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ICT A Solution for Big Data in South African Healthcare

Paul Kankwende

ABSTRACT

By digitizing, combining and effectively using big data, healthcare organizations ranging from single-physician offices and multi-provider groups to large hospital networks and accountable care organizations stand to realize significant benefits. Potential benefits include detecting diseases at earlier stages when they can be treated more easily and effectively; managing specific individual and population health and detecting health care fraud more quickly and efficiently. Numerous questions can be addressed with big data analytics. Certain developments or outcomes may be predicted and/or estimated based on vast amounts of historical data, such as length of stay; patients who will choose elective surgery; patients who likely will not benefit from surgery; complications; patients at risk for medical complications; or other hospital-acquired illness; illness/disease progression; patients at risk for advancement in disease states; causal factors of illness/disease progression; and possible comorbid conditions (EMC Consulting).

Keywords: Big data, Human interaction, Healthcare, Information Communication Technology (ICT)

Introduction and Background

and unstructured. And big data may be as important to business – and society – as the Internet has become.

Big data is a popular term used to describe the exponential growth and availability of data, both structured

Why? More data may lead to more accurate analyses.

Big data usually includes data sets with sizes beyond the ability of commonly used software tools to capture, curate, manage, and process data within a tolerable elapsed time.[13] Big data "size" is a constantly moving target, as of 2012[update] ranging from a few dozen terabytes to many petabytes of data. Big data is a set of techniques and technologies that require new forms of integration to uncover large hidden values from large datasets that are diverse, complex, and of a massive scale. [14]

The healthcare industry historically has generated large amounts of data, driven by record keeping, compliance & regulatory requirements, and patient care [1]. While most data is stored in hard copy form, the current

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trend is toward rapid digitization of these large amounts of data. Driven by mandatory requirements and the potential to improve the quality of healthcare delivery meanwhile reducing the costs, these massive quantities of data (known as 'big data') hold the promise of supporting a wide range of medical and healthcare functions, including among others clinical decision support, disease surveillance and population health management [2-5].

Problem Statement

Healthcare organisations are the central sources of where information is gathered from patients and entered into a data capturing system for processing and analysing of this data. Sepulveda and Young (2013) emphasized that this organisations are the purveyors of information, in the form of laboratory results, which may be numbers, text, graphs, or images, together with interpretive data, to assist health care providers in delivering optimal patient care. This data is captured highly desirable since it can be used to assist the decision makers to make informed decisions and provide adequate data to the respected team members to assist in saving patient lives.

That why it has become paramount to address the issue in having a reliable data capturing system to facilitate in the process of providing patient care. However, the challenges becomes on how to handle the capturing of big data? Akiyama and Koshio (2011) further highlighted that capturing and documenting accurate data of activities by medical workers that has a capability to facilitate high quality communication based on real-time accurate information. Akiyama and Koshio (2011), Went on to defend their statement by stating that by having an effective data capturing system can result in effective use of resources as well as improve patient safety. The captured data can contribute to the safety of patients and assist in improving health care delivery to patients. But the questions remains as to how do we address healthcare big data issue?

Literature review

Big Data

Among all the definitions offered for "big data," my favorite is that it means data that's too big, too fast, or too hard for existing tools to process. Here, "too big" means that organizations increasingly must deal with petabyte-scale collections of data that come from click streams, transaction histories, sensors, and elsewhere (Madden, 2012).

"Too fast" means that not only is data big, but it must be processed quickly — for example, to perform fraud detection at a point of sale or determine which ad to show to a user on a webpage.

"Too hard" is a catchall for data that doesn't fit neatly into an existing processing tool or that needs some kind of analysis that existing tools can't readily provide. A similar breakdown is being promulgated by Gartner (which is probably a sign that I'm oversimplifying

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things), citing the "three Vs" — volume, velocity, and variety (a catchall similar to "too hard").

Human interaction

Human interaction is a fundamental aspect and an integral part of every organisations. The purpose of human interaction is to ensure functionability and usability of an organisational system, as it relates to user friendliness (Carey, et al., 2004).

