2

6.1. Recommendations

Evaluation of the health care delivery services showed that the organizational structure of health care services are similar in private and public sector, the difference being the resources used to deliver them. The state and local government structure was found to play an essential role in organizing the health care system. In Kenya, the health sector is composed of the public health system with the majority being the ministry of health (MOH) while Non governmental organizations (NGOs), Mission and private sector provide supplement services. The major categories of health care services are preventive and curative offered at levels based on the structure especially in public health system. There is no form of information system linking the health institutions and hence care continuity in case of referrals is not possible, thereby leading to inefficient, ineffective and costly delivery of the health care services.

Research into the strategic role of ICTs in health care delivery showed that a variety of technologies are in use within hospitals while geographically dispersed health centres are linked by telecommunication technologies. The commonly used ICT tools aiding capture, storage and retrieval of patient information are ERP, patient smart cards and PDAs while telemedicine provides remote health care services. Web and internet technologies were found to provide free health care information to patients without the need of seeing the physician. Usage of these technologies varies from hospital to hospital and more so from private to public hospitals. Governments are targeting electronic health care delivery with the starting point being national EPR system. Main barriers to electronic health care delivery include lack of standards, ICT infrastructure, costs, security, privacy and shortage of ICT staff. This has contributed to the slow uptake of ICTs in health care compared to other service delivery industries such as banking industry.

The survey carried out in health institutions in Nairobi province showed that it is feasible to deliver majority health care services electronically by implementing EPHMIS. Quality of service was likely to

improve through improved efficiency and effectiveness of care delivery while running costs of service provision were likely to decrease. It was found that cell phones was the only ICT tool currently in use for health care delivery by most of the service providers, with a very small percentage using E-mail/internet facility for care delivery.

The key opportunities for electronic health care delivery through integrated EPHMIS include the following:

- Improved and (better) integrated Hospital Management Information Systems will facilitate a bigger take-up of healthcare schemes by Kenyans (insurance or pre-paid). Standards would include:
  - Common patient identification
  - Common codes for medical treatment, drugs, tests and facilities
  - Improved referral systems and procedures
- Harmonization of interactions between hospitals and stakeholders for example insurance companies.
  - Common information repository on members shared by healthcare providers and stakeholders, in an on-line system.
- Institutions of higher learning and professional bodies have not yet taken up a leadership role in ICT but can step in to facilitate implementation of common ICT/Healthcare systems.

The findings from the research on the key challenges indicate the need to overcome the barriers to provide electronic health care delivery. There is need for international bodies to oversee issues pertaining to standards and legal as well as policies regarding privacy in the area of electronic health care delivery.

The review from the literature and the findings of the survey have enabled the development of an integrated EPHMIS model for providing accessibility of the patients' electronic file online by authorized health care providers in order to provide continuity of patient care as given in chapter 6 of this thesis. This model enables users to share a variety of diagnostic, treatment and laboratory data according to the need to know the principle in a hospital's inner cycle and query the system databases to obtain similar occurrences of a specific case which provides information that helps decision making process of medical personnel in hospitals. This model also provides accurate decision making support for all integrated hospitals by maintaining medical records dynamically, including medicine personnel's experience, with full participation of the end-users, in multi-vendor equipped environment over TCP/IP Network.

Hardware and software requirements for the implementation of this model are given. Suitability of this model for health care delivery electronically is also highlighted.

6.2. Constraint

Because of lack of funds, I selected those health facilities, which are located in the main roads and within short distances from each other as my case study sites, so that I could reach them with minimum costs.

6.3. Areas for further research

The findings of this research identified a number of risks involving electronic health care delivery, which include unauthorized access or power failure (Epinosa, 1998 & Smith and Eloff, 1999). Other hazards as listed by Ammenwerth et al, 2004 include functional errors of the system, unreliability, user-friendliness,

and environment not prepared adequately to changes in working processes among others. The other area of interest would be to look into strategies to bring onboard private practitioners.

6.4. Conclusion

The proposed framework provides a starting point for further work in solving the problem of inefficient referral system.

