

# Needs and Capability Analysis of Health Information Systems for Diabetes Care in Sub-Saharan Africa

Risper Mwangi, MPA  
Auburn University

Philip F. Musa, PhD, PE, MPH\*  
The University of Alabama at Birmingham  
[musa@uab.edu](mailto:musa@uab.edu)

\*(Corresponding author)

**Paper Category:** Research-in-progress

## **ABSTRACT**

It was not long ago when mortality rates due to chronic diseases surpassed those due to infectious diseases in industrialized countries. While that has not yet occurred in Sub-Saharan Africa, there is evidence that chronic diseases, along with the casualties they bring are trending up significantly. About 70% of Africans live in rural areas, where there is very little access to healthcare, technologies, and other “luxuries” of industrialization. Given the disparities between the urban and rural parts of Africa, we are embarking on a study to that would shed some light on how three independent variables may impact the ability to track diabetes incidence and quality of diabetes care in Kenya. The preliminary survey study will cover about 64% of Kenya. The goal is to use the results to influence policy makers to implement Health Information Systems (HIS) at a national level. Future studies would be needed to justify HIS implementation to manage other chronic diseases across Sub-Saharan African countries.

**Key words:** Health Information System, ICT, Diabetes mellitus, type1 diabetes, type2 diabetes, gestational diabetes, chronic diseases, Sub-Saharan Africa, Kenya, developing countries.

## **INTRODUCTION**

At the global level, deaths from infectious diseases are projected to decline by about 3% over the next 10 years, while mortality due to chronic diseases are projected to increase by 17% over the same period. The World Health Organization (WHO) estimates that the probability of dying between ages 30 and 70 years from the leading chronic diseases such as cardiovascular, diabetes mellitus, cancer, stroke, and arthritis is 18 % (WHO, 2014). At the Sub-Saharan Africa (SSA) level, WHO projects the number of deaths from chronic diseases reach 28 million by 2015 (Johnson and Stoskopf, 2010, p.20). While deaths due to tropical and infectious diseases are still very problematic, we are drawing attention to the escalating and debilitating comorbidity health problems brought by chronic diseases. Relative to infectious and acute diseases, it was not that long ago when chronic diseases were considered minor public health problems in the US (CDC, 2015). Our plan in this survey study is to conduct a needs and capabilities analysis of health information systems (HIS) to manage diabetes in 30 of the 47 counties in Kenya. The preliminary goal is to see if there is a difference in the incidence and management of diabetes between counties that have HIS versus those that do not. A part of the study will examine the factors that impede the effective implementation and utilization of integrated web-based Health Information systems (HIS) in the management of diabetes. Data for this preliminary study will

be collected from 30 departments of health across 30 of the 47 counties in the country. Of the 30 counties we plan to survey, 15 will have HIS and the remaining 15 will not have HIS. Our research questions are:

- 1). What Factors Impede the Effective Implementation and Utilization of (HIS) Health Information Systems?
- 2). Are there significant differences in incidence of diabetes between counties that have HIS versus those who do not?
- 3). Are there significant differences in quality of diabetes care between counties that have HIS versus those who do not?

The ultimate goal for the study is to induce policy makers to implement a national HIS based on the evidence. The lessons from Kenya could then be shared with other African countries.

In Kenya, there were 775,200 cases of diabetes in 2014 among adults 20-79 years. The number of undiagnosed cases of diabetes in adults in the same age group was estimated to be 582,100 cases, while the number of deaths in adults due to diabetes was estimated to be 15, 523 (IDF, 2015).

The health sectors in SSA countries are also plagued with numerous problems such as limited medical personnel, health care services/facilities, Information Technology and Communications (ICT) infrastructure and dearth health data. There is also a huge disparity in access to healthcare between urban and rural settings, with a concentration of health services in urban areas.

A major challenge in Sub-Saharan African countries is that they are ill equipped to adequately treat and manage chronic diseases such as diabetes. A viable solution to the crisis is the implementation and use of e-Health technologies such as integrated web-based Health Information Systems or Clinical Information Systems (HIS). These have been found to offer socioeconomic benefits, reduce costs, and improve access to healthcare services. E-Health has been defined as use of electronic Information and Communications Technology in health care. E-Health is a cost effective tool used in the delivery of health services, health surveillance, health literature and education, research. It uses digitally stored and transmitted data (Reid, 1996, Tan, 2005, WHO, 2008).

Web-based health information systems can help integrate data collection, processing, reporting and use of the information necessary for improving health service effectiveness and efficiency through better management at all levels of health services. Literatures on Health Information Systems and Clinical Information Systems emphasize that timely information on individual patients is vital in proactive care of diabetes (Glasgow, et al., 2001, IOM, 2009, Barr et al 2003). Easy access to patient registries means that healthcare personnel are able to call or text patients with specific needs, and therefore avert complications and possibly, death.

Only a small number of studies specific to the SSA region have examined the use of Health Information Systems in the fight against chronic diseases such as diabetes (e.g., Wilkins, 2008, Travis et al., 2004, World Health Organization, 2012, Health Network Metrics, 2010). According World Health Organization, health information systems in most developing countries are inadequate in providing the needed health management support. Information systems at public hospitals/clinics are generally characterized by inadequate information on patients, health conditions, and treatment history. Hand-written patient data are often incomplete, inaccurate, and obsolete. This contributes to fragmented and inadequate analysis of disease records at local and national levels.

According to a study commission by the WHO's Global Observatory for e-Health, the following are some challenges associated with measuring e-Health outcomes (Scott, et al., 2008):

1. A limited number of structured programs for the measurement of e-Health-related outcome indicators by national or international entities.
2. Lack of a global consensus about which qualitative or quantitative factors authorities should assess to determine the value of e-Health interventions and guide evaluations.
3. Lack of a global e-Health outcome indicator strategy.

Our literature search on the criteria for assessing performance of health information systems and the quality of data they generate in Sub-Sahara Africa did not yield anything of significance. The limited evidence for e-Health applications in the Sub-Saharan African region would entail learning and extrapolating from other developing countries. We are also cognizant of another limitation that may be attributable to the survey instruments for the study. The plan is to use standardized survey, which may not capture data in great depth. A way around this may be to include a section where the respondents or their surrogates can write/type comments that could be analyzed for content. This strategy could be a major strength and contribution of this research.

