Use of ehealth and big data in management of Non Communicable Diseases in Developing Countries; the Kenyan Healthcare sector.

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Abstract
The burden of disease in developing countries is undergoing demographic transition from communicable diseases to increasing prevalence of non-communicable diseases (NCDs). NCDs disproportionately affect people in low- and middle-income countries where more than three quarters of global NCD deaths 31.4 million occur. Big data and ehealth has implications on healthcare on patients, providers, researchers and health professionals. Big data in the healthcare sector can be used to predict outcome of diseases and epidemics, improve treatment, quality of life, and prevent premature deaths and disease development. Big data also provides information about diseases and warning signs for treatment to be administered. This will help not only to prevent co-morbidities and mortality but also assists government to save the cost of medical treatment. Ehealth allows healthcare providers to better engage with patients, make more efficient and accurate decisions about care, and streamline provider workflow in real-time. Despite the immense benefits accrued from big data management and ehealth in the healthcare sector developing countries are grappling with a myriad of challenges in its utilization. By analyzing existing literature using scoping review research approach this paper explored the use of ehealth and big data in management of non communicable diseases in Kenya. To achieve our main objective, six databases were searched and 291 papers screened for inclusion. As a result of the search and screen process, we identified 36 relevant articles.
Key words: Big data, Ehealth, Healthcare

Introduction

The last decade has seen huge advances in the amount of data we routinely generate and collect in much of what we do, as well as our ability to use technology to analyze and understand it. The intersection of these trends is what we call Big Data and it is helping businesses in every industry to become more efficient and productive. Its main characteristics include volume, variety, velocity, value, visualization, variability, and veracity. Thus state-of-the-art techniques, technologies, and equipment are required to deal with Big Data in correlation analysis, clustering analysis, modeling, and prediction [1]. Healthcare is no different. Beyond improving profits and cutting down on wasted overheads, Big Data in healthcare is being used to predict epidemics, cure disease, improve quality of life and avoid preventable deaths. With the world's population increasing and everyone living longer, models of treatment delivery are rapidly changing, and many of the decisions behind those changes are being driven by data [1]. The drive now is to understand as much about a patient as possible, as early in their life as possible hopefully picking up warning signs of serious illness at an early enough stage that treatment is far more simple and less expensive than if it had not been spotted until later. Recent rapid increase in the generation of digital data and development of computational science enables us to extract new insights from massive data sets, known as big data, in various disciplines [2]. In the healthcare sector, discovering new actionable insights has not been as common, although several success stories have been published in media and academic journals. This delayed progress of big data

technology in the healthcare sector in developing countries is a little bit odd, considering an earlier prediction that the application of big data technology was inevitable and that the healthcare sector would be one of the sectors expected to be benefitting the most from big data technology [3]. E-health symbolizes potential solutions for enhanced healthcare. E-health is referred to 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 [25]. It consists of ICT applications that boost disease prevention, timely patient diagnosis, and enhanced patient management. Application of ehealth allows healthcare providers to longitudinally and accurately store data through a shared network of information exchange. Additionally the system helps to improve reliability in patient records by ensuring integrity and security of patient data through authentication and various level of access authority [25]. Similarly, evidence in the literature also indicates the system's capability to improve safety in the healthcare by supporting better decision-making in patient treatments. The ehealth applications include electronic Medical Records (EMRs), Telemedicine, Health Knowledge Management, Consumer Health Informatics (CHI), M-Health and Healthcare Information Systems (HIS) [25]. Ehealth provides the platform for storage of clinical data and acts as an enabler of big data analytics for enhanced healthcare delivery.

The increasing gap between healthcare costs and outcomes is one of the most important issues in the health sector, and many efforts to fill this gap are under way in many developing countries. The gap between healthcare costs and outcomes was analyzed to be the result of poor management of insights from research, poor usage of available information, and poor capture of care experience, all of which lead to missed opportunities, wasted resources, and potential harm to patients [4]. It has been suggested the gap could be overcome by the development of a continuous learning electronic healthcare system, in which a virtuous cycle is formed between the research and operational arms of healthcare, and data could be used effectively. Therefore, a pressing need to improve healthcare quality and patient outcomes, increasing data availability, and increasing analytic capabilities are the drivers of ehealth and big data in healthcare [5]. This paper explores the use of big data and ehealth in management of non communicable diseases in developing countries, the case of Kenyan healthcare sector. The following research questions were explored i.) How can big data and ehealth be utilized to manage non communicable diseases ii.) What are the challenges of utilizing big data and ehealth and possible solutions.

