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Factors to Improve Data Quality of Electronic Medical Records in Public Health care Institutions in South Africa

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By

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Factors to Improve Data Quality of Electronic Medical Records in Public Health care Institutions in South Africa

By

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Abstract

Electronic Medical Record (EMR) systems have been identified as having the potential to improve health care and allow the health care sector to reap a number of benefits when implemented successfully. These benefits include enabling quick and easy access to patient files and also reducing the problem of misplaced or lost patient files. Such EMRs allow for patient records to be up to date, provided that health care practitioners capture standard and consistent data in the relevant fields. In Africa, there are only a few countries that have successfully implemented EMR systems due to social and technological challenges. Social factors include lack of computer skilled health workers, lack of adequate training, physician's resistance to shift from using paper records to electronic records, either due to complex systems or the fear of being replaced by the systems. On the other hand, the technological factors include lack of Information Technology (IT) and clinical resources, lack of internet access, financial barriers to purchase the necessary technological hardware and implementation costs.

A few South African health care institutions have implemented EMR systems, however, most of the public health care facilities still make use of a manual system to capture patient information. In the case where public health care facilities do have an EMR system implemented, there are problems with the consistency of the data that is captured. The inconsistency is caused by the different understandings that the health care professionals have regarding the importance of capturing the necessary information that is collected at various points in health care institutions, thus affecting data quality. For the successful implementation and use of EMR systems, everything within the health care organisation should be integrated. In other words, the steering committee and workgroup, the equipment, the product, the processes, the system and the facility design and construction should be incorporated to work together.

The common problems identified in literature regarding data quality in EMRs include misspelled words, inconsistent word strings, inaccurate information entered on the record and incompleteness of the record. These problems lead to poor quality information, lack of accessibility of the record, poorly organised notes and inaccurate information about the patient.

The South African strategy aims to implement a National Health Insurance (NHI) which will provide citizens with equitable access to health care. For the successful implementation of the NHI strategy, South African health care sectors should address the barriers which were identified and learn from other African countries that have successfully implemented EMR systems and had positive outcomes. Therefore, this study investigates how data quality can be improved on electronic medical records in public health care in South Africa?

The qualitative research methodology approach was used for this study. Interviews were conducted with eight health care professionals at Klerksdorp, in the North West province to obtain data regarding the factors they would deem important for the improvement of data quality in EMRs. The Data Quality Framework (DQF) was applied in this study and six dimensions were identified as the factors to improve data quality. These dimensions include completeness, accuracy, consistency, conformity, timeliness, and integrity. From the analysis of the interview responses, it was discovered that there were, in fact, data quality issues experienced at the public health care facilities of South Africa. A need was identified for the use of data quality assessment tools and solutions to address the data quality issues or challenges that health care practitioners are faced with during their daily jobs. Seven barriers were also identified as having an impact on the successful implementation of EMRs at health care institutions. These barriers, together with the data quality issues, influence the successful use of EMRs and should not be overlooked. From these barriers the study developed seven Critical Success Factors which can be used by the National Department of Health to improve the quality of EMRs.

Keyword Phrases: Electronic Health Records; Electronic Medical Records; Public Health Care; Health Information Systems; South African Health Care.

Declaration

I, Noloyiso Anele Makeleni, hereby declare that:

- I am fully aware of the University of Fort Hare's policy on plagiarism and I have taken every precaution to comply with the regulations.
- The work in this dissertation is my own work and where based on other authors' works, all sources used or referred to have been documented and recognised.
- This dissertation has not previously been submitted in full or partial fulfilment of the requirements for an equivalent or higher qualification at any other recognised educational institution.
- I am fully aware of the University of Fort Hare's policy on ethics and I have taken every precaution to comply with the regulations. I have obtained an ethical clearance certificate from the University of Fort Hare's Research Ethics Committee and my reference number is CIL051SMAK01.
- My Supervisor is Professor Liezel Cilliers.

NA Makeleni

Dedication

I dedicate this dissertation to the memory of my late father, Meshack Makeleni, who loved and encouraged me to be the best that I can be at all times. I also dedicate it to my late sister, Nangamso Makeleni, with whom I started this journey, but who was unfortunately defeated by death. I know how hard she was working towards obtaining her Master's in Business Management so find it sad that I could not witness her achieving this goal. I, therefore, dedicate this dissertation to her.

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Acronyms

- DMAIC - Define, Measure, Analyse, Improve, Control
- DOH - Department of Health
- DQ - Data Quality
- DQIC - Data Quality Improvement Cycle
- EHR - Electronic Health Record
- EMR - Electronic Medical Record
- GDP - Gross Domestic Product
- HISs - Health Information Systems
- HITs - Health Information Technologies
- IT - Information Technology
- NHI - National Health Insurance
- PDCA - Plan, Do, Check, Adjust