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APPENDIX 1: WORK PLAN AND RESEARCH PROJECT SCHEDULE

Activities	Time: 2009 - 2011				
	October /2009	November /2009	April-June /2010	July/2010 – April/2011	June /2011
Problem definition					
Proposal writing					
Proposal presentation					
Data collection					
Data analysis					
Writing findings report					
Final submission					

APPENDIX 2: BUDGET

ITEM	PARTICULAR	COSTS (in Ksh.)
Consumables	Pens, writing materials, Printing papers	11000
Bureau services	Photocopying Printing Typing and type setting Binding	10000 5000 6500 2000
Traveling expenses		5000
Reference materials	Books, magazines publications etc	10000
Research assistants	2@1200 each	2400
Internet cyber café	Browsing, emails, bulleting boards	4000
Airtime (calling expenses)		6000
software	Spss, office applications	10000
Hardware	Storage devices (flash disks)	3500
TOTALS		**75400**

APPENDIX 3: SURVEY INSTRUMENTS

PATIENT e-REFERRAL SYSTEM

SURVEY INSTRUMENT

Instructions:

1. *Please answer the following questions based on your current practice.*
2. *Be brief, clear and specific in your answers.*

SECTION A: GENERAL INFORMATION

1. What is the name of your Facility? _____

2. Please indicate the type of facility from the choices provided below.

Facility type		Facility owner	
□1	Dental Clinic	□1	Academic (if registered)
□2	Dispensary	□2	Armed Forces
□3	Health Centre	□3	Christian Health Association of Kenya
□4	Medical Clinic	□4	Kenya Episcopal Conference-Catholic Secretariat
□5	Nursing home with Maternity	□5	Other Faith Based
□6	Nursing home without Maternity	□6	Local Authority
□7	Primary Hospital	□7	Ministry of Health
□8	Tertiary Hospital	□8	Other Public Institution
□9	VCT Centre (Stand-Alone)	□9	Non-Governmental Organizations
□10	Rehabilitation Centre	□10	Private Medical Enterprise
□11	Other Health Facility, (Specify)_____	□11	Other Private
		□12	Parastatal
		□13	Prisons
		□14	Community

3. Please indicate your job position from the choices provided below.

□1	Enrolled community nurse	□10	HRIO
□2	Kenya registered nurse	□11	MRO
□3	Kenya registered midwife	□12	Health records clerk
□4	Kenya registered nurse/midwife	□13	Clinical laboratory technologist
□5	Kenya registered community health nurse	□14	Clinical laboratory technician
□6	Clinical officer	□15	Public health officer
□7	Physician	□16	Other, (specify) _____
□8	Doctor		
□9	Pharmacist		

4. What is your age?

Your Age range	
□1	18 to 24
□2	25 to 34
□3	35 to 44
□4	45 to 54
□5	55 to 64
□6	65 to 74
□7	75 or older

5. What is your gender?

Gender	
□1	male
□2	Female

6. Please indicate the name of your department from the choices provided below.

□1	Paediatric	□9	Laboratory
□2	Medicine	□10	Psychiatry
□3	Surgery	□11	Health records and information
□4	Obstetrics/gynaecology	□12	Pharmacy
□5	Specialized Outpatient	□13	Hospital finance
□6	General Outpatient	□14	Administration
□7	Physiotherapy	□15	General store
□8	Radiography	□16	Other, (specify) _____

7. What is your highest qualification level (formal training)?

□1	Certificate
□2	Diploma
□3	Higher Diploma
□4	Bachelors Degree
□5	Masters Degree
□6	Doctorate Degree
□7	Other, (specify) _____

SECTION B: CURRENT STATE OF ICT USAGE

To be filled by Hospital Administrator/Head of the facility/ Head of department.

