The current and potential role of blockchain-based technology in managing medical records in Africa

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Abstract

Accurate and well-managed medical records play a major role in high-quality health care. They are a valuable asset that allows hospitals to treat patients in an effective and efficient way. They also play an important role in health care governance, providing evidence in court cases between patients and hospitals. However, in Africa, medical records are not given much academic attention. Good record-keeping has been hampered by a poor management, as well as a lack of trained personnel who understand how to record and keep these records. This study is aimed at exploring the utilisation of blockchain technology in improving medial records at African hospitals. The reserach is qualitative, comprising desktop research of secondary material and its analysis. It finds that poor medical records in hospitals contribute to the prevalence of disease in African countries, which results in funds that could be invested in development projects being diverted to health care instead. It also shows that 4IR, specifically blockchain-based technology, could play a significant role in the management of medical records in Africa. It could help staff to capture and maintain more accurate medial records, and ensure their security and longevity. Moreover, it could improve access to medical records for all health practitioners. Patients could also access their records, thus helping them to evaluate and manage their own health.

Keywords: Medical records, medical records management and governance, blockchain-based technology, health care systems

Introduction

Accurate medical records play a major role in effective medical care. They are also a vital source of information for understanding health services, diseases, and disparities in health and health care. They are also vital for redressing health disparities in patient populations. High-quality health care depends on the ongoing documentation of diseases and their treatment, recorded by authorised health care professionals. Good medical health are required for the delivery of high-quality health services, which improves the health of a given population in turn. According to Luthuli and Kalusopa (2017:2), effective medical records play a vital role in good health service delivery, and ultimately in relieving Africa's health burden. Medical records must be accurate and complete, in order to facilitate ongoing diagnoses and to help health care professionals provide patients with the most appropriate treatment. Wll-

maintained medical records help hospital administrations to run smoothly. To summarise, good medical care depends on accurate record-keeping (Abdulazeez 2015).

According to the NHO's Health Care Records Management Steering Committee (2007: 16), record management is the 'systematic and consistent control of all records in which they are held throughout their life cycle'. According to the World Health Report (2000), the health of a nation partially depends on access to medical records. According to the World Health Organization (WHO), health information records and management determine everything from the availability of health services to the quality and effectiveness of professionals. They also determine the financial resources required for a patient to receive health care services. Medical records are also important for governing health care recipients and providers. They play a key role in heal care policy-making and implementation and ultimately the achievement of good health care governance, which contributes to the health of a nation and the wellbeing of its citizens.

Howson, Fineberg, Bloom (1998) note that policy-makers, practitioners and other role players in the global health system rely on medical records when they design policies for treating patients in hospitals and clinics. Effective management of medical records or health information boosts the maintenance and improvement of curative, preventive, rehabilitative and palliative care. Obversely, poor management of medical records have a range of high negative consequences.

A failure to manage medical records results in poor regulatory frameworks in which vital patient data is fragmented in the form of sheets of paper, scanned images, and electronic data, whose inefficiency ultimately drives up costs (Medeiros and Schwierz 2015). High mortality reates in Africa is the result of negligence coupled with poor diagnoses and treatment, often caused by poor record-keeping (Marutha 2011; Katuu 2015; Pyrene 2015; Marutha 2016). In South Africa, despite efforts to equalise health services for all, poor governance and poor management of medical records has hampered health service delivery, and created numerous problems that overwhelm the health care system (Kaseje 2006).

In Kenya, poor record-keeping has widened the gap between the rich and poor in terms of access to health care services, and opened the door to chronic corruption and inflows of counterfeit drugs that worsen patients' conditions (Oketch 2017: 19). Oketch (2017:21) argues that poor medical records are not only a major cause of iatrogenic injuries, but also make it more difficult to conduct a clinical negligence claim or disciplinary inquiry. It is axiomatic in Africa that poor medical record-keeping is evidence of poor clinical practice. It leads to delayed and inappropriate treatment, wastes time, and frustrates both health care providers and recipients (Alegbeleye 2009).