Research Approach

This study employed a scoping review in order to determine the utilization of big data and ehealth in the Healthcare setting as well as identify challenges and potential solutions. A scoping review is defined as a "form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts, types of evidence, and gaps in research related to a defined area or field by systematically searching, selecting, and synthesizing existing knowledge" [6]. A scoping review was selected as it allows the researcher to explore the nature, extent and range of research activity, determine the value of undertaking a full systems review, identify research gaps in the existing literature and summarize and disseminate research findings [7]. The scoping review was considered appropriate as use of big data and ehealth in the health care industry in developing countries is at an early stage.

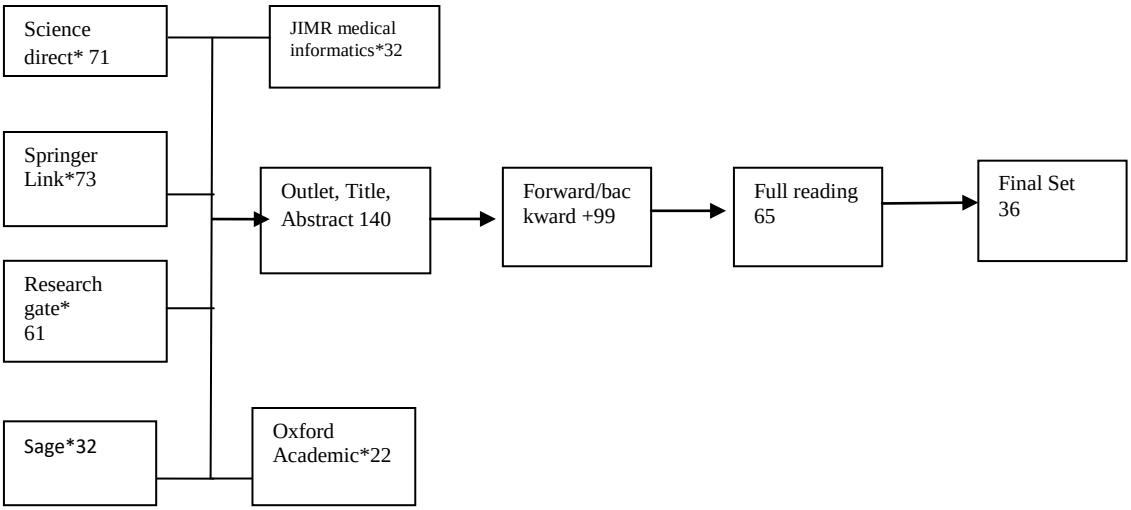
2.1 Scoping Process

In conducting the scoping review, the process involved a formal and detailed review protocol to address research questions. As recommended by leading methodologists, the protocol was not a

rigid tool to be used in a strict manner [6]. In contrast, it served as a guiding framework, which was modified as the researcher saw fit. In line with the scheme of a scoping review, the objective was to conduct comprehensive overview of prior work relevant to the research questions but willingly excluded even high quality papers on big data management and ehealth in healthcare if they did not help answer the research questions. The process involved defining sources of research to search, ways of accessing them and the rudimentary criteria for inclusion and exclusion of single paper [7]. As this research was focused on scientific knowledge on the application of ehealth and big data management in healthcare, the research was only interested in scholarly literature and hence excluded ideas, visions and manifold statements of ehealth and big data in healthcare proponents.