## **LITERATURE REVIEW**

The review of literature for this study is divided into 3 three sections. Section I addresses the following Independent Variables (IV): (1) Information and Communication Technologies (ICT) infrastructure, (2) Health System Infrastructure and Access, and (3) Health Information Systems (HIS). Section II focuses on two Dependent Variables (DV): (1) Tracking of Incidence of Diabetes, and (2) Quality of diabetes care. Lastly, Section III will focus on literature that relates to both the independent and dependent variables and literature deficiencies as it pertains to SSA.

### **Section I**

#### ***ICT Infrastructure:***

Africa faces immense challenges in providing adequate healthcare especially to rural areas. There is a huge disparity in healthcare, including healthcare technology between rural and urban areas across the continent. Access to information and communications technology (ICT) infrastructure in this region is hampered by limited funds. Educational, social, and cultural challenges which include language barriers also add to the problems. Other critical issues affecting the use of ICT in Sub-Saharan African countries include value of information, training, viability and investment (Bagayoko 2006, Cline 2013, Kifle, 2008, United Nations 2005).

Value of information in health technologies entails identifying health information that is valuable to developing countries. For instance, information about epidemiology and public health would help facilitate an urgent response to control epidemics and ensure adequate supply of drugs and equipment to remote areas (Kifle et al., 2007). It is crucial that African governments and other stakeholders put in place relevant ICTs to achieve quality and equitable delivery of health care.

E-Health applications such as web-based Health Information Systems can enhance quality of care. The right information and communications technologies need to be used strategically to solve specific problems in specific regions in order to achieve efficient health services delivery. According to a survey conducted by The Commonwealth Fund, when asked to rate the effectiveness of several key strategies for improving the quality and safety of healthcare, the highest-rated strategy was to accelerate the development and deployment of Health Information Technology (IOM, 2009).

E-Health is the use of electronic Information and Communications Technology in health care. The prefix “e” is characterized by the emergence of electronic business models and applied to telecommunications in many fields including clinical care, healthcare, home healthcare, consumer health informatics, public health care and more (Tan et al., 2005). The World Health Organization (WHO) defines e-Health as the “cost effective and secure use of ICT in support of health and health-related fields, including health care services, health surveillance, health literature and health education, knowledge and research.

E-Health tools include products, systems and services that go beyond Internet-based application. They include tools for health authorities and professionals as well as personalized health systems for patients and citizens. Examples of these tools are health information networks, electronic health records, telemedicine services, wearable portable monitoring systems and health portals (European Commission, 2004). E-health tools are “designed to improve health surveillance, health-system management, health education and clinical decision-making and to support behavioral changes related to public-health priorities and disease management (Piette 2012, p. 365).”

Health ICTs are able to reduce the effects of geographic isolation, harsh climate and low population densities by providing a mechanism for remote data access (removing long distance travel), health information sharing and medical support; as well as clinical examination, diagnosis and treatment thus bringing the health-system and healthcare provider to the patient. An example of an e-Health application is where the elderly are better served by a reduction in repeated testing, drug interactions of inappropriate prescriptions, facilitated by an easily accessible electronic health record. For instance, using electronic images and pictures, diagnoses may be made from a remote location, either within or outside the facility.

The factors that affect the adoption and implementation of e-health solutions include (Scott & Saeed, 2008):

- Delays in reaching agreement on best practices and processes. For instance in South Africa, just like any other African country, there is a lack of uniformity in the approach to healthcare or even a uniform health system.
- Another factor is the lack of standardization and integration between health information systems. The benefits of integration include standardization of medical records, therefore preventing duplication of diagnosis, medical errors, etc.

- Geographic distribution also hinders full realization of e-Health. In Africa, the vast majority of the population resides in rural areas, where they are most disadvantaged.
- ICT infrastructure is another limiting factor. Health institutions, especially those in rural areas have limited or no access to technological resources.
- A limitation in patient identifiers is another challenge. This is because in the majority of rural areas, some adults and a majority of children do not have ID documents. Many births and deaths are not recorded. The lack of identifiers make patient tracking very difficult.

Other important factors that affect e-health outcomes relate to e-health policy or the legislative, regulatory, and planning framework. E-Health policy has been defined as “a set of statements, directives, regulations, laws and judicial interpretations that direct and manage the life cycle of e-Health” (Scott et al., 2002). These policies provide a framework for implementation by all stakeholders. Concerns about the quality, safety and cost of healthcare have driven many countries to increase their focus on Information and Communications Technology issues. The lack of public policies geared toward e-Health greatly affects its diffusion. When setting policy goals, key considerations should focus on some of the following areas to achieve successful e-Health programs:

- Making e-Health feasible – focuses on areas of policy development that enable health institutions reap better benefits from health technology. Governments should implement policies that enhance growth of the telecommunication sector, therefore increasing connectivity especially to remote and marginalized areas.
- Providing effective governance in e-Health – entails implementing structured leadership for e-Health initiatives, developing well established strategies and goals for the adoption and execution of e-Health (Khoja, 2008; Kwankam, 2004). There is also a need for security policies and standards to address patient data, accountability and privacy issues (Scott et al., 2004).
- Setting guidelines for stakeholders –these guidelines should be included in organizational leadership, technology procurement, maintenance and support, clinical standards and outcomes, and in the guidelines for human resources.
- Making policies flexible – this ensures that policies are flexible enough to adapt to change and also ensure sustainability and promote innovation in the healthcare sector (Khoja, 2008).

The major policy issues affecting the diffusion of health technologies in SSA include:

- Data management –there is need for policies specifically geared toward privacy, confidentiality, content management, and security issues.
- IT infrastructure – there exists a big gap in the distribution of IT infrastructure between urban and rural areas. Other infrastructure issues include poor service quality and connectivity, limited network capacity, delays in adoption of new technologies, etc.
- Coordination and collaboration - In many countries, governments have failed to integrate policies that stimulate coordination and collaboration into their national health care agenda. There needs to be better communication between stakeholders (Mars, 2008).
- Human capacity – addresses the human health resource needs, skills including using the use of e-Learning as a tool to enhance knowledge.
- Equity – ensuring the equitable access to e-Health services to all through citizen oriented, patient-centered health care (Hamalainen et al., 2006).
- Interoperability – The aim of interoperability is to ensure that adequate access to patients’ electronic health records, medical summaries and patient data from any region. Interoperable electronic medical records (EMRs) have the potential to produce better health outcomes while improving the efficiency of care delivery and reducing its costs (James, 2005).
- Funding and sustainability – includes integrating e-Health into the national budget process.
- Monitoring and evaluation – measuring outcomes.