Chapter 1
Introduction

1.1. Background

Health care institutions are moving away from paper-based record systems to record patient data and instead are making use of electronic health information systems. According to Adane, Muluye and Abebe (2013), the biggest problem with paper-based systems are related to the quality and completeness of medical entries. If a medical record is not complete or does not reflect accurate information, it becomes difficult for the doctor to make an accurate diagnosis or prescribe the right treatment. However, electronic medical record systems have the potential to reduce these errors by providing improved access to the medical information, while also improving the accuracy of the information (Yanamadala, Morrison, Curtin, McDonald & Hernandez-Boussard, 2016). In the United States, medical errors caused by clinicians' mistakes are one of the largest causes of death among patients with "44, 000 to 98, 000 unnecessary deaths and an additional 1, 000, 000 injuries per year" (Adane, et al., 2013, p. 3; Neville, Tarn & Yamamoto, 2017). This study focuses on electronic medical records that are used in the public health care sector of South Africa. According to Brand South Africa (2012, p. 2), public health care is defined as "a health system with care facilities from rural and mobile clinics. Public health care is funded by the state and offers health services to a great population which may put health care practitioners under immense pressure, which could lead to them documenting poor or substandard quality data in EMRs".

Electronic medical records (EMRs) were the first electronic sources used to digitise patient information (McMullen, Howie, Philipsen, Bryant, Setlow, Calhoun & Green, 2014). The health care institutions that are able to successfully implement electronic medical record systems are likely to reap a number of benefits including: easy access to information; improved decision support and patient monitoring; efficiency and financial improvements (Katsande, 2014). According to McMullen, et al. (2014), EMRs were initially created to remain in the practitioner's offices, making it difficult to share the medical information with outside providers or to other health care systems. Thus, electronic health records (EHRs) were developed to overcome the lack of interoperability of the EMRs. According to the World Health Organisation (2006, p. 6), "an electronic health record (EHR) is defined as a system containing the collection of individual patients or a population's health information such as laboratory data, allergies, vital signs and imaging reports". The records are in digital format and can be shared across diverse health care settings through network-connected enterprise-wide information systems. The electronic records may contain summarised data or they may include an overall view of data regarding the patients' health. The term EHR is often used interchangeably with EMRs, however, EMRs are defined as patient information recorded by a physician during a consultation for his/her own use, such as medical history, diagnoses, treatment including medication prescription, immunization dates, and allergies in digital format (Practice Fusion, 2016). The EMR data is patient data that is developed and maintained by clinicians and providers for direct patient care and thus the first electronic record of the patient. If the quality of this record is poor, it will directly impact on the diagnosis and treatment of the patient (Safran, Bloomrosen, Hammond, Labkoff, Markel-Fox, Tang & Detmer, 2007). These EMRs can improve public health care in South Africa by enabling quick and easy access to patient files and also by reducing the problem of misplaced or lost patient files. Such EMRs allow for patient records to be up to date, provided that health care practitioners capture standard and consistent data in the relevant fields. The focus of this research study will be on the data recorded in EMRs. An example of the current use of an EMR system is the Clinicom which is implemented at the Khayelitsha Hospital in the Western Cape, South Africa. When the records kept in this system were evaluated, fifteen percent of the records for trauma cases were found to be missing or incomplete, some had missing vital signs and 73% of the records did not record the patients' time of arrival (Ohuabunwa, Sun, Jubanyik & Wallis, 2015).

The quality of the EMRs is thus critical as it determines the final outcome of the health care patients receive. According to Bowman (2013, p. 1), the "quality of health care across the continuum depends on the integrity, reliability, and accuracy of health information". The aim of this study was to evaluate the factors that are required to ensure data quality in an EMR. According to Botha, Botha and Herselman (2015, p. 2), data quality is defined as "the extent to which i) data entries are aligned with actual values; ii) data is applicable to the needs of data users; iii) data is accessible; and iv) data is represented in an understandable way". The definition of data quality serves as a standard to which data should conform. Botha, et al. (2015), provided a list of prioritised data quality challenges of EMRs that include: need for more training for data users, inconsistent definitions and formats because of different systems used (standardisation), data not meeting all relevant needs, data being out of date and the transformation from paper records to electronic records. A study conducted in KwaZulu-Natal in South Africa revealed that EMRs can lack data accuracy. The data accuracy of public health information was determined by making a comparison between the data recorded in the District Health Information System (DHIS) with the data obtained from individual facility registers during a data audit. According to Mphatswe, Mate, Bennett, Ngidi, Reddy, Barker and Rollins (2012), during the first data audit there was a poor correlation between the data that appeared in the DHIS and the data from facility registers.

1.2. Problem Statement

One of the challenges that are facing the health care system in South Africa regarding EMRs is how to ascertain or evaluate the data quality of an electronic medical record (Botha, et al., 2015). Critical health information tools can be deployed to measure the performance of systems at all levels in terms of costs, quality and individual clinicians to national network (Seahloli, 2016). The problem identified regarding EMRs is that there is a lack of consistency in terms of how the data is documented across different health care institutions by health care workers. The inconsistency is caused by the different understandings that the health care professionals have regarding the importance of capturing the necessary information that is collected at various points in health care institutions, thus affecting data quality (Anthony, 2014).