To have the best possible scoping review outcome different databases were searched. The databases comprised Science direct, Springer Link, Research gate, Sage, JIMR medical informatics and Oxford Academic. For the purpose of quality assurance, all working papers and workshop proceeding to be published were not considered and we retained only published academic work in conference proceedings and scholarly journal articles. The databases were selected to cover the fields of the multidisciplinary research topics. The search was conducted in 2017 and 2020. At first all the health related databases were searched using the term “big data” and the technological databases were searched for “big data management”, “ehealth” AND “healthcare”. To maximize the breadth of coverage and due to novelty of the concept of ehealth and big data management time restriction was excluded on the search. However, only papers written in English were included. All the selected papers were read and those papers that were not targeting the focus area were expunged from the abstract. A set of 36 papers were used to provide contents on the target focus area. Figure1 illustrates the numbers of papers that emerged from the selection process. In summary, a wide-range of literature that provided input to content analysis emanated from various disciplines and databases.

Figure 1.



What is Medical big data

Big data are data whose scale, diversity, and complexity require new architecture, techniques, algorithms, and analytics to manage it and extract value and hidden knowledge from it [9], [10].

The development of information and communication technology has led to the rapid growth of medical data encountered by various players in healthcare industry. Big Data in health encompasses high volume, high diversity biological, clinical, environmental, and lifestyle information collected from single individuals to large cohorts, in relation to their health and wellness status, at one or several time points. In other words medical big data refers to the fact that medical data today is often too large and heterogeneous and changes too quickly to be stored, processed, and transformed into value by traditional technologies. Moreover it refers to the vast quantities of information created by the digitization of everything that gets consolidated and analyzed by specific technologies. Applied to healthcare, the data of the population is analysed and used to potentially help prevent epidemics, cure disease, cut costs, etc. [11]. Furthermore, big data technologies hold the promise for consolidating and analyzing these digital treasure troves in order to discover trends and make predictions, improve patient care through guideline adherence, drug target discovery and validation and optimize clinical management approaches. The complexity of healthcare results from the diversity of health-related ailments and their co-morbidities. In addition the heterogeneity of treatments and outcomes as well as the subtle intricacies of study designs, analytical methods and approaches for collecting, processing, and interpreting healthcare data. There are various sources of medical big data, such as administrative claim records, clinical registries, electronic health records, biometric data, patient-reported data, the internet, medical imaging, biomarker data, prospective cohort studies, and large clinical trials [11]. Integration of these data sources causes complementary dimensions of data such as large size, disparate sources, multiple scales, incongruence's, incompleteness, and complexity. There is no universal protocol to model, compare, or benchmark the performance of various data analysis strategies in the healthcare sector in developing countries [12].

Medical big data have several distinctive features that are different from big data from other disciplines. Medical big data are frequently hard to access and most researchers in the medical field are hesitant to practice open data science for reasons such as the risk of data misuse by other parties and lack of data-sharing incentives [13]. Medical big data are often collected based on protocols and are relatively structured, partially due to the extraction process that simplify raw data. Another important feature is that medicine is practiced in a safety critical context in which decision-making activities should be supported by explanations. Medical big data can be costly due to involvement of the personnel, use of expensive instrumentation, and the potential discomfort of the patients involved. Medical big data are relatively small compared to data from other disciplines, and may be collected from a non-reproducible situation. Medical big data can be further affected by several sources of uncertainty, such as measurement errors, missing data, or errors in coding the information buried in textual reports. Therefore, the role of the domain knowledge may be dominant in both analyzing the data and interpreting the results [12]. Other distinctive features of medical big data in analytic aspects includes the different types of patient characteristics, which sometimes may require weighting; the time structure, which may be an additional dimension; and treatment information, time point of treatment decision and change.

A medical big data project involves making sense out of all accumulated data on as many variables as possible due to increasing availability and decreasing expense of computing technology. Basically, there are four ways in which a project might be big data: material, question, analytic method, and aspiration [14]. Medical big data may include data from new sources as materials for analysis, such as the internet, social media, and so on. Medical big data can give answers to questions focusing on the usefulness of locally stable associations and correlations even in the absence of causal evidence as well as with analytic methods such as new,

often nonlinear, tools for pattern recognition from computer science and other fields, in addition to the conventional statistical tools. Finally, medical big data technology has been increasingly viewed as the catalyst for a continuously learning health system allowing bidirectional flow between healthcare research and operations [14].