When implementing ICTs in the healthcare sector, it is imperative that decision-makers clearly outline who the beneficiaries may be for the various options. Beneficiaries can be grouped as follows: stakeholders within health institutions and stakeholders in the society as a whole. With health institutions, it is important to pay attention to factors like individual capacities, access as well as the potential for ICTs to assist in efficiency and effectiveness at each level in the system. These institutional stakeholders can be grouped as follows (Chetley, 2006):

1. International Level: International agencies (UNAIDS, WHO), donor agencies, international non-governmental organizations (NGOs).
2. Regional Level: e.g., European Union, New Partnership for Africa’s Development (NEPAD), African Union (AU).
3. National and provincial levels: Government ministries, national NGOs, National and provincial governments, provincial hospitals and health departments

4. Local Levels: includes personnel at health clinics, health workers, doctors, traditional healers, community leaders, patients and citizens.

#### ***Health System Infrastructure and Access:***

Many low and lower middle income countries lack the capacity to deal with chronic conditions such as diabetes due to barriers, which include organization of health systems and care, human resources, sufficient information for decision-making, availability and affordability of medicines, policies and alleviating the financial burden of care (Beran, 2015). The systems in these countries have fragmented healthcare services that are designed to respond to single diseases, usually infectious diseases such as HIV and tuberculosis (Atun et al., 2013, p. 690)

The Health Metrics Network lists the following as factors that influence a health system infrastructure (Health Metrics Network, 2008):

- Inputs to the health system – variables include Policy, Financing, Human Resources, Organization and Management
- Outputs from the health system – the variables used to measure this are Information availability and quality and health service availability and quality

The health care industry in Sub-Saharan Africa (SSA) is plagued with numerous problems such as limited number of medical personnel and healthcare services/facilities. There is a huge disparity in healthcare between urban and rural settings, with a concentration of health services in urban areas. The shortage of healthcare services in rural areas where over 70% of the region's population resides continues to worsen (Musa et al., 2006).

Inadequate health system infrastructure also contributes to poor quality of care and outcomes. The institute of medicine (IOM) identified structural elements that may affect quality improvement as follows:

- Information systems for data collection, quality improvement analysis, and clinical communication support.
- An adequate and well-distributed workforce.
- Organizational capacity to support emerging models of care, cultural competence services, and ongoing improvement efforts.

In the development and management of a country's healthcare system it is important to take into consideration the following environmental or national factors: (1) social and cultural

beliefs and behaviors; (2) physical environment such as levels of sanitation, environmental hazards, food and water supply safety; (3) the political climate, which include legal issues impacting provision of funding healthcare; (4) economic development such as poverty level, distribution of wealth, types of industries and agriculture; (5) other social structures e.g. education system; and (6) types of diseases present in the population and rates of mortality (Johnson and Stoskopf , 2011, p.17).

According to Johnson, the assessment of population health needs in light of national profile should drive how medical resources are distributed and health services are provided. This is because public health systems provide a variety of non-medical services such as sanitation improvements, environmental hazard control, vector control and surveillance of disease. Healthcare systems should also understand the populations they serve and work in collaboration with community public health efforts and other social institutions to effect change (p.17).

The shortcoming of most health care systems as they exist today is that they are structured around the concept of infectious diseases. The WHO's Innovative Care for Chronic Conditions framework (WHO ICCC), which serves as a blueprint for health systems to address the growing demands of chronic disease care (WHO, 2014; Oni et al., 2014) emphasizes the importance of examining the micro-, meso- and macro-levels of healthcare when addressing problems affecting current health systems. The micro-, meso- and macro-levels of healthcare refer to the patient interaction level, the healthcare organization and community level and the policy level respectively (Oni et al., 2014). In relation to these three levels, the WHO's ICCC framework states that in order to improve chronic conditions, it is important to pay attention to patient behaviors. Patient care for chronic conditions also needs to be coordinated using scientific evidence to guide practice. By the same token, community resources must be integrated. At the healthcare organization level, services must be streamlined to ensure efficiency, skills of health workers must be upgraded, focus on prevention and establish information tracking systems to provide planned healthcare for predictable complications (WHO, 2002).

### ***Health Information Systems (HIS):***

Health information systems (HIS) have been identified by the World Health Organization as one of the six key building blocks to strengthening health systems around the world. The other five building blocks are service delivery, health workforce, access to essential medicines,

financing and Leadership/Governance (WHO, 2012). Health Information System is defined as ‘a system that integrates data collection, processing, reporting and use of the information necessary for improving health services effectiveness and efficiency through better management at all levels of health services (WHO, 2004). Lippeveld defines HIS as an integrated effort to collect, process, report and use health information and knowledge to influence policy-making, program action and research (Lippeveld, 2001). Therefore, the main objective of a health information system is to allow decisions to be made based on evidence and in a transparent way. The HIS structure should permit the generation of information allowing rational decision making at each level of the health services systems from the center to the periphery (Lippeveld et al., 1997).

Assessing the HIS of a particular country allows one to better appreciate the country’s ability to integrate data collection, processing, reporting, and use of information necessary for improving health service effectiveness and efficiency though better management of all levels of health services (Lippeveld et al., 2000). In addition to data that are routinely collected and reported by healthcare facilities and other entities, a country’s HIS should also be measured for performance through the quality of data produced and the evidence of continued use of data for improving the performance of the health system and the population’s health status .