The common problems identified regarding data quality in EMRs include misspelled words, inconsistent word strings, inaccurate information entered in the record and incompleteness of the record (Singer, Yakubovich, Kroeker, Dufault, Duarte & Katz, 2016). In addition, Anthony (2014) identified the problems with medical records which are the cause of adverse events. These include poor quality information, lack of accessibility of the record, poorly organised notes and inaccurate information. Thus, poor quality records can result in fatal consequences such as patients dying or suffering due to inaccurate diagnosis and treatment. For example, a patient by the name of Annette Monachelli died of a brain aneurysm after her doctor had ordered a head scan through the clinic's software system. According to Schulte and Fortune (2019), the bleeding in the patient's brain could have been detected, but the order had never been transmitted to the lab. The software in question was an EHR system where previously similar issues had been detected.

The objective of this research study was to develop factors that will help improve the quality of the data that will be collected through EMRs by public health care facilities in South Africa. The following research questions were then created to help the researcher solve the problem.

1.3. Research Questions

1.3.1. Main Research Question

How can data quality be improved of electronic medical records in public health care in South Africa?

The objective of the main research question was to discover the factors that are required to ensure data quality on an EMR to promote public health care in South Africa. To help answer the main research question, three secondary questions were posed and answered in each of the subsequent chapters.

1.3.1.1. Secondary Research Questions

Three sub questions are provided below:

i. **What is the perceived current state of data quality in electronic medical records among public health care professionals in South Africa?**

Knowing the state of data quality in EMRs in South Africa helped the researcher understand the factors that affect data quality. The researcher interviewed nurses and IT specialists from public health care facilities in the North West province. The feedback was then evaluated to reach a conclusion of the current state of data quality in EMRs in South Africa.

ii. **What factors are required to ensure data quality in an electronic medical record system?**

Data quality in EMRs is essential in that health care practitioners use the medical records to capture patients' medical diagnoses in order to prescribe medicine or treatment. Thus, having complete, consistent and accurate EMRs will enable health care practitioners to effectively provide care to patients. Poor data quality may lead to poor decisions which may result in poor quality health care.

iii. **What factors will improve the data quality of electronic medical records?**

Once the problems with data quality in EMRs were identified and compared to the list produced in sub-question 2, the researcher was able to produce critical success factors that health care organisations can use to improve the quality of information in EMRs.

1.4. Objective of the Study

The objective of this study was to produce factors to improve data quality in EMRs in public health care facilities in South Africa. The factors will address the data quality challenges of EMRs to ensure that health care practitioners maintain data quality in EMRs at public health care facilities in South Africa. The next section discusses the significance of the study.

1.5. Significance of the Study

According to the Department of Health South Africa (2015), the government aims to implement a National Health Insurance (NHI) to provide all South Africans with access to quality health care services. Such a NHI is a health financing system that is designed to provide South Africans with the opportunity to obtain access to quality and affordable health care, regardless of their socioeconomic status (Department of Health South Africa, 2015). The National Department of Health in South Africa plans to implement a national electronic health record system to support the NHI. Thus, an individual's medical record from a local hospital should conform to the same standards when integrated into the national electronic health record system. The proposed factors that were developed upon the completion of this study aim to ensure that health care practitioners maintain good quality data when collecting, capturing and storing patient data in an electronic medical record. If there is consistency in the medical data, there will be quality in electronic medical records. According to Seahloli (2016), the Health Department's Director, Mr Thami Mseleku, confirmed that there is no uniform standard in place for collecting and storing patient health records. This makes it difficult for South African hospitals and clinics to share information to eliminate issues of patient data duplication and patient misdiagnosis. Thus, the significance of this study is to improve the quality of the medical data collected at public health care institutions to improve patient health care and to produce better results for monitoring and evaluation. This is to ensure that the collected data is fit for the purpose for which it was collected. The next section is the evaluation of the relevant literature.

1.6. Literature Review

An electronic medical record (EMR) is a collection of individual health information that is captured and stored in a digital format by a clinician during a visitation by a patient (Ohuabunwa, Sun, Jubanyik & Wallis, 2015). Although the adoption of EMR does have challenges, countries globally are working towards developing integrated health information systems to help improve the overall quality of health care. In the past, most hospitals in South

Africa used paper-based records to gather, store and share patient information. Paper-based records are not a secure place to store important patient information because the ink can fade with time or the file can be lost. In South Africa, there are several different electronic record systems in provincial hospitals, however, the systems lack interoperability (Katurura & Cilliers, 2018; Department of Health South Africa, 2012). This research study will evaluate the state of data quality in electronic medical records around the world, in developing countries and in South Africa, respectively.

World

Big financial investments have been made by countries such as Canada, United States of America and Australia to implement electronic medical record (EMR) systems (Fragidis & Chatzoglou, 2017). However, the rate at which EMR systems are being implemented worldwide has been slower than it was originally anticipated (Morrison, Robertson, Cresswell, Crowe & Sheikh, 2011). According to Carlson (2017), EMR customers, including hospitals and physicians, have been dissatisfied with EMRs due to glitches in the system operation, unmet expectations in system implementations, lack of features and technical support. The EMR adoption in developing countries is discussed below.