Potential Use of big data and ehealth in the Kenyan healthcare sector

Kenya is a Lower Middle Income Country (LMIC) facing significant challenges in the healthcare sector. The healthcare sector is acknowledged as having trailed behind other industries, for example the financial sector, in the usage and implementation of new information technologies. Manual processes represent a substantial part of the processes resulting to generation of huge amounts of unstructured data [15], [16], [22], and [25]. Over time, health-related data will be created and accumulated continuously, resulting in an incredible volume of data. The already daunting volume of existing healthcare data includes personal medical records, radiology images, clinical trial data submissions, human genetics and population data genomic sequences. The enormous variety of data structured, unstructured and semi-structured is a dimension that makes healthcare data rather challenging. Relatively little of this data can presently be captured, stored and organized so that it can be manipulated by computers and analyzed for useful information [2],[3]. Healthcare applications in particular need more efficient ways to combine and convert varieties of data including automating conversion from structured to unstructured data. Velocity of mounting data will increase with data that represents regular monitoring, such as multiple daily vitals measurements. Meanwhile, in many medical situations in developing countries, Kenya included, constant real time data can mean the difference between life and death. The ability to perform real time analytics against such high volume data in motion and across all specialties would revolutionize healthcare. Veracity or data assurance is very key to timely interventions by the clinicians for improved outcomes. Veracity assumes the simultaneous scaling up in granularity and performance of the architectures and platforms, algorithms, methodologies and tools to match the demands of big data to ensure there is optimal accuracy [17].

Thus big data can be used in healthcare to improve healthcare quality and patient outcomes while increasing data availability, and increasing analytic capabilities. In addition the potential of big data analytics application is improving the values of healthcare by improving outcomes and reducing waste in resources. The strength of big data is finding associations, not showing whether these associations have meaning, and finding a signal is only the first step. Big data analytics are generally not focused on causal inference, but rather on correlation or on identifying patterns amid complex data [2], [3]. The potential value of medical big data in the Kenyan healthcare sector has been demonstrated in: 1) the delivery of personalized medicine; 2) the use of clinical decision support systems such as automated analysis of medical images and the mining of medical literature; 3) tailoring diagnostic and treatment decisions and educational messages to support desired patient behaviors using mobile devices; 4) big data driven population health analyses revealing patterns that might have been missed if smaller batches of uniformly formatted data had been analyzed instead; and 5) fraud detection and prevention. Furthermore, the monitoring of molecular characteristics in the course of treatment to use for prediction and treatment decisions, and continuous monitoring of individuals' health are among the potential uses of medical big data. Moreover, population management, drug and medical device safety surveillance, and precision medicine with clinical decision support are other benefits [18], [8], [5]. Besides predictive analytics using big data technology can be utilized to

predict the future behavior of individuals in order to drive better healthcare decisions. For example, gain future insights, based on a full picture of associations, across time or a wide geographic area, or observed in a substantial fraction of entire population. Thus, big data are necessary but not sufficient, and simply accumulating a large dataset is of no value if the data cannot be analyzed in a way that generates future insights that can be acted upon in enhancing decision making. However despite these benefits there are a myriad challenges that need to be addressed before developing countries like Kenya can harness the full potential of big data in healthcare.