#### *Application of HIS in evidence based practice:*

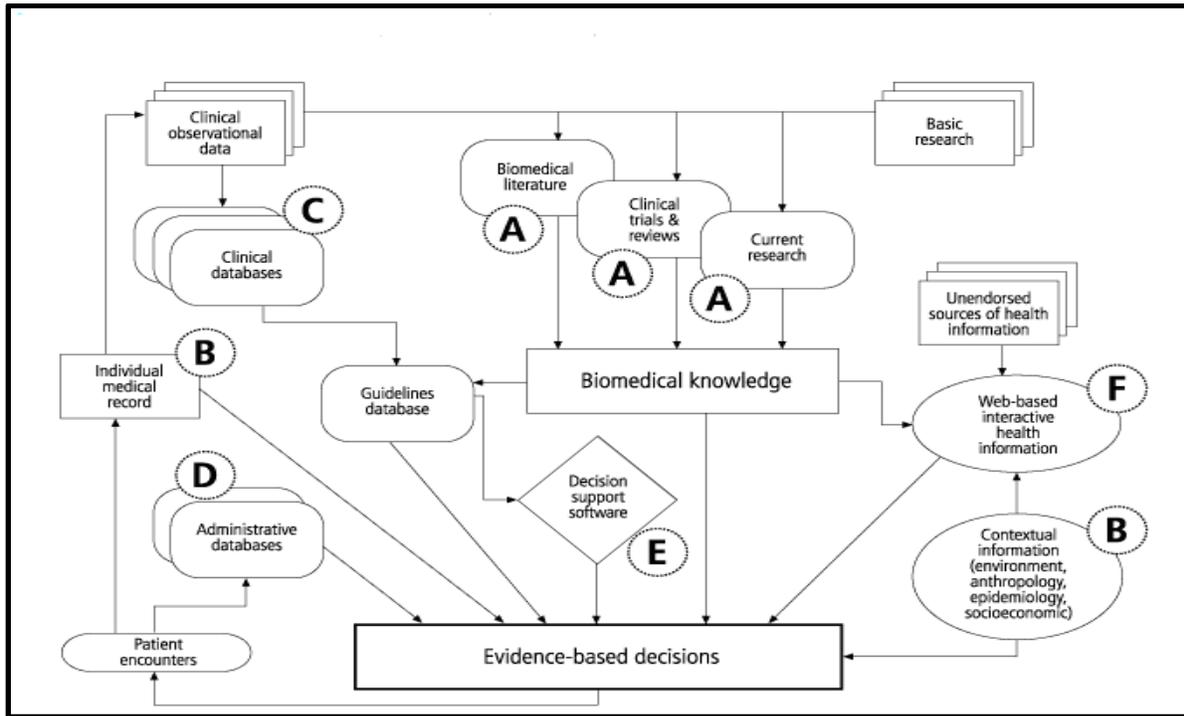
A Health Information System is biased toward quantitative data (AbouZahr & Boerma, 2005) such as mortality rate. It has been found valuable in evidence-based health practice. Rodrigues states that “in supporting evidence-based practice, HIS can capture, transform and maintain data at three levels: raw data, processed data and knowledge.” This is because the information extracted from processed raw data is considered equivalent to evidence (Rodrigues, 2000, p.1345). Rodrigues identifies six application areas as shown in Figure 1 where information systems and technology (IS&T) contributes to evidence-based practice:

- *Reference databases (A)* – these databases represent a body of biomedical knowledge that is useful in supporting decision-making and producing clinical guidelines and protocols of care.
- *Contextual and case-specific information (B)* – contextual information relates to environmental, socioeconomic and epidemiological factors for a specific site and time. This type of information is especially vital in clinical decision making process. Contextual data is usually temporary and restricted to a specific geographic area and should therefore be shared

with decision-makers in a timely manner. A report of incidents of communicable diseases is an example of contextual data.

Case-specific information refers to a health care system's data accumulated over time. These data consist of clinical and administrative data such as patient medical records, insurance information, and business transactions.

- *Clinical data repositories (C) and Administrative data repositories (D)* – the importance of data warehousing technology is that it facilitates merging and accessing digital health data (clinical, administrative and financial) from various sources. Standardized and integrated data repositories are important in solving the major issues that affect HIS in most developing countries. These issues include data fragmentation, lack of structure, incompatible terminologies and separation of health related data such as separation of clinical and administrative data.
- *Decision support software (E)* - this involves the use of computer-based information system to support organizational decision-making process by automating select areas of clinical decision-making through replicable rules contained in a database of guidelines. Rodrigues (p. 1347) raises the following questions that require policy and legislation actions in order to address emerging problems associated with this method of decision-making:
  1. Does the amount of automated “clinical thinking” done by the software application constitute the “practice of medicine” with all its ethical and legal implications?
  2. Is the expert software to be considered a medical device, subject to regulation?
  3. To what extent does the software or its documentation allow clinicians to examine independently the underlying logic involved and evaluate the validity of the automated conclusions?
  4. What is the role of such products in critical clinical decisions?
  5. Who will take the blame for errors?
- *Internet-based interactive health information (F)* – interactive health communication (IHC) is the use of communication technology to send and receive health information and support. HIC facilitates informed decision-making, healthy behavior, information exchange through the interaction between consumers, patients, caregivers and between health professionals. A shortcoming of interactive web-based technologies is the presence of non-validated and fraudulent health information that can prove to be harmful to the general public.



**Figure1: Spectrum of IS&T application in support of evidence-based practice**

**Source:** Rodrigues, 2000, p.1346

*Factors that hamper successful HIS:*

Lippeveld associates the inefficiency of existing information systems in developing countries with structural weakness and lack of integration in the overall health system. This is because historically, information systems in developing countries were not designed to provide management support to the health services in an integrated way (Lippeveld et al., 1997). The development of Health Information Systems in developing countries is also hampered by organizational complexity, fragmented health system structures, lack of sustainability, irrelevant data and unrealistic ambitions (AbouZahr & Boerma, 2005; Braa et al. 2007; Heeks, 2002).

When it comes to techniques for gathering and recording information, the following should be taken into consideration:

- 1. Information systems audit** - this includes technology, staffing and skills, management systems and structures dimensions.

2. **People analysis** – should take into account objectives and values dimension such as SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis and personal objective setting e.g., asking stakeholders about their personal objectives vis-à-vis the proposed government system.
3. **Problem analysis** – these include poor technology, lack of skills, lack of motivation and lack of data.
4. **Context Analysis** – entails examining an organization within its wider environment e.g., impact of political pressure.