Against this background, this study examines whether digital technologies, and specifically blockchain-based technology, can be utilised to improve medical record-keeping in African settings, thus contributing to improved health care and heal service delivery. This has received insufficient academic attention. According to several analysts, blockchain-based technology could provide a reliable platform for electronic health records (Koushik et al 2019: 985). Blockchain technology is a new type of digital technology that consists of 'a shared, immutable ledger that can better ensure the resilience, provenance, traceability, and management of health data' (Mackey et al 2019: 2), and can 'shape the foundation of a decentralised medicinal service stage shared by the patients and suppliers, acting as an interface to the patient's record' (ibid). It is decentralised, which provides open access to

patients and medical practitioners alike, and can there make a major contribution to improed medical care (Haddad et al 2021).

This study confirms that blockchain-based technology can indeed improve the management of medical health records, thereby addressing major problems plaguing Africa's health care industry. This, in turn, can improve the physical wellbeing of African citizens, a prerequisite for sustainable development.

The aim of this paper is therefore to evaluate the benefits of applying 4IR technologies in the health care industry, with a particular emphasis on exploring and conceptualising the role of blockchain-based technology for managing medical records.

It seeks to answer the following research question: *how can blockchain-based technology be utlised to improve medical record-keeping in Africa, thereby improving health care and the wellbeing of African citizens?* The next section sets out the conceptual framework utilised for this study, and the methods used to collect and analyse data. Next, the data is presented and analysed, following by conclusions and recommendations.

Definition of terms

The first term we need to define is 4IR. It was coined by Klaus Schwab, founder and executive chairman of the World Economic Forum. He described a 'world in which individuals move between digital domains and offline reality, utilising connected technology to enable and manage their lives' (Miller 2015: 3). Velásquez, Estevez and Pesado (2018: 259) note that 4IR is not subject to a singular accepted definition; however, they characterise it as incorporating Information Technology (IT) into Operations Technology (OT) in a way that 'allows communication between machines and the use of customers' data in the production process to enable the customisation of products'. Zezulka et al (2016: 8) further state that 4IR serves three interconnected purposes, namely: (i) the digitisation and integration of any economical complex networks; (ii) the digitisation of products and services, and (iii) new market models, adding: 'These human activities are interconnected by communication systems.'

The first industrial revolution involved the transformation of an agrarian and handicraft economy into one dominated by industry and machine manufacturing In the second, mas producdtion was aided by the discovery of oil and electricity. The third industrial revolution involved the introduction of information technology (IT), used inter alia to automate production (Xu, David & Kim 2018: 90). While each industrial revolution is frequently regarded as a separate event, they can be better understood as a series of events that built on the innovations of the previous revolution and led to more advanced forms of production.

This means that numerous parallels exist between four industrial revolutions and the five ages of civilisation: the hunter-gatherer age, the agricultural age, the industrial age, the information worker age, and the emerging age of wisdom (ibid: 91). Covey (2011: 11-17) argues that 'the characteristics of these five ages of civilisation can be used to infer the opportunities of the 4IR'. Every industrial revolution has had ramifications for and negative impacts on the world at large. It has been argued that the productivity of each succeeding age increases 50 times over the preceding age, with the most notable increase from the articultural to the industrial age (Xu, David & Kim 2018: 91). Furthermore, each succeeding age eliminates many of the jobs created by the preceding age; for example, the information age is replacing the jobs created by the industrial age (ibid). The numerous job losses occasioned by the advent of 4IR

have almost nothing to do with government policy or free trade agreements, and everything to do with the dramatic shift to the 'knowledge worker' (ibid). Thus the 4IR has resulted in very significant changes and is transforming entire production, management and governance systems (Schwab 2015).