Developing Countries

The implementation of EMRs is advantageous, these benefits include improved timeliness, better data accuracy and the availability of routine reports (Akanbi & Agaba, 2011). The implementation of EMRs is limited in developing countries compared to developed countries (Katurura & Cilliers, 2018). According to Douglas (2009), the limited adoption of EMRs in developing countries is due to limited or lack of understanding of the challenges surrounding the delivery of health care in resource constrained settings. Sikhondze and Erasmus (2016) identified the challenges faced by developing countries, some of these challenges include:

i. Poor health care infrastructure - The implementation of EMRs in developing countries is difficult as it is restricted by the lack of resources and inadequate infrastructure (Katurura & Cilliers, 2018). Considering the percentage of the population that stays in rural areas, there is an increased burden on health care facilities which results in an overuse of health resources. As a result, the health care practitioners may end up capturing poor quality data in EMRs due to having to assist many patients within the time constraints (World Health Organisation, 2012).

ii. Language barriers with the large diversity of languages - African countries use diverse languages, for example, in South Africa there is isiXhosa, isiZulu, Sesotho, Afrikaans and Setswana and since most EMR systems use English, it becomes a challenge for some health care practitioners to operate the electronic medical record systems (Bain, 2015).

iii. Lack of skilled health care informatics - The cost of implementing EMRs is high and only a few African countries have the skilled manpower to develop the required infrastructure that will accommodate EMRs (Akanbi & Agaba, 2011). In public health care, there is a lack of Information and Communications Technology (ICT) staff who can support technology in health care. Thus, the benefits provided by EMRs may not be realised.

In South Africa, despite the high expenditure of the National Department of Health to improve the quality of health care, the implementation of EMR systems in the country remains low (Sikhondze & Erasmus, 2016). With the exorbitant cost of commercial software packages, Open Source Software has presented several African countries with the opportunity to gain access to EMRs (Akanbi & Agaba, 2011). According to Pickett (2017), open source software is software that can be freely used and shared by anyone. However, the implementation of EMRs in Africa is not without challenges, meaning more efforts are required to improve the benefits of EMRs. The next section evaluates the benefits of EMR adoption.

1.6.1. Benefits of Electronic Medical Records' Implementation

The International Organisation for Standardisation (ISO) defined the EMR as patient data that is in digital form which can be stored securely (with privacy safeguards), and can be accessed only by authorised users (Hayrinena, Sarantoa & Nykanen, 2008). When properly implemented, EMRs can help health care institutions improve the quality of care of patients, while saving on costs and improving the delivery of health care services (Bain, 2015). According to Fragidis and Chatzoglou (2017), an interoperable EMR system reduces ambiguity and enables better workflows. It also enables the transfer of data across EMR systems. Data quality can be achieved with EMR interoperability and implementing a national EMR system in South Africa will enable data quality since all public health care facilities will be using an integrated EMR system with the same set of standards. This section discusses the benefits of EMRs which are as follows: financial improvements, improved access to information, improved decision support, patient monitoring improvements and time improvements. Each of these benefits will be briefly discussed below.

Financial Improvements-By efficiently keeping track of the services that have been rendered to patients and capturing the charges accordingly, EMRs can help South African health care institutions with cost savings and revenue increases (Hatton, Schmidt & Jelen, 2012; Ohuabunwa et al., 2015). The EMRs may also be integrated with billing systems so as to improve the billing of patients and lead to financial benefits (Miller & Sim, 2004). The EMRs also allow for the identification of patients in need of care through data mining thereby increasing revenue (Hatton et al., 2012).

Improved access to Information-Through efficient documentation, EMRs enable access to patient information. Through the use of EMRs, accurate, legible and well-structured patient information can be retrieved timeously (Miller & Sim, 2004; Hatton, et al., 2012). By implementing EMRs, public health care facilities in South Africa can benefit from improved access to information.

Improved Decision Support-According to Hatton et al. (2012), this functionality allows practitioners to make informed decisions regarding the care they provide to patients. Accurate and complete EMRs can enable the practioners to make the best decisions regarding the patients' health.

Patient Monitoring improvements-Through the use of reminders, warnings, reports and decision support, EMRs improve the efficiency with which patients are monitored. These features also allow for better disease prevention and management (Ohuabunwa et al., 2015). Practitioners and nurses at South African public health care facilities can easily monitor the health of patients as they can easily access patient information through EMRs.

Time Improvements-Through improved communication and access to information, EMRs enable practitioners to save time and therefore provide care to patients timeously (Hatton, et al., 2012). Where practitioners would have had to use scribbled notes to communicate, or physically retrieve hard copy patient files in the past, they are able to do this electronically, saving valuable time (Miller and Sim, 2004; Hatton, et al*.,* 2012). By implementing EMRs, South African public health care facilities can save time. Instead of having to look for patient files through many files physically stored, the staff can just search for patient information electronically, using patient details such as name or surname. The next section will discuss the characteristics of data quality in electronic medical records, which is the theoretical foundation of the study.

1.6.2. Characteristics of Data Quality in Electronic Medical Records

Despite the benefits provided by EMRS, there are factors which affect the final outcome of EMRs. According to Weiskopf and Weng (2013), the re-use of EMR data has been restricted by factors such as the quality of data. Although there is no single agreed upon definition of what data quality entails, the most broadly adopted conceptualisations are identified by Juran and Gryna (1988, p. 22) who defined data quality through "fitness for use", in other words, this entails that data is of sufficient quality if it is to serve the needs of a specific purpose.