*Implementing successful HIS:*

The Health Metrics Network (HMN), whose mission is to assess health information systems and sustainably improve them through the use of the HMN framework lists the following as key components for a successful Health Information System: Inputs, Processes and Outputs (HMN, 2008) as shown in Figure 2:

**1) INPUTS**

- a) **HIS resources** – include the physical and structural resources that need to be put in place before a strong system can be built. These requirements are legislative, regulatory and planning framework; and personnel, financing, logistic support, IT and communication systems e.g. computer systems, office supplies, capable staff, policies etc.

**2) PROCESSES**

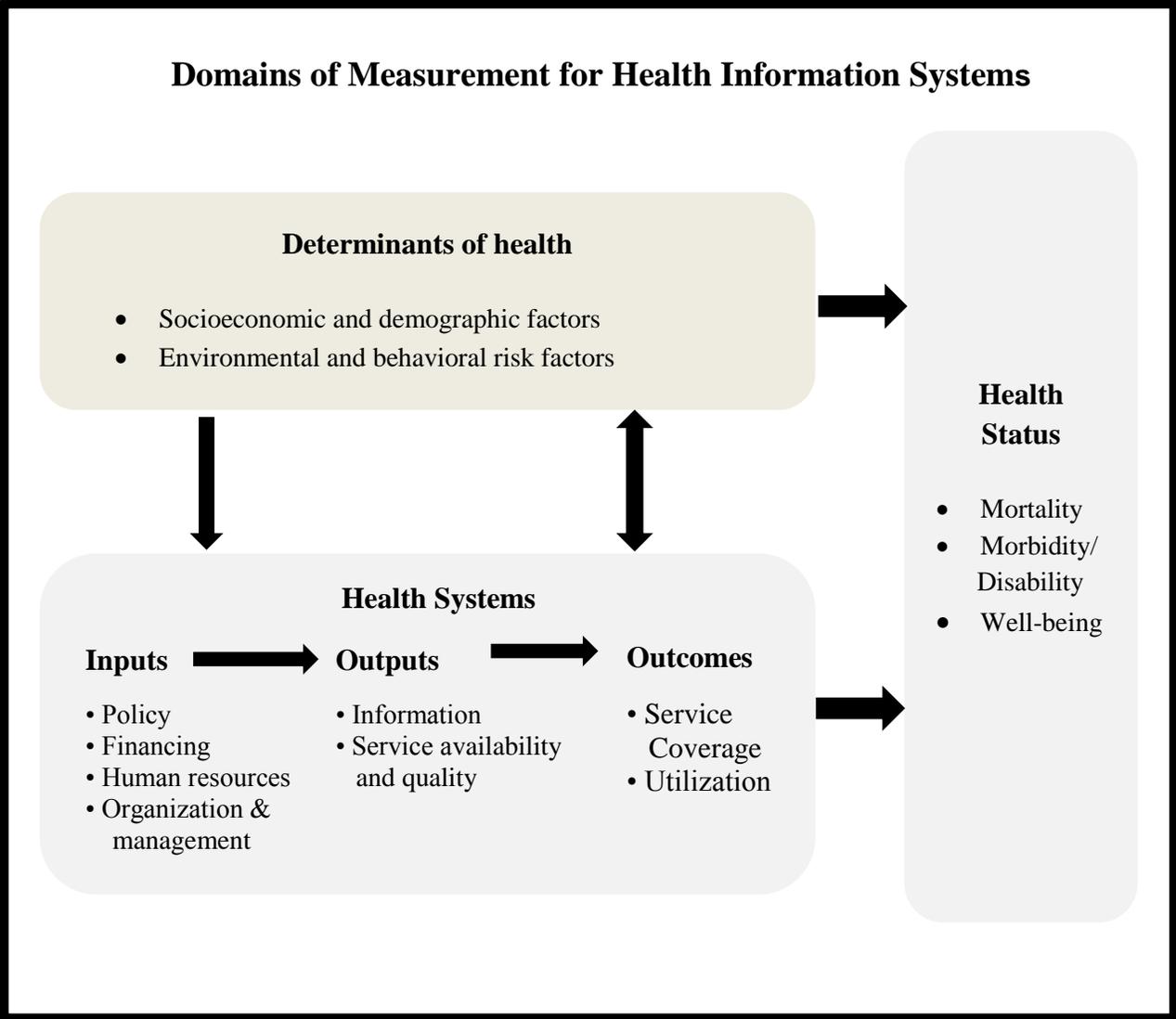
- a) **Indicators** – instruments to monitor the system's effectiveness. These indicators need to measure determinants of health, health system and health status. They also need to be valid, reliable, specific, sensitive and feasible to measure.
- b) **Data sources** – should include a combination of sources, both periodic and continual. These sources are 1. Population-based sources - include population surveys, civil registration and census 2. Institution-based sources – such as individual records, service records and resource records. Data sources should also provide the best quality information most efficiently.
- c) **Data management** – to achieve best collection, storage, quality assurance, processing, compilation and analysis, datasets should be kept at minimum in order to simplify

collection and improve data quality. Integrating data also helps combine data from various sources and facilitates a wide distribution of this data.

### 3) **OUTPUTS**

- a) **Information products** – this category entails transforming data into information that can be used by decision makers to improve healthcare. This is described as a cycle of value adding through compilation, analysis, interpretation, presentation, influence and implementation results in a strengthened HIS and a more effective health system. Fast access to information and analyzed data can be achieved through user dashboards, reports, queries and alerts.
- b) **Dissemination and use** – value of information is enhanced by being accessible to decision makers and by providing incentives for information use. Countries are encouraged to place greater value on information collection, management and use.

Reliable information/data is important in designing and implementing health policies specifically geared toward chronic diseases. This information is generated from such sources as civil registration, census reports and vital statistics systems. There are 3 major domains described as being determinants of national HIS, which overlap with information systems in other fields (Health Metrics Network, 2008, WHO, 2012).