Medical records

Luthuli and Kalusopa (2017:4) define medical records as written accounts of a patients' examination and treatment that include the patients' medical history and complaints; the physicians' findings; and the results of diagnostic tests, procedures, medications and therapeutic procedures. The International Records Management Trust (IRTM) defines them as 'patient records' (1999: 10), and Haux (2006: 272) as a 'confidential record kept by a health care professional or organisation for each patient Medical records include 'personal information about the patient (such as name, address, and date of birth), a summary of the patient's medical history, and documentation of each event, including symptoms, diagnosis, treatment, and outcome' (ibid). Furthermore, Huffman (2001) defines medical records as 'any records that document the pertinent facts of a patient's life and health history, including past and present illness (es) and treatment(s), as written down by the health professionals handling the patient's care'.

Medical record management

The IRMT (2009) defines record management as the task of ensuring that all recorded information, regardless of form and medium, is managed in an economical and efficient manner. Zali et al (2018: 1) note that medical record management provides 'evidence of activities or business transactions'. This means that the purpose of medical records is to record past diagnoses and treatments, thereby easing the task of future medical care practitioners. They further submit that good health record management provides a foundation for making informed health care decisions and good health care policies, based on a solid foundation of knowledge. According to the IRMT (1999: 12), good health record management is necessary for the delivery of high-quality health services and the achievement of high levels of performance in hospitals and agencies.

Blockchain-based technology

According to Sadiku, Kelechi and Sarhan (2018), blockchain-based technology consists of a shared or distributed database used to keep track of a growing list of transactions known as blocks. The term 'blockchain' refers to the way in which transaction data is stored in blocks that are linked together to form a chain (Sadiku, Kelechi and Sarhan 2018: 155). This is often referred to as the 'chain of trust'. When applied to governance, blockchain technology has the potential to increase trust, accountability, openness, participation and transparency. In the business world, it is used to aid transactdions and streamline business processes (ibid). Satoshi Nakamoto created this technology in 2008 as the foundation for the exchange of the digital cryptocurrency popularly known as Bitcoin. The technology serves as the foundation for cryptocurrencies such as Bitcoin, Litecoin, and Ethereum (ibid).

Blockchain has largely been utlised in the financial industry, allowing Bitcoin to operate, among others (Tsai et al 2017: 452; Iansiti and Lakhani 2017). Today, blockchain technology is used in a variety of industries, including health care, insurance, pharmaceuticals, manufacturing, e-voting, legal contracts, tourism, energy, and travel (Engelhardt 2017; Manski 2017: 514). For example, blockchain-based technology can be used to improve patient care, financial

transactions, drug distribution, and medical record management and governance. According to Manski (2017: 513), blockchain technology allows patients and caregivers to securely share patient identity and health care information across platforms. Therefore, it allows patients to envision a future in which they hold the keys to their own health care (ibid: 514).

Methodology

This is a qualitative study based on secondary research, namely desktop research and analysis. This method is best suited to health studies due to its emphasis on people's lived experiences (Al-Busaidi 2008). According to Miles and Huberman (1994), it is well suited for locating the living meanings that people place on events, processes and structures, as well as their perceptions, presuppositions and assumptions. Denzin (2005) and Creswell (2007) state that when applied to health research, the qualitative method has the advantage of being based on a systematisation of knowledge which allows it to provide a sense of order and orientation. Furthermore, it allows a better understanding of diverse data sources, and an identification of information relevant to the study (Katurura and Cilliers 2017; Boell and Cecez-Kecmanovic 2014).

Data was gathered by means of desktop research, specifically about medical records, health care, 4IR, and blockchain technology. Reports in various African countries were studied to identify their specific challenges and issues in resapect of medical record-keeping. Document analysis is commonly used in health policy research. Weber (2015) argues that written documents are essential components of the bureaucracies that enable modern societies to function, including in public health. Document analysis allows one to describe the content or categorise approaches to specific health problems in existing policies (Adebiyi et al 2019). For example, this method has aided the understanding of South African health policy responses to foetal alcohol spectrum disorder (Katchmarchi et al 2018; Adebiyi et al 2019). This is due to the fact that document analysis is a methodical process for reviewing or evaluating documents that can be used to provide context, generate questions, supplement other types of research data, track hangeover time, and corroborate other sources (Bowen 2009).