1.7. Theoretical Review

Data quality consists of six primary dimensions including completeness, consistency, conformity, accuracy, integrity and timeliness (Thatipamula, 2013). Each of the dimensions will be defined below.

Completeness- Data is complete when all the necessary data is present. Askham et al. (2013) describe completeness as the "proportion of stored data against the potential of 100% complete" (p. 8).

To clarify the mandatory fields, an asterisk can be used to ensure that practitioners or nurses enter all the required data regarding a patient to eliminate issues such as incorrect diagnoses, incorrect medication and incorrect information regarding previous hospital visitations. For example, according to Pinto-Valverde, Pérez-Guardado, Gomez-Martinez, Corrales-Estrada and Lavariega-Jarquín (2013), after a data quality assessment of EMRs at hospitals in Mexico, completeness was identified as a problem arising from findings of issues such as incomplete addresses, incomplete e-mail addresses and incomplete dates of birth. Therefore, the incompletness of data will decidedly result in poor data quality.

Consistency- Consistency refers to the absence of difference in data captured in one system, when it is compared against data captured in another system, by a different individual (Askham et al., 2013). Data should be the same across all systems used in the hospital/clinic. The health information systems should contain integrated information in order for the results to be accurate. According to Chen, Hailey, Wang and Yu (2014), the attributes of data quality are grouped into two categories such as: those of good quality and those of poor quality. Inconsistencies in the definitions of the attributes were identified as a factor that can affect the quality of data. Inconsistencies in the definitions could result in one health care institution capturing, for example, patients' blood type, while another institution finds it irrelevant, which could result in adverse effects on the patients' health outcome. Thus, data should be consistent to produce good quality data. The focus of this study is on the consistency of data as identified in the problem statement section.

Conformity- Conformity refers to the degree to which data conforms to the same set of standard data definitions like data size, format and type (Thatipamula, 2013). A health information system in a hospital/clinic should follow the same set of standards and regulations to ensure that conformance is maintained as it is important. For example, Price, Singer and Kim (2013) stated that although EMR products may conform to national data standards, such as, those developed by the Canadian Institute for health information, users of the systems are likely not conforming. Users of the EMRs, including the practitioners and nurses, should thus conform to data standards to maintain data quality.

Accuracy- According to Askham et al. (2013), accuracy is defined as the degree to which data reveals the truth about the event being described. Data should be complete to ensure it is accurate. Accuracy can be achieved by correctly capturing and representing data. Data needs to be validated to ensure it is accurate. For example, according to Chen et al. (2014), coding errors were reported by Australian researchers, these errors were due to poor quality documentations in the clinical informaion systems. "These errors had led to inaccurate hospital perfomance measurement and inappropriate allocation of health funding" (Chen et al., 2014, p. 5172). Thus, it is evident that poor documentation of medical or health data can lead to inaccuracy of data which can result in poor health outcomes.

Integrity- Integrity entails that data stored in a database or data warehouse should be accurate and consistent (Teeling, 2012). Improper use of EMR systems can jeopardise the integrity of a patient's information, leading to errors that may harmfully affect the patient's health (Bowman, 2013). Thus, when documenting patient records, the health professionals should ensure that all the required information regarding the patient is recorded to maintain data integrity. The health professionals should verify that the patient information is free of errors. For example, in a study of the records in the Veterans Health Administration's electronic health system, it was found that the notes contained atleast one documentation error including inconsistent text, outdated information and copied text which all jeopardised the data integrity (Bowman, 2013).

Timeliness- timeliness refers to the degree to which data represents reality from the required point in time (Askham et al., 2013). The next section will discuss the empirical evidence that was found in literature with regards to the quality of EMRs. Data should be up-to-date from the time it is collected until the time it will be used. For example, a study by Ahn, Choi and Kim (2016) was completed to investigate the factors associated with the timeliness of electronic nursing documentation using entry times in the EMR system. The study defined timeliness according to the time when a nurse is on duty and enters electronic patients' documents. The study divided the hospital departments into the internal medicine and the surgery department; the study showed that more time was taken to capture patients of the surgery department with 80% as compared to the internal medicine department with a 78%. Thus, timeliness is important as it is a characteristic of maintaining appropriate health records (American Nursing Association, 2010).

According to Teklegiorgis, Tadesse, Mirutse and Trefe (2016), previous studies showed that data quality of EMRs was poor in different resource limited settings and it is affected by different technical, organisational and behavioural factors. A report by Gebrekidan, Negus and Hajira (2012) regarding the assessment done on data quality showed that there was inadequate supervision to address the problems of inadequate documentation, inaccurate reporting, late- and incomplete reporting. From the findings, there was an indication that limited investment in human resources and infrastructure had an effect on data quality.