Potential Use of big data in Management of Non Communicable Diseases

Although the burden of disease in developing countries continues to be dominated by communicable diseases, countries are undergoing a demographic transition leading to increasing prevalence of non-communicable diseases [25]. Non-communicable diseases (NCDs), also known as chronic diseases, tend to be of long duration and are the result of a combination of genetic, physiological, environmental and behavioural factors. The main types of NCD are cardiovascular diseases, cancers, chronic respiratory diseases and diabetes. NCDs disproportionately affect people in low- and middle-income countries where more than three quarters of global NCD deaths 31.4 million occur [30]. NCDs are characterized by their long duration or continual recurrence and slow progression, and high prevalence. Data from the Global Burden of Disease study showed that the most common chronic sequelae, as consequences of disease, are largely attributable to NCDs [33]. In cognizance of this disease burden of NCD's, healthcare institutions need to take advantage of the emerging technologies for enhanced service delivery as well as better outcomes for patients. Such technologies include big data analytics and ehealth. Big data analytics in healthcare has given a deeper insight into the management of non-communicable diseases. It has helped re-define the catalogue of diseases, as well as providing new opportunities for improving disease management, including therapeutic response, and even development of new therapeutic agents. Big data can develop personalised and targeted healthcare. The purpose of personalised medicine is to facilitate clinical decision-making that is predictive, personalised, preventive and participatory. Personalised medicine affords individuals with targeted diagnosis of disease and therapies according to their own profile. Individual profiles can be captured by a variety of data sources including electronic health record, genomic data and personally captured data [26]. In personalised care a clinician can use a combination of patient history, behaviours and genetic data to identify individualised treatments and drugs. Depending on how this information is stored and shared the clinician can also potentially compare their patient profile to a databank of similar patient profiles. With this information, clinicians are empowered to make evidence based decisions including the ability to narrow down appropriate drugs, avoid side effects and adverse reactions; provide more insightful advice on risk prediction and focus on prevention [26].

In Kenyan public hospitals the patient's data is in large volumes disintegrated and found in different places [16]. This makes it really difficult to enhance timely decision making. Thus there is a need to collect, store and analyze this data into a single electronic system. Business Intelligence may be applied collect data, store and analyze patient's data, in order to provide deeper insights that will help in better decision making [20]. This data may include; patients medical history, physical exams, laboratory results, radiology examinations and drug reactions. To effectively improve health care for patients, big data analytics may be used to combine all the patient's medical records. Different types of data stored in the system can be analyzed depending

on the clinician's request and exported in pdf format. This can assist clinicians to analyse different kinds of medical data, develop specific care plans, monitor treatment doses of patients and make follow up for better outcomes. Analyses of this kind of information may be helpful to the clinicians in enhancing treatment [27]. In addition it may assist the clinicians to have timely interventions, better management of any drug reactions and better outcomes. By getting insights such as medication type, symptoms, and the frequency of medical visits, among many others, it is possible for healthcare institutions to provide accurate preventative care and ultimately, reduce hospital admissions. Not only will this level of risk calculation result in reduced spending on in-house patient care, but it will also ensure that space and resources are available for those who need it most [27].

In management of cancer as an example, medical researchers can use large amounts of data on treatment plans and recovery rates of cancer patients in order to find trends and treatments that have the highest rates of success in the real world. For example, researchers can examine tumor samples in bio databases that are linked up with patient treatment records. Using this data, researchers can see things like how certain mutations and cancer proteins interact with different treatments and find trends that will lead to better patient outcomes. This data can also lead to unexpected benefits, such as finding drugs that have the ability to manage certain cancers [27]. Moreover cancer is triggered by genetic changes and often genome information is required for therapeutic treatment. In this direction, big data as a huge data repository would provide enough information about human genomics, patients' case reports and their background details. The valuable insight which can be obtained from the data would help to identify the genetic changes which had triggered cancer in a patient and the treatment procedure [34], [35]. In management of diabetes for instance, data collected can be transmitted on real time basis to care teams. Any change in key indicators can trigger notifications to the care team allowing for intervention or changes in treatment options. Thus patients are able to adopt healthier lifestyle choices, know how to reduce advancement of the disease and other comorbidity factors, thereby enjoying greater wellness and reduced treatment needs. On the other hand health care providers are able to closely monitor patients and their progression allowing them to intervene earlier to offset disease progression [31]. In management of cardio vascular diseases the data collected from a variety of sources would help clinicians have a better understanding of heart diseases, the development of new therapy targets, improved drug utilization and the laying of the scientific foundation for a for personalised treatment. High-risk patients can be identified through data analytics offering an opportunity for preventative engagement. On the other hand patients would be able to adopt healthier lifestyle choices known to reduce advancement of the disease and other co-morbidity factors, thus enjoying greater wellness and reduced treatment needs.