**Figure 2:** Domains of Measurement for Health Information Systems

**Source:** Health Metrics Network, 2008

**Section II**

**Tracking Incidence of Diabetes and Quality of Diabetes Care**

The Center for Disease Control defines diabetes as a group of diseases characterized by high blood glucose, which when left untreated can lead to health complications such as vision loss, kidney failure or even death. The three major types of diabetes are Type 1 diabetes, which is commonly first diagnosed in children and young adults accounts for about 5% of all diagnosed cases of diabetes. Type 2 diabetes accounts, which for approximately 95% of diagnosed diabetes

cases can be controlled through health eating and regular physical activities in addition to any prescription medicines. Lastly, gestational diabetes develops as a result of pregnancy and occurs in approximately 2%-10% of pregnant women (CDC, 2012).

The International Diabetes Foundation (IDF) states that there are an estimated 21 million people living with diabetes in Africa. This figure is expected to double by 2035 if drastic measures are not implemented to tackle the prevalence of this disease. Africa has a high number of undiagnosed cases of diabetes, estimated to stand at a staggering sixty two percent (62%). It also comes as no surprise that the region has the lowest diabetes-related expenditure, at only USD 4.5 billion (IDF, 2014). The region also lacks primary data on the prevalence in adults, which in turn impedes effective prevention strategies necessary to stymie to rapid rise of type 2 diabetes cases.

In 2014 there were 775,200 cases of diabetes in 2014 among adults 20-79 years in Kenya. The number of undiagnosed cases of diabetes in adults in the same age group was estimated to be 582,100 cases and the number of deaths in adults due to diabetes was estimated to be 15, 523. The country's mean healthcare expenditure due to diabetes per person was USD 81.8. Although a framework for diabetes monitoring and surveillance in Kenya exists, it has not been routinely implemented (IDF, 2014).

Due to limited resources and other barriers such as fragmented health services, health systems in middle-income and low-income countries are not in a position to provide adequate services to their populations (Beran, 2015). A way around the issue of fragmentation and limited resources due to single disease funding that is characteristic of health systems in low and middle incomes countries is to implement integration of Non-Communicable Diseases (NCDs) prevention and control with existing service delivery for single diseases such as HIV/AIDS and tuberculosis. This approach has been used to improve outcomes of non-communicable diseases (NCDs) in Kenya where HIV/AIDS services have been used as a platform to screen for NCDs. Integration of information systems can also bring together individual-level socioeconomic, behavioral, clinical and service utilization data, which help build individual risk profiles and establish targeted responses (Atun et al., 2013).

## **Quality of diabetes care**

To explore how to best move forward with Information Technology in the healthcare industry to address its various challenges, a blue print was developed in 2007 by an independent nonprofit organization called e-Health Initiative. The blue print was meant to drive improvement in the quality, safety, and efficiency of healthcare through information and information technology. It was largely based on Ed Wagner's Chronic Care Model (Institute Of Medicine, 2009). Walters et al., (2012) describe the Chronic Care Model (CCM) as one of the more popular and pervasive models for framing disease management programs. The elements of CCM include the health system, the community, self-management support, delivery system design, decision support and clinical information systems.

The Clinical Information Systems component of CCM is based on the principle that in managing chronic conditions such as diabetes, timely information about individual patients is vital. There is a need to establish a disease registry that identifies the population to be served, (e.g., all patients with heart disease or diabetes, and also information on the performance of various guideline-informed quality of care (Glasgow, et al., 2001)). Easy access to patient registries means that healthcare personnel are able to call or text patients with a specific need and therefore offer proactive care, collect information, design reminder systems, etc. Other advantages of disease management programs like CCM include using case management systems to coordinate workflows by enhancing communication between health professionals and patients. Efficient sharing of health records for patients with multiple conditions that require multiple health providers is also a measure of quality. Disease management programs also help track cases and patterns of chronic disease; monitor patients' condition and implement interventions aimed at modifying the patients' lifestyles so as to improve their conditions and possibly prolong their lives (Hillestad et al., 2005).

In the case diabetes, Leeman states that an institution using CCM may implement a database of patients with the condition, and then integrate evidence-based guidelines with the organization's clinical information system. This in turn generates alerts when patients are due for a procedure or screening. Using the same model, a healthcare institution can also redefine the responsibilities of a nurse to include self-management support such as referring patients to community resources such as access to low cost drugs and exercise programs (Leeman & Mark, 2006, p. 19).

### **Section III**

Difficulties in achieving health targets, such as millennium Development Goals (MDGs) and growing consumer demand have forced health planners to look for innovative ways to improve the outcomes of healthcare and public health initiatives while controlling service costs (Piette, 2012). Piette also states that e-health tools are designed to improve health surveillance, health management, health education and clinical decision making and to support behavioral changes related to public health priorities and disease management.

Literature focusing on e-health research and outcomes in Kenya and Sub-Saharan Africa is scant, especially on costs of implementing and maintaining electronic medical record systems and decision support systems. Studies on the use of e-Health explore health informatics in a general way. Only a small number of studies specific to the region have examined the use of Health Information Systems in the fight against the chronic disease epidemic (e.g., Wilkins, 2008; Smith, M. et al. 2008; Travis et al 2004; World Health Organization, 2012; Health Network Metrics, 2010). These studies cited the following as factors hindering effective information systems in developing countries:

- lack of trained personnel, diagnostic laboratories and funds to support surveillance
- inadequate data-collection systems;
- an apparent lack of interest and motivation among personnel
- a lack of data analysis among data managers
- overly complex systems
- delays in reporting urgent events
- incomplete reporting
- a lack of dissemination and feedback of information
- a lack of reliability in case reporting
- a perception that data users did not have input into the collection of information

Piette's work on 'The impacts of e-health on the outcomes of care in low-and middle-income countries' found that the District Health Information System used in African countries of Malawi, Rwanda and South Africa may have limited impact on outcomes in settings where data quality is poor. From studies of e-Health projects in Asia, Africa, Europe and South and North America, that included such countries like Canada, United Kingdom, Brazil, United States, and China. Piette et al., "conclude that e-health architecture can help connect disparate health

information systems, how interoperability can support coordination between multiple points of care, and how this coordination can improve health outcomes. Given the encouraging evidence regarding the benefits of mobile health tools, studies of their costs and impact on outcomes in low- and middle-income countries should be a priority” (Piette, et al., 2012).