An organisations can have both technical and non-technical interactions. Non-technical interaction could refer to interaction that does not involve any form equipment, hardware or software, whereas interaction with a technical system, such as with computers, can be referred to as human-computer-interaction (HCI) (Stupak, 2009).

Jane, et al (2004) further explains that HCI is "concerned with the ways humans interact with information, technologies and tasks, especially in business, managerial, organisational and cultural contexts".

Thus, enhancing computer usability and receptiveness of the user's needs is indicated to improve
interactions between users and computers (Jacko, 2012).

Data capturing systems

The legacy paper based data capturing system currently being employed to manage and deliver patient care has become hindrance in delivering timely care to patients. Qin, Qin, and Liu (2011) confirmed that with the advancement in IT, more and medical devices or equipment are controlled, operated or managed by computers. Therefore, medical data becomes easier to be collected, processed and transported.

It has become critical that the processes undertaken in capturing data into a paper based system or electronic system has to be accurate and this has become critical in healthcare organisations. (Gunter, Yasmeen, Gunter, and Nguyen (2009) Confirms this by stating that humans use computers to carry out tasks that neither is able to do easily alone: humans provide eyes, hands, and judgment while computers provide computation, networking, and storage.

In order to improve on the current data capturing system it has become important to note and understand the current environment we are finding ourselves in. According to (Musa, Yusuf, & Meckel, 2012), in order to address this issues the necessary technology platform that would allow hospital assets, personnel and patients to be tracked in real-time for the purpose of optimising operations in all aspects of the daily activities of the hospitals. This is paramount as technology has become integral in the daily lives of patients and this needs to be harnessed in order to provide optimised patient care.

Having a data capturing system that is an enabler

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to health practitioners to carry out their duties effectively and efficiently can be integral information hub to the healthcare practice. According to (Konrad & Lawley,

2009) patient flow modeling is challenging on account of three factors: lack of consideration of patient activities from admission to discharge, incomplete acknowledgement of patient heterogeneity, and poor input data.

Information Communication Technology (ICT)

The introduction of information and communication technologies (ICTs) to rural community health workers (CHWs) has been shown to bridge lacunae in their work environment resulting from under-capacitated facilities, constrained access to information and delayed responses to emergencies (Ganapathy & Ravindra, 2008). In particular, the use of mobile phones has been noted in the monitoring of pregnancies, for treatment, and for post-natal healthcare support (Maniam, Chin, & Chenapiah, 2007).

According to Health Metrics Network FrameworkJanuary (2009) the health information system provides the underpinnings for decision-making and has four key functions: data generation, compilation, analysis and synthesis, and communication and use. The health information system collects data from the health sector and other relevant sectors, analyses the data and ensures their overall quality, relevance and timeliness, and converts data into information for health-related decision-making. Health information systems serve multiple users and a wide array of purposes that can be summarized as the generation of information to enable decision-makers at all levels of the health system to identify problems and needs, make evidence-based decisions on health policy and allocate scarce resources optimally (Geneve, WHO, 2008).

According to HIS, (2009) in the developing countries the health information system is not used by those providing or managing health services at the local level, as these individuals are often presumed to not need health information of this nature. The data collected is determined by users far removed from the actual delivery of health services, and seldom has relevance to improving those services.

Research Methodology

Data was collected from group interviews and workshop sessions. The semi-structured interviews was conducted with groups of doctors. There were nine groups, and there were four doctors in each of the groups. The workshop consisted of nurses from different areas of specialisation. The workshop lasted for five working days. The data which were collected from both doctors and nurses were combined for the purposes of this study. The data collection focused on how mobile application could be used to provide services to the communities.

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A conceptual model "Innovation-decision process" from the perspective of DoI theory was employed in the data analysis. In DoI theory, technological Innovation is communicated through particular channels, over time, among the members of a social system (Nemutanzhela and Iyamu, 2011). The theory is concerned with the manner in which a new technological idea, artifact or technique, or a new use of an old one, migrates from creation to use.

Diffusion is the "process by which an innovation is communicated through certain channels over a period of time among the members of a social system". An innovation is "an idea, practice, or object that is perceived to be new by an individual or other unit of adoption". "Communication is a process in which participants create and share information with one another to reach a mutual understanding" (Rogers, 1995).