1.7.1. Current State of Electronic Medical Record Adoption in South Africa

South Africa is one of the many countries that have adopted electronic health. According to Gerber, Olazabal, Brown & Pablos-Mendez (2010), "e-health has been implemented in cities and rural areas globally" (p. 218). South Africa has made many improvements in the application of health information systems; however, the National Department of Health in South Africa still faces numerous challenges. Data quality is identified as a challenge in health information systems (Department of Health South Africa, 2012). As a result, Botha et al. (2015) provided a list of a total of 18 prioritised data quality challenges. The challenges are as follows: need for more training for data users; data entry errors; inaccurate collection of data from patients; shortage or absence of infrastructure, such as internet connections; inconsistent definitions and formats because of different systems used (standardisation); practitioners are hesitant to change existing processes; data governance (this includes challenges such as: lack of assignment of responsibilities regarding data; the importance of data quality is not emphasized enough by managers; ineffective organisational procedures; lack of data quality assessments); information is produced subjectively by the data capturer; shortages of appropriate software for data management; the length of the form is too long; nurses' notes may go unread by practitioners; transformation from paper records to electronic records; privacy, confidentiality and legal challenges; data not meeting all relevant needs; information is not suitable for analysis purposes; financial barrier to purchase necessary hardware and cost challenges in general; and lastly, data is out of date.

The next section discusses the methodology used in this research study.

1.8. Research Methodology

Crotty (1998, p. 2) states that "research methods of enquiry reflect the researchers' assumptions about the nature of reality and the nature of knowledge". According to Cohen, Manion & Morrison (2003), research methods are the "range of approaches used in educational research to gather data which are to be used as a basis for inference and interpretation" (p. 44). On the other hand, methodology is the strategy, or action plan that justifies the use and choice of certain techniques (Crotty, 1998). The following sections will cover the research paradigm, research approach, research design, sample and population, data collection methods, the data analysis methods, the delimitation of the study and lastly, the ethical considerations.

1.7.1. Research Paradigm

Saunders, Lewis & Thornhill (2013), describe a research paradigm as a means to study social phenomena from which certain understandings can be achieved.

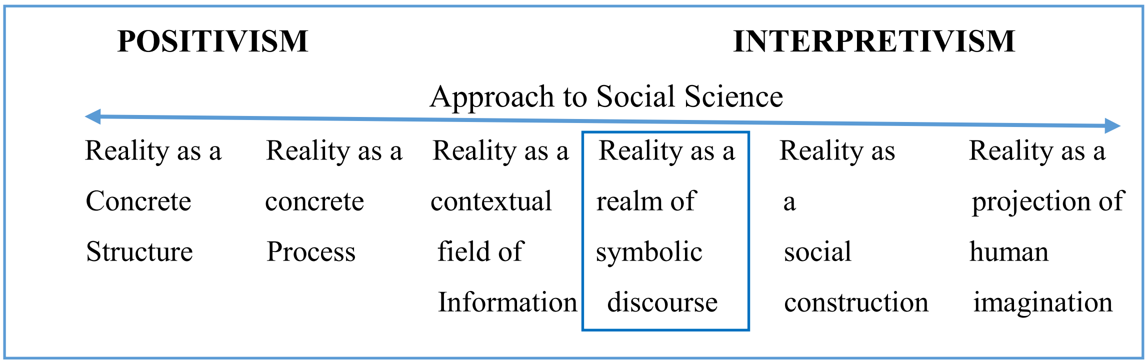

Figure 1.2- Continuum of Core Ontological Assumptions (Collins & Hussey, 2013)

In order to construct meaning of the social world around them, people are considered to be in a continuous process of interpreting the actions of those with whom they interact (Saunders et al., 2013). This interpretation leads to the modification of a person's actions and provides understanding regarding the reality of the social world. Figure 1.1 shows an illustration of the Continuum of Core Ontological Assumptions which indicates that this study is suited to the fourth stage of the Continuum: "Reality as a realm of symbolic discourse". According to Collins and Hussey (2013), the social world is created by individuals through language, actions and routines. Interpretivists note that the knowledge acquired about the social world is constructed through the intervention of participants, rather than objectively determined and perceived (Carson, Gilmore, Perry & Gronhaug, 2001). Therefore, this research study followed the interpretivist paradigm which was appropriate as qualitative data was collected through interviews with nurses and Information Technology (IT) experts at public health care facilities in South Africa. This was done in order to investigate what constitutes data quality in electronic medical records.

1.7.2. Research Approach

This study followed a qualitative approach to acquire data from the study's participants. Qualitative research focuses on how people can have different perspectives regarding reality (usually psychological or social reality). This research study used the qualitative approach as it provides different views which are necessary to constitute the data quality. The focus of the qualitative approach is a description and interpretation which might lead to the development of new concepts or theory (Hancock, Ockleford & Windridge, 2009).

1.7.3. Research Design

Research design is defined by Yin (2014) as a functional plan where procedures and research methods are combined. This study made use of a case study design. Yin (2014) defines a case study as a first-hand investigation focusing on an existing phenomenon within its real-life environment and boundaries between phenomenon and its environment are not clearly evident. The case study was conducted in Klerksdorp, North West Province. This province was chosen because Klerksdorp is still behind with the use of electronic records management system (Department of Health, 2016). According to the Department of Health (2016), the North West Province was prioritised to needing to improve public health care. The National Department of Health piloted an electronic records management system in the province to improve access to patient files and reduce patient waiting times in health care institutions.