Literature review

Health is wealth, and hospitals play a key role in underpinning the health of citizens. Yeo (1999) notes that hospitals are those institutions that deal with the life and health of patients. A good medical care system is dependent on well-trained doctors and nurses, as well as high-quality facilities and equipment. Hospitals are concerned with their patients' lives and health. Medical personnel may not provide the best treatment or may misdiagnose a condition if accurate, comprehensive, up-to-date and accessible medical records are not available (Garba 2016). Associated records such as X-rays, specimens, drug records, and patient registers must also be well managed (Luthuli and Kalusopa 2017: 3). The management of medical records play a major role in the efficacy of hospital governance and administration. Ultimately, good record-keeping saves time as well as lives. Garba (2016) notes that good record-keeping includes the transfer and/or destruction of all unnecessary records, thereby saving time and resources. Managing and maintaining medical records further demonstrates a hospital's accountability (Yeo 1999). They serve as an important source of information for medical research, statistical reports, and health information systems (Yeo 1999).

Huffman (2001) asserts that medical records are the who, what, why, where, when and how of patient care during hospitalisation'. They serve as records of the entire history of patients

in hospitals, as well as measurements of the work of doctors and nursing staff. They also track patients' progress, the nature of diseases, and serve as data sources for researchers in the pharmaceutical industry (Garba 2016). Dikopoulou and Mihiotis (2012) note that medical records are at the centre of the daily operations of hospitals. Population growth, an increase in the number of patients, and the emergence of new diseases all necessitate health care organisations able to capture and manage massive amounts of information (Desouza 2005). Medical records are an essential component of any medical practice, because they help to ensure good patient care and may also play an essential role in any future dispute or investigation (Dikopoulou and Mihiotis 2012).

Medicalrecords include relevant documents and correspondence between patients and health professionals. They contain vital information for monitoring patient care, conducting clinical audits, and assessing patterns of care and service delivery (Houston 2008). Furthermore, medical health records are vital because they connect the information chain that generates depersonalised, aggregated and coded data for statistical purposes (Houston 2008). Furthermore, Adeleke (2014) argues that, in addition to providing patient information, medical records also play a vital role in medical schools, the training of other health professionals, and in pharmaceutical firms. To this end, Garba (2016) confirms that medical records must be properly compiled and kept up to date. They contain sufficient data to allow health professionals to identify patients, support diagnoses, and justify the treatments administered to patients. Medical records are the visible and audible evidence of health professionals' activities, achievements and accomplishments in hospitals and clinics.

Likewise, Haux (2006) asserts that medical records provide information about patients' health that allows for the accurate identification of the patient. They are an invaluable tool within hospitals and the communities in which they operate, exemplifying good health service delivery (Hajavi, Ebadi and Meidani 2005). Medical records can also be used to support a diagnosis based on a patient's history, physical examination and investigations (Haux 2006). This means that proper medical record-keeping ensures patients' continuity of care. They also help to justify the activities of health care workers in relation to specific patients. Ball (2003: 83) affirms that 'medical health records are aide memoires for health professionals treating patients, and serve as essential components of patient care'. Medical records play a significant role in the treatment of disease because they contain information about the patient, as well as the physicians' opinions and clinical judgment.

According to Huffman (2001), medical records include or should include the following:

- Doctors' clinical notes;
- Recordings of discussions with patient /next of kin about disease/management (with witness);
- Referral notes to other specialist(s) for consultation/co-management;
- Laboratory and histopathological reports;
- Imaging records and reports;
- Clinical photographs;
- Drug prescriptions;
- Nurses' reports;
- Consent forms and At-Own-Risk discharge forms;

- Operation notes and anaesthetic notes;
- Video recordings;
- Printouts from monitoring equipment;
- Letters to and from other health professionals ;
- Computerised/electronic records; and
- Recordings of telephone consultations/instructions relevant to the care of the patient.