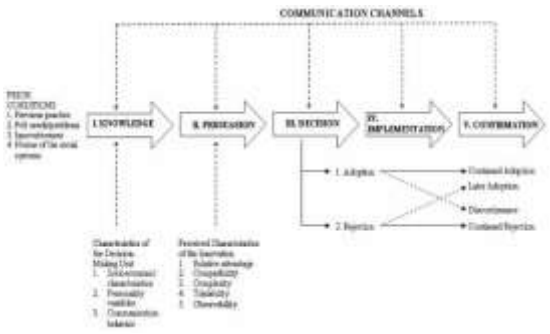

Figure 1: Innovation-decision process (Rogers, 1995)r

Rogers (2003), adoption is a decision of "full use of an innovation as the best course of action available" and rejection is a decision "not to adopt an innovation" (p. 177). Rogers defines diffusion as "the process in which an innovation is communicated thorough certain channels over time among the members of a social system" (p. 5). As expressed in this definition, innovation, communication channels, time, and social system are the four key components of the diffusion of innovations.

Data analysis

The data was analyzed to get a better understanding on how to use ICT as a solution to improve the process of using big data in healthcare instutions. Even though the data was combined, they are labeled according to the sources, Care Group and IT Group, for doctors and nurses, respectively. Using the Innovation-Decision Process conceptual model (Rogers, 2003), the analysis of the data is presented as follows:

Communication Channels Knowledge

Knowledge on the privacy and use of mobile health is required. However, because many healthcare organisations are already using different types of mobile health information systems it becomes easy to communicate this knowledge. With the growth of technology usage around the world, the knowledge and training required for the devices used because less costing as most people are familiar with the use of cellphones and tablets.

The use of this technology in the field of health and wellness is known as pervasive healthcare. Mobile

computing describes a new class of mobile computing devices which are becoming

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omnipresent in everyday life. Handhelds, phones and manifold embedded systems make information access easily available for everyone from anywhere at any time. We termed the integration of mobile computing to pervasive health care as mobile health care. The goal of mobile health care is to provide health care services to anyone at any time, overcoming the constraints of place, time and character.

According to Right to Care health service in South Africa, "the nurses are more knowledgeable on the use of mobile devices (Tablets and Phones) which made it easier for them to translate the knowledge of using these technologies.

Persuasion

In short, many countries including the United States are challenged to provide adequate health care. Difficulties include physical distance between doctors and patients, too few skilled health care professionals and the extraordinary complexity between insular medical systems and costs of health care equipment and infrastructure. In addition, the current epidemic of chronic illnesses, in both developed and developing economies, illustrates the need for innovative, efficient, technology-supported interventions. According DocGroup "*Without comprehensive security safeguards to protect patient privacy, the transition to electronic medical records systems may well fail. Patients must believe that use of health information technology is in their best interest and buy into the mammoth effort to transform the practice of medicine through digitization*". Any well-publicised privacy leaks could erode patient trust in computerised systems and create political backlash against them, especially if the breaches cause discernable harm, such as embarrassment, loss of employment opportunities, or damage to reputation. Fear of such consequences may cause individuals to forego needed medical care or not to be fully candid with Clinicians who treat them.

Mobile technologies offer the ability to connect patients with their doctors, care-givers and loved ones and enable timely health monitoring which suggests improved patient engagement and better health outcomes. Mobile technology can aid in providing access to information, helping to lower costs, facilitating remote care and increasing efficiencies by connecting patients to their providers virtually anywhere. Mobile health applications and services are becoming an essential tool in extending health care resources around the world.

To help ensure successful adoption of mobile Health Information System to be used to improve big data and wellness testing, the people (Nurses) who will use the mobile system most frequently must be included in the implementation project from the beginning. They will have the most knowledge of what graphic user interface works best to ensure efficient hospital workflow. They will be able to think of usability issues that executives might not be aware of. They would be the logical people to test the mobile devices before the

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New technology usually increases costs. However, DocGroup, usually improves the medical outcome that can be achieved". As with other industries, a better product sometimes carries a higher, but justifiable cost.