Challenges of using big data management in the healthcare sector

Healthcare institutions often fail to know even the basics of what big data actually is, what its benefits are, what infrastructure is needed, etc. Devoid of a clear understanding, a big data adoption project risks being doomed to fail. Thus healthcare institutions may waste lots of time and resources on things they don't even know how to use. Additionally if employees don't understand the value of big data or are unwilling to change the existing processes for the sake of its adoption, they can resist it and impede the institutions progress [19], [6]. Moreover confidentiality and data security emerges as an issue of concern in big data management**.** Data security is the number one priority for healthcare organizations, especially in the wake of a rapid-fire series of high profile breaches, hackings, and ransomware episodes. From phishing to malware attacks, healthcare data is subject to a nearly infinite array of vulnerabilities [32], [29].

Patients fear that misappropriation of their health information particularly medical data may adversely affect personal circumstances, including insurance coverage and employment. Unfortunately, data access and confidentiality risks are directly correlated. Currently there is a Data Protection Act in Kenya [36]. The act focuses on protection of the subjects data in terms of confidentiality, integrity and availability of the same. However most of the subjects may not be aware of their rights as the act is relatively new. On the other hand new devices and technologies like cloud computing provide a gateway to access and to store information for analysis. This integration of IT architectures will pose greater risks to data security and intellectual property. Researchers have technical infrastructure to access the data from any data source including social networking sites, for future use whereas the users are unaware of the gains that can be generated from the information they posted [18],[12]. Big data researchers fail to understand the difference between privacy and convenience thus posing a security threat to the patient's data.

A competing challenge is access to information. Individual perceptions of powerlessness in data control are currently at odds with organizational beliefs of data ownership. Concerns regarding data access and use legitimize the question: are society's best interests in mind as data access pathways are negotiated? For the consumer, a primary concern is third-party access and data control. Companies, too, are interested in internal collection and use of information but also worry about disclosure of intellectual property. The financial and nonfinancial interests of health care providers may also be challenged by information sharing. These organizations may consequently be less inclined to disclose information regarding performance or may actively work to game data return through exception reporting or singling out of patients, giving rise to concerns of data validity [19], [20], and [27]. Data reliability is an issue of concern in use of big data systems in healthcare. At an operational level, manually fed electronic health data may be prone to error and bias from human entry. Yet, regularized systems can also introduce systematic bias into data collection and analysis. For example, public health institutions lacking adequate technological infrastructures to document and share information may only be able to capture data from a subset of the population or may in fact capture incorrect information if collection or processing algorithms are flawed. For instance if an electronic medical records system lacks information about a medical event, it is not necessarily because the event did not occur. Blind acceptance of big data should therefore be cautioned against. As a result there is a need for measured use of big data and careful interpretation of results, as well as investment in big data system development and audit [14], [8]. Data interoperability poses a challenge in development of ehealth systems. Interoperability is crucial for recording and sharing health information, developing common interfaces, agreeing on common data sets, and defining quality standards. Interoperability necessitates development of data platforms in an international, comparable context and thus requires common principles. In Kenya for instance there no common agreed standards on how data is shared between healthcare institutions. In addition there are no standards on how different healthcare institutions are integrated to share data. Basically different countries have different regulations, making it difficult for coordination and collaboration between researchers and other healthcare institutions. Interoperable data sets are further complicated by varying clinical standards and languages [5], [12]. Management and Governance is cited as a challenge**.** There is little information in the published literature discussing governance and management of health data in developing countries Kenya included. There is little evidence of coordinated efforts to promote health sector objectives through the use of big data. It also remains unclear how responsibilities regarding health data systems are shared among different organisations both locally and globally. From a user's perspective, improved clarity on

health data governance and management is needed and may facilitate access and effective data use [17], [16]. Big data implementation projects entail lots of expenses yet developing countries are still grappling with issues of inadequate funding. There are the costs of new hardware, new hires and electricity. Additionally there is the cost of development, setup, configuration and maintenance of new software. The choice of cloud based big data solutions, would require hiring of staff, paying for cloud services, big data solution development as well as setup and maintenance of needed frameworks [16]. Moreover, there is an additional cost of catering for future expansions to avoid big data growth getting out of hand. [6]. Heterogeneity of data presents difficulty in big data analysis. The huge size and highly heterogeneous nature of big data in healthcare renders it relatively less informative using the conventional technologies. High volume of medical data collected across heterogeneous platforms has put a challenge to data scientists for careful integration and implementation [28]. New strategies and technologies should be developed to understand the nature, complexity and volume of the data to derive meaningful information. The most common platforms for operating the software framework that assists big data analysis are high power computing clusters accessed via grid computing infrastructures.