In addition, Durking (2006) states that medical health records contain, or could contain, items such as:

- Patient history and examination reports;
- Consultation reports;
- Operative reports;
- Radiology reports;
- Pathology reports;
- Laboratory reports;
- Emergency reports;
- Subjective, Objective, Assessment & Plan notes;
- Progress note reports;
- Therapy reports;
- Clinical notes;
- Autopsy reports;
- Biopsy reports;
- Psychiatric observations;
- X-ray reports;
- Scan reports;
- Referral letters; and
- Daily reports.

The significance of medical records

A medical record is a primary tool in the practice of medicine, patient treatment, and disease prevention. It provides adequate and better health care to patients by maintaining meticulous records about the their medical conditions (Huffman 2001). Polit, Beck and Hungler (2001) note that a medical record facilitates communication between the patient and health professionals by detailing the patient's progress. It also acts as a communication link between the patient's caregivers (Huffman 2001). Furthermore, for those health professionals who provide health services on subsequent occasions, the medical record provides a history of illnesses and treatment provided, allowing them to critically assess the patient's status. It can be argued that without proper medical records, satisfactory treatment cannot be achieved, and good health in Africa will remain a pipe dream.

Berg (2001) emphasises that medical records are vital tools for communicating a patient's progress. To that end, medical records provide valuable information about disease epidemiology, which is vital for a country's health system and, by extension, a nation's health (Berg 2001). Medical records enable hospital staff to assess the quality and quantity of the services provided. They are invaluable to hospitals for medical legal purposes; if properly written, kept and maintained, they serve as the hospital's or practitioners' primary defence and advocate in any official proceeding (ibid). Medical records are also essential during the teaching and training process (Adeleke 2014; Szajna 1996; Terry 2005). This means that medical records are used to ensure the continuity of patient care throughout the patient's life, monitor and evaluate the patient's progress, to compile health statistics, and conduct research and education in medical schools and institutes.

Medical records are an important source of evidence in hospitals, and are supposed to be kept and preserved as evidence of business transactions (Zali et al 2018: 233). It is argued that when preparing medical health records, health professionals must keep in mind that they are creating documents that reflect his personal findings and disease management (Mayo Foundation for Medical Education and Research 2014). These records may be required by the patient and courts during litigation proceedings (Malaysian Medical Council 2006). Furthermore, medical records must be kept in secure rooms to ensure that they are well secured even when not in use (Zali et al 2018: 233). They should be protected from any harmful threats such as vermin and adverse weather, and should be easy to access when needed. They should also be returned in complete and undamaged form after use (ibid).

Mampe (2013) and Luthuli (2017) argue that medical records support accountability, security, integrity and comprehensiveness, and are vital to effective health service delivery. According to the IRMT (1999: 1), if medical health records are not properly managed, health services will suffer and good health will not be achieved. Good medical care is dependent on well-trained doctors and nurses as well as proper health record-keeping (ibid). The provision of the best medical treatment and disease diagnosis is largely based on the patient's comprehensive, up-to-date and accessible medical records (ibid: 2). Furthermore, easy access to records will ensure consistent service delivery (Dunlay et al 2008).

Poor record management endangers patients' health and has a negative impact on treatment and medical diagnosis. According to Asunmo and Yaya (2016: 2), 'poor medical health records tend to affect patient care adversely because clinical treatment of patients is dependent on case histories contained in their medical files'. Poor medical record-keeping practices across Africa have exacerbated illnesses and hampered efforts to achieve good health and the well-being of citizens. The literature reveals that similar issues arise as a result of poor medical record-keeping across the African continent. For example, in Zimbabwe, Chikuni (2006) argues that the lack of effective medical record-keeping has significantly affected health service delivery. Chikuni also claims that the lack of medical records to guide decision-making has made it difficult for medical practitioners to provide good health services in Zimbabwe (ibid). Mayanja (2005: 11) reports that hospital staff in Uganda appeared unconcerned about the importance of medical records in patient treatment and follow-up.