In the article ‘Why is it difficult to implement e-health initiatives? A qualitative study’, Murray et al., explored the experiences of e-Health implementers – the senior managers and other staff charged with implementing e-Health initiatives and their assessment of factors which promote or inhibit the successful implementation, embedding, and integration of e-health initiatives. The study used a case study methodology, using semi-structured interviews with implementers for data collection. Using the Normalization Process Theory as a theoretical lens, they found that “New technology was most likely to ‘normalize’ where implementers perceived that it had a positive impact on interactions between professionals and patients and between different professional groups, and fit well with the organizational goals and skill sets of existing staff.”

There is a need to conduct a study investigating the factors that prevent successful e-health implementation and in particular Health Information Systems given that e-health is a fast growing field that has been found to offer socioeconomic benefits, reduce costs, and improve access to healthcare services. The limited research on African countries on this issue also justifies the need for the study. Wilkins et al., assertion that efforts to improve health information systems have focused on the development of new forms and computerization rather than taking a system-wide approach to identifying and solving problems (Wilkins, 2008), adds more weight to this study’s objective.

## **RESEARCH DESIGN AND DISCUSSION**

The purpose of the validated cross-sectional survey instrument to be administered in Kenya is to examine the factors that impede the implementation of Information and Communication Technologies (ICT) infrastructure, Health System Infrastructure and Access, and Health Information Systems (HIS). It will also be used to assess the differences across 30 of the 47 counties with regards to tracking the incidence of diabetes, and quality of diabetes care for counties that have HIS and those that do not. The study will also explore the relationships between the independent variables (Information and Communication Technologies (ICT)

infrastructure, Health Systems infrastructure and access, and Health Information Systems) versus the dependent variables (tracking the incidence of diabetes and Quality of diabetes care). The hypotheses for the study are as follows:

H<sub>1</sub>: The factors that drive effective implementation and utilization of Health Information Systems in counties with HIS are similar to those without HIS.

H<sub>2</sub>: There is a difference in ability to track the incidence of diabetes between counties that have HIS versus those that do not have HIS.

H<sub>3</sub>: There is a difference in the quality of diabetes care between counties that have HIS versus those that do not have HIS.

Due to the relatively small sampling frame, we will use purposive sampling to select subjects. A purposive sample is useful in cases where a researcher needs to have access to a sample quickly, and where proportionality of samples is not of much concern. The survey instrument will be in the form of a questionnaire. With permission, the survey questionnaire will be a modified version of the Health Metrics Network framework that describes HIS components in terms of resources, indicators, data sources, data management, information products, etc. According to Creswell (p.155), a survey research design “provides a quantitative or numeric description of trends, attitudes or opinions of a population by studying a sample of that population.” In line with the Creswell survey design, we anticipate to be able to draw inferences to the population. Most of Sub-Saharan countries share similar characteristics with regards to healthcare and information and communications technology sectors. Therefore, results from the Kenya case study would be generalizable to other parts of the continent. Survey designs also allow a researcher to collect large amounts of data in a short time.

A disadvantage to using a survey design relates to closed responses, which do not allow subjects to expressive any views not addressed by the survey instrument. Surveys also have a set number of answers and therefore may miss out on important elements of the phenomenon under investigation.

The subjects for this study will comprise of one health manager and one personnel responsible for the implementation and maintenance of health IT at the healthcare institutions under investigation. We intend to select subjects from at least two public hospitals (including teaching hospitals) in each of the 30 counties to be surveyed. The subjects will also include personnel from the ministry of health responsible for implanting health information systems and

managers. We plan to share the results from this and a follow-up study with policy makers with the hopes of inducing them to implement a national HIS across Kenya based on the evidence. Ultimately, the lessons from Kenya would then be shared with other African countries.

## REFERENCES

- Atun R, Jaffar S, Nishtar S, Knaul FM, Barreto ML, Nyirenda M, et al. (2013). Improving responsiveness of health systems to non-communicable diseases. *Lancet*. 381(9867):690–7. doi:10.1016/S0140-6736(13)60063-X.
- Azevedo, M. and Alla, S. (2008). Diabetes in Sub-Saharan Africa: Kenya, Mali, Mozambique, Nigeria, South Africa and Zambia. *International Journal of Diabetes in Developing Countries*, 28(4), 101–108. <http://doi.org/10.4103/0973-3930.45268>
- Bagayoko, O. C., Muller, H., Geissbuhler, A. (2006) Assessment of Internet-based Telemedicine In Africa – The Raft Report. *Computerized Medical Imaging and Graphics*. Vol. 30, pp. 407-416.
- Bambra, C., Fox, D. & Samuel, S. A. (2005). Towards a politics of health. *Health Promotion International*, Vol. 20 (2): 187-193. doi:10.1093/heapro/dah608.
- Barr, J V., et al. 2003. The Expanded Chronic Care Model: An Integration of Concepts and Strategies from Population Health Promotion and the Chronic Care Model. *Healthcare Quarterly*. Vol. 7 No.1, pp. 73-82.
- Beran, David. (2015). The Impact of Health Systems on Diabetes Care in Low and Lower Middle Income Countries. *Current diabetes reports Journal*. Vol.15 No.4, pp. 1-13.
- Braa, J., Hanseth, O., Heywood, A., Mohammed, W., & Shaw, V. (2007). Developing Health Information Systems in Developing Countries: The Flexible Standards Strategy. *MIS Quarterly*, 31(2), 381-402.
- Centers for Disease Control and Prevention (CDC). Diabetes Report Card 2012. <http://www.cdc.gov/diabetes/pubs/pdf/DiabetesReportCard.pdf>. Retrieved on October 10, 2015.
- CDC, 2015 (Centers for Disease and Prevention). Fifty Years of Progress in Chronic Disease Epidemiology and Control. Retrieved on September 27, 2015.
- Chetley, A. (2006). Improving health, connecting people: The role of ICTs in the health sector of developing countries. (A framework paper). Infodev, World Bank. Washington, DC.