8. Are you aware of usage of computers in the health sector? Yes □1 No □2
9. Are computers used in your department? Yes □1 No □2

10. If yes, in which area are the computers being used?

Area	Yes	No
a. Data collection	□1	□2
b. Data storage	□1	□2
c. Data retrieval	□1	□2
d. Data analysis	□1	□2
e. Point of sale	□1	□2
f. Pharmacy	□1	□2
g. Laboratory	□1	□2
h. Administration	□1	□2
i. Radiography	□1	□2
j. Hospital finance	□1	□2
k. Other, (specify_____	□1	□2

SECTION C: CURRENT APPLICATION OF ICT TOOLS

To be filled by the individual staff/respondent (Doctor, pharmacist, Clinical Officer, Nurse, Clinical laboratory technician)

11. How do you interact with your patient?
    i) Over Telephone call □1
    ii) Face - to - face □2
    iii) Other (please specify):
    _____

12. How do you record patients' data?
    i) On clinical registers □1
    ii) Electronically □2
    iii) Other (please specify):
    _____

13.
    a) Do you share patients' medical information within the hospital?
    Yes □1 No □2
    b) If yes, briefly specify the process._____
    _____
    _____
    c) If no, why?_____
    _____
    _____

14.

a) Do you share patients' medical information with another hospital in case of need?

Yes □1 No □2

b) If yes, how is it done?_____

_____

_____

_____

c) If no, what are the reasons?_____

_____

_____

_____

15. Do you have a specific application currently in use within your department?

	Department	Name of Application
1.	Pediatric	
2.	Medicine	
3.	Surgery	
4.	Obstetrics/gynecology	
5.	Specialized outpatient	
6.	General outpatient	
7.	Physiotherapy	
8.	Radiography	
9.	Laboratory	
10.	Psychiatry	
11.	Health records and information	
12.	Pharmacy	
13.	Hospital finance	
14.	Administration	
15.	General store	
16.	Other, (specify)_____	

SECTION D: EXISTING ICT INFRASTRUCTURE

To be filled by Hospital administrator/Head of facility/Head of department/IT Officer.

16. Indicate the number of functional ICT tools available in your department.

	Name of ICT tool	**Number available**
1.	Laptops	
2.	Desktop	
3.	Servers	
4.	Printers	
5.	PDAs	
6.	Mobile Phones	
7.	Other (please specify):_____	

17. Is there an operational LAN: Yes □1 No □2

18. Is there Internet Access: Yes □1 No □2

19. How is the internet connected?

$\square_1$	Broadband
$\square_2$	Dial up
$\square_3$	Cell phone
$\square_4$	Other (please specify):___

20. Do you have an institutional E-mail address Yes □1 No □2

SECTION E: SATISFACTION WITH THE APPLICATION

To be filled by ALL respondents.

21. In this section, we would like to know your level of satisfaction with the system you use to *handle patient information.*

	Never	Seldom	About half of the time	Most of the time	Always
1. Content					
a. How often does the information content meet your needs?	□1	□2	□3	□4	□5
b. How often does the system provide reports that seem to be just about exactly what you need?	□1	□2	□3	□4	□5
c. How often does the system provide sufficient information?	□1	□2	□3	□4	□5
2. Accuracy					
a. How often is the system accurate?	□1	□2	□3	□4	□5
b. How often are you satisfied with the accuracy of the system?	□1	□2	□3	□4	□5
3. Format					
a. How often do you think the output is presented in a useful format?	□1	□2	□3	□4	□5
b. How often is the information clear?	□1	□2	□3	□4	□5
4. Ease of use					
a. How often is the system user-friendly?	□1	□2	□3	□4	□5
b. How often is the system easy to use?	□1	□2	□3	□4	□5
5. Timeliness					
a. How often do you get the information you need in time?	□1	□2	□3	□4	□5
b. How often does the system provide up-to-date information?	□1	□2	□3	□4	□5

SECTION F: BARRIERS TO ICT ADOPTION AND USE

To be filled by ALL respondents

In this section, we would like to know your view of the current barriers in handling patient electronic referral system.

22. Please indicate the extent to which you consider each of the following to be a barrier to Electronic referral system implementation:

BARRIERS	Not a barrier	Minor barrier	Major barrier	Do not know
The amount of capital needed to purchase and implement an electronic health management information system.	□1	□2	□3	□4
Uncertainty about the return on investment (ROI) from a health management information system.	□1	□2	□3	□4
Concerns about the ongoing cost of maintaining a health management information system.	□1	□2	□3	□4
Resistance to implementation from other health care providers (e.g., nurses, doctors and physiotherapists)	□1	□2	□3	□4
Lack of capacity to select, contract for, and implement an electronic public health information system system.	□1	□2	□3	□4
Lack of adequate IT staff	□1	□2	□3	□4
Concerns about inappropriate disclosure of patient information	□1	□2	□3	□4
Concerns about illegal record tampering or "hacking"	□1	□2	□3	□4
Finding an electronic referral system. that meets your organization's needs	□1	□2	□3	□4
Concerns about a lack of future support from vendors for upgrading and maintaining the system	□1	□2	□3	□4
Other (*please specify*):_____	□1	□2	□3	□4

Suggestions for improvement?