In Ghana, existing record-keeping systems at some public hospitals are not designed to collect information on some diseases, leading to poor monitoring, supervision and decision-making (Adjei 2000:5). According to Wong and Bradley (2009:3), a researcher at a rural hospital in Ethiopia described a similar challenge in which patient registration numbers were duplicated, records were lost and patients were assigned new registration numbers, clinical information was recorded on loose scraps of paper, and medical records were poorly archived. In South

Africa, the Western Cape Government's Desai Commission reported that poor medical records management hampered service delivery (Ngoepe 2004). According to Luthuli and Kalusopa (2017:4), unpaid patient bills amounting to millions of rands from 1994 to 1999 had to be written off due to incomplete patient records in North West and Gauteng provinces.

Some scholars have argued that poor medical record-keepiong is a major cause of poor health service delivery in South Africa (Khoza 2008; Marutha 2011; Katuu 2015; Pyrene 2015; Marutha 2016). Moreover, poor health and ill health are the consequences of failing to properly manage and keep medical health records (Zali et al 2018: 233). Due to a lack of funding, hospitals in Africa may well lack the equipment and resourcers needed to capture and maintain medical records. The Mayo Foundation for Medical Education and Research (2014) reports that many hospitals are edperiencing problems with paper-based records.

Challenges affecting medical records in africa

The management of medical records have remained a challenge for many African hospitals, generating a slew of concerns over time. One of the challenges is that many African health practitioners and governments have failed to recognise the link between medical records and good health. Larsen and Marstein (2000) assert that training record managers and improving the record-keeping methods and systems will ultimately improve health care in African countries. It has also been argued that adequate medical health records allow health practitioners to reconstruct the essential components of each patient contact without reliance on memory, which may prove increasingly unreliable and deficient over time (Medical Protection Society 2016).

The failure to record and maintain proper medical health records on a regular and efficient basis is another challenge. Patients' records are not available in many African hospitals; this detrats from their treatment, and complicates the possibility of fighting diseases and achieving good health. According to the Medical Protection Society (2016), taking down medical records on a regular basis is difficult in Africa. According to a report by the Medical Protection Society, good quality medical records taken on a regular basis by trained experts are an essential component of safe and effective healthcare (ibid). It is submitted that keeping proper medical records and updating them on a regular basis facilitates health care continuity and the provision of quality care, which leads to good health and promoters human well-being.

Another barrier to achieving good health in Africa is a lack of trained and experienced personnel. According to Davenport (2005), record-keepoing staff should consist of workers who have expertise, knowledge, training and experience in medical record-keeping. They must be people who understand the effects of medical record-keeping on patients and societal health (ibid). Preserving and conserving medical records in African hospitals has remained one of the most difficult challenges, contributing to increased mortality rates and disease. Hospitals and governments have not invested adequately in training and educating hospital record-keepers. Adeyemi (2012) notes that this challenge has become prominent because record preservation is not at the centre of most medical science curricula, and thus inadequate technical expertise in medical records prevails.

Another issue is the poor storage of inactive records. Also, many African hospitals still use outdated forms. Besser (1999) notes that medical records kept in out-of-date formatd do not last as long because they become brittle and deteriorate quickly. They may also be damaged

by dust and dirt on storage surfaces, as well as various types of insects. They may be damaged by fungi and stained by water, oil, ink, or simply dirt.

The safety and security of medical records is also a concern, and personnel in charge of patient records are at risk of losing those records. In Africa, many hospitals are maintaining manual records on outdated forms, resulting in storage issues. Medical records on outdated forms do not meet accepted standards of data safety and security. Unsecured medical records pose a hazard to both patients and society, and endanger doctors and nurses as well as hospitals.