In general a very positive perception of mobile technology devices by doctors was evident even though half of them had never come into contact with one before. They perceived the device being able to provide them with relevant information either via the internet or software for the device. They perceived the device as a reference tool, patient information tool and even contemplated its use as a decision support tool that could help in diagnosis and medication prescription. *However, NuGroup said "It also usually improves the medical outcome that can be achieved". As with other industries, a better product sometimes carries a higher, but justifiable, cost.*

Decision

What decisions needed to be made?

When dealing with sensitive data that has a big data status of patients certain measures should be taken to help prevent loss or theft in the first place. Devices should be stored securely if not in use, for example. GPS activation can be utilized to monitor device location. Consequences should be established for the hospital employee if the device is lost. An education program with reminders should be put in place to educate employees about keeping their devices safe. In the event of loss or theft, there should be a feature on the device that allows the hospital tech department to remotely (selectively) wipe the data off of the device. According Nugroup, study conducted showed that it will cost a lot to actually make sure that the electronic medical record system is functioning properly without any use of paper. However, if this process can be fully functional lot of benefits will be achieved, and risk of data being accessed by wrong people will be reduced.

Reason being when making a decision as whether to adopt this innovation the following should also be taken into consideration Medical devices are approved if "the device successfully performs as intended in a manner in which benefits outweigh expected risks". According to DocGroup "*on devices used by doctors. There has to be a balance of using technology to make the job more productive versus the risk of private data being accessible by people not authorized.* However, one of the Nugroup states that "*In general electronic health records are safer than paper, if they aren't accessible online. Stealing paper records isn't too difficult in small scale. And if electronic medical records are appropriately encrypted, then even if data is accessed improperly the data is unreadable. Unlike with paper records that can be read by anyone*".

Lack of resources to support their use of these devices by the hospitals did not negatively

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influence their

Implementation

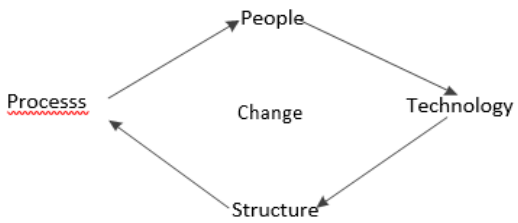
Intention to adopt. This could be attributed to the social circumstances South African doctors find themselves in, where they have learnt to cope with limited resources on a daily basis. Despite their extremely pressurised work environments, and poor hospital management and administration, patient care is uppermost in their minds. According to DocGroup "*we are will to use our personal mobile phones and tablets to initiate this project". This group was persuaded and were willing to give this innovation a go.*

While the patient's adoption of mobile health technology has been rapidly trending upward, physicians and healthcare systems are often not yet equipped to use and/or disseminate the mobile Health data obtained by their patients and vice versa. Over time through additional innovation, adoption of required skills, and acceptance, mobile healthcare technology as a medium for receiving one's health data will become as much a part of everyday patient healthcare as picking up the phone and/or driving to their healthcare provider for treatment. According to NuGroup, "*Our Patient will appreciate the use of this new technology more especially those who use to wonder where we take those papers that have their details, some will resist at first because of fear to change."*

Confirmation

The development of mobile medical applications has opened new and innovative ways for technology to improve health and healthcare for all consumers. The large adoption rate from consumers of smartphone mobile medical apps is one example of their willingness to embrace this newer method of receiving and delivery medical care.

Big data analytics has the potential to transform the way healthcare providers use sophisticated technologies to gain insight from their clinical and other data repositories and make informed decisions. In the future we'll see the rapid, widespread implementation and use of big data analytics across the healthcare organization and the healthcare industry. To that end, the several challenges highlighted ove, must be addressed. As big data analytics becomes more mainstream, issues such as guaranteeing privacy, safeguarding security, establishing standards and governance, and continually improving the tools and technologies will garner attention. Big data analytics and applications in healthcare are at a nascent stage of development, but rapid advances in platforms and tools can accelerate their maturing process.



Change

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Healthcare is no different. Beyond improving profits and cutting down on wasted overhead, 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. 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.