1.7.4. Sample and Population

The term `population’ refers to a large group of people who share common characteristics. A representative of the larger group of population is selected through sampling (Gay, 1976). The researcher intends to evaluate what factors are required to ensure data quality in EMRs to improve public health care in the North West province of South Africa. The envisioned sample consisted of 8 health care professionals, but the interviews continued until a saturation point had been reached and no new information was reported by the participants (Olson, 2010). The sample covered both spectrums, the end users which are the nurses at different levels such as registered nurses or nursing sisters (who are responsible for the supervision of enrolled and enrolled auxiliary nurses and for performing typical nursing responsibilities), enrolled nurses (who perform limited nursing care) and enrolled nursing auxiliaries (who are responsible for basic care for patients on a general level) (Maidment, 2016) and those responsible for implementing the EMRs, the Information Technology Department (analysts/coders/technicians). Experts from the IT department and the nursing department were interviewed as they might have had different insights regarding the quality of EMRs based on their different work experience. The interviews were analysed, after which themes were developed from the literature presented in Chapters Two and Three and from the quality problems identified by the health care practitioners making use of EMRs.

The sampling method included purposive and snow ball sampling. According to Martinez-Mesa, Gonzalez-Chica, Duquia, Bonamigo and Bastos (2016), purposive sampling “is used when a diverse sample is necessary or the opinion of experts in a particular field is the topic of interest” (p. 328). The purposive sampling technique was used in this study as interviews with nurses and IT specialists would help clarify the challenges concerning data quality in EMRs. According to Alvi (2016), snowball sampling is used for reaching populations that are hard to reach. Snowball sampling allows the researcher to identify and interview the next person who is relevant to the research upon referral by the first participant, if the targeted population is not available. The following section discusses the data collection methods used for this research study.

1.7.5. Data Collection Methods

Data collection is a process in which a researcher collects information with the intention of acquiring an in-depth understanding of a research problem. This research study used primary and secondary data to obtain information regarding the research problem at hand. According to Oates (2006), primary data is often referred to as raw and unprocessed data that is collected for a specific research. On the other hand, secondary data includes data that has previously been collected and recorded by someone else and is readily available from other sources (Surbhi, 2016).

1.7.5.1. Secondary Data Collection Method

According to Saunders et al. (2013), the secondary data collection method is the process of using data that has been collected and reported by other researchers for other research purposes. This study collected secondary data by means of reviewing literature from books in both print and electronic format, academic journals, conference proceedings and academic websites. Electronic databases such as Science Direct, Google Scholar and ACM Digital Library were used to find the relevant literature. Key phrases such as `electronic health records', `electronic medical records', 'data quality', public health care' and `South Africa' were used as search terms. The secondary data was used to develop the research instrument which was used to interview health workers at public health care facilities about data quality challenges in EMRs.

1.7.5.2. Primary Data Collection Method

The primary data was collected by means of interviews. In qualitative research, researchers "examine how people learn about themselves and others and how they structure and give meaning to their daily lives" (Hox & Boeije, 2005: p. 595). Open-ended interviews were the best way to gather information for this research study as they would be helpful in terms of verifying and expanding the data quality challenges identfied through the literature review. A questionnaire that was previously published by Botha, Botha and Herselman (2015) was used to develop the current research instrument (see Appendix D). A pilot study was conducted with 5 nursing students that did not participate in the study, to make sure that the questionnaire was user friendly and that the questions were not ambigious. The questionnaire used in this study consisted of the following sections: the demographics of the participants, the participants' perceptions of the current quality of electronic medical records and what factors are necessary to ensure quality in EMRs. The questionnaire consisted of open-ended interview questions which corresponded to the six dimensions identified in Section 1.7 of the previous chapter. The next section discusses the data analysis methods that will be used in this study.

1.8. Data Analysis Methods

Data analysis is the process in which the collected data is analysed to reach a conclusion in a particular study. The qualitative interviews were analysed by means of thematic analysis, while the information obtained from the secondary data was analysed inductively. According to Crowe, Inder and Porter (2015), thematic analysis is the process of interpreting data and analysing it to find a pattern which will provide meaning to the data. The data is analysed to ensure that it supports or disproves the literature review or the secondary data which was collected through desktop research in order to reach a final conclusion so as to develop a solution to the research problem.

The validity of qualitative data refers to the trustworthiness of this data (Mertler, 2015). For this study, the credibility, dependability and confirmability of the data were established. According to Mertler (2015), credibility refers to acceptability of the results obtained from qualitative research, from the participants' perspectives. To ensure the credibility of this study, member checks were conducted. In other words, the participants were provided the opportunity to review the gathered information in order for them to validate whether it was truthful or not.

Dependability emphasises the importance of a researcher to be able to account for and describe any changes in the research setting, while noting how these changes affected the way in which the researcher directed the study (Mertler, 2015). A dependability audit was conducted to confirm the quality of the study. The audit was conducted to ensure that other researchers who are interested in this particular study will be able to search for and use the contents of the research study for its intended purpose.