The role of blockchain technology

Mackey et al (2018: 68) show that blockchain technology is being used and can be used to improve businesses in the health care sector, patient outcomes, and medical records. This technology is improving compliance, lowering hospital bills and costs, and enabling better use of health care-related data (ibid). Blockchain technolgoy has proven to be a reliable platform for improving and ensuring the security of health records. It serves as an effective conduit between patients and suppliers, and an interface with patients' records. According to Alhadhrami et al (2017), blockchain-based technology can be permissioned or permissionless. Both are useful in health care and in overcoming the challenges associated with managing medical records.

Ensuring the safety and security of medical records

Blockchain-based health care systems can help to address the issues and problems related to data security, privacy, sharing and storage (Azaria 2016; Engelhardt 2017:25). It will enable the establishment of easily accessible central records, which will work to imrove the quality of health services. Centralised systems are valuable because they secure medical records and make them easily accessible (Green 2011: 10). As a result, time is saved and patients are treated more efficiently. Blockchain-based technology in health care ensures the security of medical records, management, and patient privacy.

Wang et al (2020) add that blockchain-based technology ensures data integrity and incorruptibility, and protects medical data from being tampered with or stolen. It is a distributed database that ensures data storage in each network while also providing increased stability, reliability, security, consistency and attack resistance, as well as speeding up medical data exchange (ibid). Blockchain-based technology also decentralises medical records, returning ownership to patients and allowing them to govern and manage their records in order to monitor and take good care of their own health.

Yang and Yang (2017: 6) and Xia et al (2017) state that the use of blockchain technology results in a MedRec system that 'ensures the security of medical health records MedShare system that provides data provenance and control in cloud repositories among hospitals'. Liang et al (2017), for example, used the Hyperledger fabric membership service and channel formation scheme to guarantee data privacy in a blockchain network for medical data-sharing. According to Hasavari et al (2019), blockchain-based technology is a solution for recording patients' emergency medical data, and allows ambulance crews and/or paramedics to use it for urgent, high-quality pre-hospital care.

Azaria (2016) submits that blockchain-based technology ensures data integrity in the blockchain networks. It uses the Ethereum-based blockchain to govern medical health records

and ensure their security (Nchinda and Cameron 2019). Kamel, Wilson and Clauson (2018: 25) explain that 'blockchain data is secured through cryptography so that participants can trust that blocks of data are authenticated and verifiable'. Other scholars have stated that blockchains in health care act as a 'digital backbone for other technologies such as cloud computing, artificial intelligence, eHealth and mHealth devices/applications, and the broader Internet of Medical Things' (Griggs et al 2018: 130; Brogan et al 2018: 259). A blockchain can keep an immutable record of every time a data record is accessed or modified. Governments and hospitals can use Keyless Signature Infrastructure (KSI), a blockchain-based technology, to protect government data and electronic health records from external cyber-attacks and internal misuse (Dubovitskaya 2019). The KSI blockchain technology application provides security while respecting the privacy of medical health data (ibid).

Ensuring the transparency of medical records

The use of blockchain-based technology in health care management improves the transparency and clarity of data access among practitioners, medical specialists, hospitals, and therapists. This saves time and resources, improves the medical information process among various medical stakeholders, and reduces incidents of medical negligence. Because the history of previous medical consultations with physicians is not tampered with, this fosters trust and confidence, and promotes efficient medical treatment (Koushik et al 2019)

Azaria et al (2016: 25-30) state that blockchain technology manages authentication, confidentiality, accountability, and data-sharing. It also enables patient data-sharing, and provides incentives for medical researchers to sustain the system (Azaria et al 2016: 30). Because blockchain-based technology allows patients to access an encryption key that allows health practitioners to access their personal health data, it enables a transparent and auditable system (Sadiku et al 2018). According to the OECD report mentioned previously (2020: 7), it gives health practitioners, service providers and health researchers access to patients' medical health records, and allows them to access other medical information for the purposes of direct health care delivery, as well as to allow for research, statistical, or other uses of patients' health data.