- Creswell, John, W. (2014). *Research Design: Qualitative, Quantitative and Mixed Method Approaches*. Thousand Oaks, CA: SAGE Publications, Inc.
- Economic Commission for Africa. (2012). Framework for a set of e-government core indicators [http://www.itu.int/en/ITU-D/Statistics/Documents/partnership/Framework\\_for\\_a\\_set\\_of\\_E-Government\\_Core\\_Indicators\\_Final\\_rev1.pdf](http://www.itu.int/en/ITU-D/Statistics/Documents/partnership/Framework_for_a_set_of_E-Government_Core_Indicators_Final_rev1.pdf). Retrieved September 13, 2013.
- Glasgow, Russell et al. (2001). Does the Chronic Care Model Serve Also As a Template for Improving Prevention? *The Milbank Quarterly*. Vol. 79, No. 4, p. 579-612.
- Hillestad, Richard, et al. (2005). Can Electronic Medical Record Systems Transform Health Care? Potential Health Benefits, Savings, and Costs. *Health Affairs*. Vol. 24, No. 5, p. 1103-17.
- Institute of Medicine (US) Roundtable on Health Literacy. (2009). *Health Literacy, eHealth, and Communication: Putting the Consumer First: Workshop Summary*. <http://www.ncbi.nlm.nih.gov/books/NBK36290/>. Retrieved on February 13, 2014
- International Diabetes Foundation (IDF). 2014. Global Diabetes Scorecard. <https://www.idf.org/membership/afr/kenya>. Retrieved on October 11, 2015.
- International Diabetes Foundation (IDF). 2015. IDF Diabetes Atlas. <http://www.diabetesatlas.org/resources/2015-atlas.html>. Retrieved on October 11, 2015.
- Johnson, James A. & Stoskopf, Carleen, H. (2010). *Comparative Health Systems: Global Perspectives*. Boston: Jones and Bartlett Publishers.
- Jones, Walter, J. (2010). Global Health: Systems, Policy, and Economics. In Johnson, James A. & Stoskopf, Carleen, H., *Comparative Health Systems: Global Perspectives* (pp.41-55). Boston: Jones and Bartlett Publishers.
- Kifle, M, Mbarika, V., Datta, P. (2006) Interplay of cost and adoption of tele-medicine in Sub-Saharan Africa: The case of tele-cardiology in Ethiopia. *Information Systems Frontiers*. Vol. 8, No.3. p. 211-223.
- Leeman, Jennifer & Mark, Barbara. (2006). The Chronic Care Model versus Disease Management Programs: A Transaction Cost Analysis Approach. *Health Care and Management Review*. Vol. 31 (1), 18-25.
- Lippeveld T. Routine health information systems: the glue of a unified health system. Keynote address at the Workshop on Issues and Innovation in Routine Health Information in Developing Countries, Potomac, March 14-16. Washington, DC: JSI; 2001.
- Lippeveld, T., Sauerborn, R. & Bodart, C. (eds). (2000). *Design and Implementation of Health Information Systems*. Geneva: World Health Organization.

- Lippeveld, T., Sauerborn, R. & Sapirie, S. (1997). Health Information Systems-Making them Work. World Health Forum. Vol. 18, 176-184.
- Murray, Elizabeth et al., 2011. Why is it difficult to implement e-health initiatives? A qualitative study. Implementation Science. Vol. 6, No. 6. pp.1-11.
- Musa, P.F., Mbarika, V., and Meso, P., (2006). Integrating Capability Approach and Cognitive Constructivism to Study Technology Acceptance in Developing Countries, Proceedings of Americas Conference on Information Systems, Acapulco, Mexico, August 2006.
- Piette, John D. et al., 2012. Impacts of e-health on the outcomes of care in low- and middle-income countries: where do we go from here? Bulletin of the World Health Organization. Vol. 90, p.365-372.
- Reid, J. (1996) 'A Telemedicine Primer: Understanding the Issues', Review Bulletin, Vol. 12, pp. 99-108.
- Rodrigues J., Roberto. 2002. Information systems: the key to evidence based health practice. Bulletin of the World Health Organization. Vol. 78, pp. 1344–1351.
- Scott, Richard E. & Saeed, Ayida. (2008). Global eHealth - Measuring Outcomes: Why, What, and How. Making the eHealth Connection. pp. 1-28.
- Kifle M., Mbarika V. and Okoli, C. (2005). E-medicine Diffusion: E-medicine in Developed and Developing Countries. Chapter 8 in E-health paradigm shift: Perspectives, domains and challenges. Tan, J. (Ed.), New York: Jossey Bass.
- United Nations E-Government Survey. 2012. E-Government for the People. <http://unpan1.un.org/intradoc/groups/public/documents/un/unpan048065.pdf>. Retrieved on March 3, 2014.
- UNDP (2014). International Human Development Indicators. <http://hdr.undp.org/en/countries>. Retrieved on July 15, 2014.
- Walters, B. H., Adams, S. A., Nieboer, A. P., & Bal, R. (2012). Disease management projects and the Chronic Care Model in action: baseline qualitative research. *BMC Health Services Research*, 12, 114. <http://doi.org/10.1186/1472-6963-12-114>
- Wilkins, K., Nsubuga, P., Mendlin, J., Mercer, D. & Pappaioanou, M. 2008. The Data for Decision Making project: assessment of surveillance systems in developing countries to improve access to public health information. *Journal of the Royal Institute of Public Health*, 122, 914-922. DOI: 10.1016/j.puhe.2007.11.002
- World Health Organization (WHO). 2007. e-Health for Health-care Delivery - STRATEGY 2004-2007. [http://www.who.int/eht/en/eHealth\\_HCD.pdf](http://www.who.int/eht/en/eHealth_HCD.pdf). Retrieved on February 13, 2014.

World Health Organization (WHO). 2007. Everybody's business: strengthening health systems to improve health outcomes : WHO's framework for action. WHO Press, Geneva, Switzerland.

World Health Organization (WHO). 2002. Innovative Care for Chronic Conditions: Building Blocks for Action. <http://www.who.int/chp/knowledge/publications/icccreport/en/>. Retrieved on February 13, 2014.

World Health Organization. (2014). Non-communicable Diseases (NCD) Country Profiles, 2014. [http://www.who.int/nmh/countries/ken\\_en.pdf?ua=1](http://www.who.int/nmh/countries/ken_en.pdf?ua=1). Retrieved on September 13, 2015.