Technology

For this study advantages of technology include better accessibility of data. Smart phones were just the start. With apps enabling them to be used as everything from pedometers to measure how far you walk in a day, to calorie counters to help you plan your diet, millions of us are now using mobile technology to help us try and live healthier lifestyles. More recently, a steady stream of dedicated wearable devices have emerged such as Fitbit, Jawbone and Samsung Gear Fit that allow you to track your progress and upload your data to be compiled alongside everyone else's.

In the very near future, you could also be sharing this data with your doctor who will use it as part of his or her diagnostic toolbox when you visit them with an ailment. Even if there's nothing wrong with you, access to huge, ever growing databases of information about the state of the health of the general public will allow problems to be spotted before they occur, and remedies – either medicinal or educational – to be prepared in advance.

However, several challenges with big data have yet to be addressed in the current big data distributions. Two roadblocks to the general use of big data in healthcare are the technical expertise required to use it and a lack of robust, integrated security surrounding it.

People

The value for big data in healthcare today is largely limited to research because using big data requires a very specialized skill set. Hospital IT experts familiar with SQL programming languages and traditional relational databases aren't prepared for the steep learning curve and other complexities surrounding big data.

In fact, most organizations need data scientists to manipulate and get data out of a big data environment. These are usually Ph.D.-level thinkers with significant expertise—and typically, they're not just floating around an average health system. These experts are hard to come by and expensive, and only research institutions usually have access to them. Data scientists are in huge demand across industries like banking and internet companies with deep pockets.

The good news is thanks to changes with the tooling, people with less-specialized skillsets will

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be able to easily work with big data in the future. Big data is coming to embrace SQL as the lingua franca for querying. In addition, when this happens, it will become useful in a health system setting.

Structure and Processes

The biggest difference between big data and relational databases is that big data does not have the traditional table-and-column structure that relational databases have. In classic relational databases, a schema for the data is required (for example, demographic data is housed in one table joined to other tables by a shared identifier like a patient identifier). Every piece of data exists in its well-defined place. In contrast, big data has hardly any structure at all. Data is extracted from source systems in its raw form stored in a massive, somewhat chaotic distributed file system.

The lack of pre-defined structure means a big data environment is cheaper and simpler to create. So what is the catch? The difficulty with big data is that it is not trivial to find needed data within that massive, unstructured data store. A structured relational database essentially comes with a roadmap—an outline of where each piece of data exists. On the big data side, there are no traditional schemas, and therefore not much guidance. With a relational database, a simple, structured query language (i.e. SQL) pulls the needed data using a sophisticated query engine optimized for finding data.

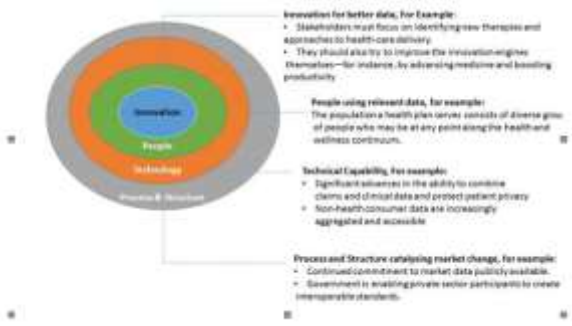

Figure 2: Big data multiple positive changes has created a tipping point for innovation

Conclusion

Although we are optimistic about big data's potential to transform healthcare, some structural issues may pose obstacles. The move away from fee-for-service care already well under way must continue. Similarly, traditional medical-management techniques must change, since they pit payers and providers against each other, framing benefit plans with respect to what is and is not covered rather than what is and is not most effective. Moreover, all stakeholders must recognize the value of big data and be willing to act on its insights, a fundamental mind-set shift for many and one that may prove difficult to achieve. Patients will not benefit from research on exercise, for example, if they persist in their sedentary lifestyles. In addition, physicians may not improve patient outcomes if they refuse to follow treatment protocols based on big data and instead rely solely on their own judgment.

Privacy issues will continue to be a major concern. Although new computer programs can readily remove names and other personal

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information from records being transported into large databases, stakeholders across the industry must be vigilant and watch for potential problems as more information becomes public.

Big-data initiatives have the potential to transform healthcare. Stakeholders that are committed to the rewards of big data and help patient achieve better outcome, innovation, willing to build their capabilities, and open to a new view of value will likely be the first to reap