Ensuring sound management of medical records

The poor governance and management of medical records has impacted on the quality and nature of health services, resulting in high mortality rates in Africa. Blockchain-based technology can assist in the governance and management of medical health records, providing patients and health practitioners with centralised access to their entire medical history across all providers. Because it can expedite patient health records, blockchain-based technology promotes and improves medical record governance. It allows medical records to be more effective, disintermediated, secure and interoperable. Health practitioners can use blockchain-based technology to sync all of their patients' medical records in real time. It also allows them to have a complete medical history of the patient, and grants access to anyone who may require the patient's records (Alhadhrami et al 2017).

Protecting drug development and distribution

Blockchain-based technology enables drug developers and manufacturers to run clinical trials and share medical samples in a secure environment (Eze and Musa 2018: 156). The use of blockchain-based technology in health care makes clinical trials more reliable by tracking and time-stamping at each stage of the trial, thereby reducing waste. It also

increases accountability and transparency in clinical trial reporting (ibid: 158). In addition, it unifies disparate health care processes, improves regulatory compliance, improves patient experience, lowers health care costs, and provides autonomous monitoring and thje preventive maintenance of medical devices.

It also reduces the time it takes for new drugs to reach the market (Mettler 2016), and has the potential to transform health care systems by putting the patient at the centre of the health care ecosystem (Alhadhrami et al 2017). It also increases patients' trust and confidence when purchasing drugs for treatment, thereby addressing problems in pharmaceutical supply chains. These issues include intellectual property protection, quality control, counterfeiting, and illegal drug sales (Mettler 2016). According to MediLedger (2020), blockchain-based technology is proving to be an effective technology for verifying the authenticity of suppliers and purchasers due to the immutability of its records.

For example, in the Hyperledger's Counterfeit Medicines Project, products are time-stamped and entered on a blockchain for tracking and verification (Taylor 2016). Moreover, blockchain-based technology ensures efficient and adequate supply while avoiding drug shortages, which have been a major issue in the health care industry. For example, Ting (2020) argues that Chinese hospitals used blockchain-based technology to ensure the accurate tracking and timely delivery of medication to Covid-19 patients' homes. In Uganda, blockchain-based technology was also used to combat counterfeit drugs, which lead to 250 000 malaria and pneumonia deaths among children each year (Rahman 2019). According to Ndemo et al (2019), blockchain technology has increased transparency, accountability, and efficiency in drug development. Blockchain-based technology provides patients with confidence and trust when purchasing drugs from medical pharmacies that use a scanned QR code. Blockchain-based technology also aids in identifying the true source of medical drugs and ensuring that suspicious and counterfeit drugs do not enter the distribution chain.

Conclusion

This study has assessed the current and potential role of 4IR in the governance of medical records in Africa, with a particular emphasis on the positive influence of blockchain-based technology. It began with a conceptual analysis of both health and 4IR literature, which aided in understanding the challenges of medical health record-keeping, as well as their role in delivering quality and effective health services. It found that poor medical record-keeping continues to jeopardise the delivery of health services in Africa, which undermines human wellbeing and sustainable development in turn Despite this, medical recordkeeping in Africa has received little academic attention.

A good record-keeping system is required for the delivery of health services that lead to good health and disease relief. Blockchain-based technology has begun to play a positive significant role in the African health care sector, and has the potential to play far greater role in the future. It enables the effective management of medical records and their availabity to health practitioners in hospitals as well as patients, allowing better and faster treatments, and saving lives. Patients are able to access their medical records, making it easier for them to evaluate and manage their own health. Blockchain-based health technology protects and secures medical records. It aids in combating financial fraud and counterfeit drugs, which plague the health care industry and impede the delivery of effective medical treatment.

Given this, governments in Africa and other stakeholders should allocate more funds for the training of staff who maintain medical records, and African universities should offer dedicated courses to this effect as well. Policy-makers and planners should ensure they understand the interconnections between good medical records, effective health services, and good health. Blockchain-based technology can play a major role in resolving the problems confronting the health care industry, and thereby promoting the health and ultimately the wellbeing of Africa's people.

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