Possible solutions

Business Intelligence (BI) is a tool that can be used to manage big data in healthcare. BI is a technology or a methodology and an architecture used to collect, store and analyze data, in order to provide deeper insights that will help in better decision making. BI is proven to have the capability to operationalize repository data such as medical records so that evidence-based medical practice is possible, thereby improving healthcare delivery [20]. Due to the dynamics of our society in terms of changes in laws, regulations, and the amount of data generated, healthcare organisations are employing business intelligence (BI) solutions to utilise data for accurate decision-making. In addition it helps improve services provided to patients, reduce administrative and service costs, as well as safeguard the prospect of healthcare industry. Healthcare providers and professionals now treat healthcare delivery as a business, thereby propelling BI to gain tremendous attention in this sector. BI as an architecture provides a framework that shows processes, which connect both internal and external actors within the healthcare environment. Thus, decision makers in healthcare need to be mindful of those processes in order to have an understanding of the usefulness of BI in healthcare [20], [5].

As the data becomes more regional and global, it gets more complicated and have more serious impact on security, standards, language and terminology. The accessibility and security of the healthcare data need to be consistently reviewed and monitored. Healthcare facilities in Kenya can do this by using transmission protocols, multilayer authentication, monitoring and auditing, anti-virus software, access control, data masking and data encryption. Big data is massive, less structured and heterogeneous. As such there is a need to identify and classify the data so that it can be used effectively [32], [29]. Although big data is excellent for modelling and simulation, there is a need to identify structure and pool the proper relevant data so that it can be used to model the healthcare problems, which later can be used for intervention and improved outcomes [21],[14]. In the absence of proper structured data, it is challenging to analyse and visualize the output and extract specific information or data. Cloud computing offers groups of servers, storages and various networking resources that can be exploited by Big Data analytics. Therefore, cloud computing appears as an efficient way to increase productivity while reducing cost to process and store huge amount of data. The cloud storage can be used to upload data or

having the whole system designed in the cloud. It offers high reliability, scalability and autonomy along with ubiquitous access, dynamic resource discovery and composability. Thus, the cloud will need to have sufficient space for the storage and sufficient speed for data upload at the same time. [6], [14], [8].

Data interoperability is a perennial concern for organizations of all types, sizes, and positions along the data maturity spectrum. Fundamental differences in the way electronic health records are designed and implemented can severely curtail the ability to move data between disparate organizations [17],[8]. This often leaves clinicians without information they need to make key decisions, follow up with patients, and develop strategies to improve overall outcomes. In that regard block chain technology would be helpful in management of patient's information. Blockchain being a decentralized peer-to peer architecture has emerged as a promising means to provide trusted interoperable ehealth systems. A blockchain has the ability to collect information from web-based and mobile applications, as well as application programming interfaces (API), sensor technologies and integrate through representational state transfer (REST). Consequently, a healthcare blockchain in Kenya is likely to promote the development of a new breed of essential applications for healthcare providers that would mine the latest medical research and develop personalized treatment plans [17],[25]. The healthcare provider and patients would have access to the same information and would be able to engage in a collaborative, informed discussion about the best-case treatment options based on research rather than conjecture. To ensure big data understanding and acceptance at all levels, IT departments need to organize numerous trainings and workshops. This would go a long way in its acceptance and implementation. Thus top management would be critical in spearheading the change management process.

Conclusion and Further Research

Big Data and ehealth has great potential in changing the healthcare outlook such as drug discovery, patient's personalization care, treatment efficiency, improvement in clinical outcomes, and patient safety management. Despite the disruptions to conventional practices, all actors in health care should be excited about the possibilities that new data analytics will bring. But obtaining this enormous potential is yet to be realised and will require overcoming challenges by all of the relevant components of the health care system. Future work related to this research would focus on the adoption of big data analytics architecture in the healthcare sector.

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