Thank you for taking the time to complete this survey.

ELECTRONIC REFERRAL SYSTEM

PATIENT SURVEY INSTRUMENT

SECTION I: PATIENT SATISFACTION
To be filled by a patient.

1. What is your age?

Your Age range	
□1	18 to 24
□2	25 to 34
□3	35 to 44
□4	45 to 54
□5	55 to 64
□6	65 to 74
□7	75 or older

2. What is the name of the health institution? _____

3. Please indicate the name of the department you last visited from the choices provided below.

	Department
□1	Pediatric
□2	Medicine
□3	Surgery
□4	Obstetrics/gynecology
□5	Specialized outpatient
□6	General outpatient
□7	Physiotherapy
□8	Radiography
□9	Laboratory
□10	Psychiatry
□11	Health records and information
□12	Pharmacy
□13	Hospital finance
□14	Administration
□15	General store
□16	**Other, (specify)**

4. Please indicate whether you are a patient or a guardian. Patient □1 Guardian □2

5. Are you aware whether the health institution is using computers? Yes □1 No □2

If no, stop answering questions here.

If yes, please go to question 6 overleaf

6. If yes, in which departments are the computers used?

Department	Yes	No	Not sure
Pediatric	□1	□2	□3
Medicine	□1	□2	□3
Surgery	□1	□2	□3
Obstetrics/gynecology	□1	□2	□3
Specialized outpatient	□1	□2	□3
General outpatient	□1	□2	□3
Physiotherapy	□1	□2	□3
Radiography	□1	□2	□3
Laboratory	□1	□2	□3
Psychiatry	□1	□2	□3
Health records and information	□1	□2	□3
Pharmacy	□1	□2	□3
Hospital finance	□1	□2	□3
Administration	□1	□2	□3
General store	□1	□2	□3
Other, (specify)_____	□1	□2	□3

7. Were you there in this health institution when there were no computers? Yes □1 No □2

8. If yes, do you think computers have improved services delivery in the departments? Yes □1 No □2

9. In which department do you think computers have improved service delivery best?

	Department
□1	Pediatric
□2	Medicine
□3	Surgery
□4	Obstetrics/gynecology
□5	Specialized outpatient
□6	General outpatient
□7	Physiotherapy
□8	Radiography
□9	Laboratory
□10	Psychiatry
□11	Health records and information
□12	Pharmacy
□13	Hospital finance
□14	Administration
□15	General store
□16	Other, (specify)_____

Thank you for taking the time to complete this survey.

APPENDIX 4: INTRODUCTION LETTER

Telegrams: "PRO-MINHEALTH", Nairobi
Telephone: Nairobi 217131/313481
Fax: 217148
E-mail: pmonairobi@yahoo.com

When replying please quote

Ministry of Health

PROVINCIAL DIRECTOR OF PUBLIC HEALTH & SANITATION HEADQUARTERS
NAIROBI PROVINCE
NYAYO HOUSE
P.O. Box 34349,GPO
NAIROBI

PDPHS/NRB/R.1//VOL.I/
Ref: No.

4TH APRIL, 2010

TO ALL DMOHs
NAIROBI.

RE: FRANCIS KAMUNYU THIONGO – REG. NO. P56/7513/2006

The bearer of this letter is a Master of Science in Information Systems degree course at the University of Nairobi.

As part fulfillment of his degree, he is undertaking a research project entitled 'Framework for Electronic Public Health Management Information System'. He has chosen a number of facilities in Nairobi province as per the attached list. This exercise will last two months May – June, 2010.

The purpose of this letter is to request you to support his study.

DR. S. OCHOLA
PROVINCIAL DIRECTOR OF PUBLIC HEALTH & SANITATION- NAIROBI

C C.

-Medical officer of Health
City Council of Nairobi