According to Mertler (2015), confirmability refers to the ability of the researcher to make the collected data available to its source, in the process the logic that is used to interpret the data should be clarified. Therefore, the researcher has archived all the gathered data in a well organised format that is explicitly available to help establish that the study's findings portrayed the participants' responses.

The next section discusses the delimitations of this study.

1.9. Delimitation of the Study

This study focuses on electronic medical records and not electronic health records. The interviews were conducted at a public health care facility within the North West Province. Only public health care is the focus of this study, thus private health care facilities were not included in the population. Only the nurses (registered nurses or nursing sisters, enrolled nurses and enrolled nursing auxiliaries) and the IT experts responsible for the implementation of EMRs were interviewed to validate the factors developed from the literature review. The next section discusses the ethical considerations.

1.10. Ethical Considerations

The primary data of this study was collected by means of interviews. Therefore, to ensure that the study complied with ethical regulations, an application was made for ethical approval from the University of Fort Hare's Research Ethics Committee and the Provincial Department of Health. The ethical clearance number for this study is CIL051SMAK01 (refer to Appendix A).

As identified by (Oates, 2006), the following rights were presented to the participants to the study, prior to acquiring feedback from them:

- **Wilful Participation** – the participants were not forced to partake in this research study against their will; instead they were encouraged to participate willingly.
- **Informed Consent** – prior to the data collection, the participants were informed as to how the data would be collected and how it would be used, as well as any third parties who would have access to the data.
- **Withdrawal** – the participants were allowed to withdraw from the study should they have felt their rights were being infringed upon.
- **Anonymity** – the participants' identities and locations were not disclosed unless permission was granted by them for it to be disclosed. Each of the participants were given a code and only the researcher knew the true identifies of the participants.
- **Confidentiality –** the participants' information was kept in a secure place and only the researcher has access to the information.

1.11. Outline of the Chapters

This study consists of eight chapters. An overview of each of the chapters of this research study is provided below.

Chapter 1: This chapter introduced the entire research study. It began by providing the background to the study. Secondly, it discussed the problem statement followed by the research questions which was divided into two sub-questions. This chapter also discussed the significance and delimitation of the study.

Chapter 2: This chapter examines how electronic medical record systems can improve patient care at public health care institutions in the North West Province. Literature will be reviewed to gain an understanding of the benefits that the public health care institutions can obtain from using electronic medical record systems.

Chapter 3: This chapter aims to evaluate the factors which constitute data quality in electronic medical records. This section will evaluate the dimensions of data quality.

Chapter 4: This chapter will cover the research methodology that was used in conducting this study. This chapter consists of a detailed explanation of the research paradigm, approach, design, study sampling and population techniques, data collection and data analysis methods.

Chapter 5: This chapter will provide the analysis and discussion of the data obtained from the interviews.

Chapter 6: This chapter will provide the conclusion based on the research findings and suggest recommendations for future research

1.12. Conclusion

This chapter provided the introduction to the entire study. Chapter 1 consisted of the background to the study followed by the problem statement. Thirdly, the research questions including a brief discussion of each has been provided. This chapter also highlighted the objective and the significance of this study, also providing the important literature review and the theoretical review which supported and provided a foundation for this particular study. A discussion of the research methodology that was used to complete this study has also been provided, followed by a discussion regarding the delimitation of the study and the ethical considerations that the researcher applied to this study. Lastly, the structure of the entire study was outlined in Section 1.11.

Chapter 2

Electronic Medical Records

2.1. Introduction

Chapter 1 provided an introduction to the research study and problem statement. A discussion regarding the research questions and the objective of this study was provided. This chapter begins by providing an introduction about electronic health (e-health). This is followed by a discussion regarding health care in South Africa with a focus on the North West Province. Furthermore, there is a discussion regarding health care in the public sector followed by a discussion regarding health care in the private sector. The public health care sector encompasses primary, secondary and tertiary health care. The next section discusses the types of medical records that are used in health care institutions, including paper-based records, personal health records, electronic health records and electronic medical records. This chapter further discusses the factors influencing EMR implementation. Followed by a discussion about the retention of medical records, concluding with the disposal of medical records. The final section concludes the entire chapter.

2.2. Introduction to electronic health

Health care institutions in both developed and developing countries have started implementing Information and Communication Technology (ICT) to improve health care delivery systems (Ruxwana, 2010; Lewis, 2012; Chen, 2010). Information technologies provide the opportunity to improve information sharing, communication and the tracking of health care. Policy-makers have begun to promote and invest in the adoption of Health Information Systems (HISs) to facilitate the coordination of medical care (Jawhari, Ludwick, Keenan, Zakus & Hayward, 2016). The application of ICT to health care is referred to as electronic health (e-health). E-health enhaces the coordination of health care and is adopted at both private and public health care facilities. E-health encompasses health information systems (HIS) which enable health workers to create and manage medical records electronically. Information systems reduce the work pressure that is experienced by health care practitioners.

2.3. Health Care in South Africa

Health care varies across developed countries and developing countries. Developed countries are characterised by a resourceful economy, with advanced infrastructure and industrialised activity (Cheprasov, 2017). According to Anand (2000), developing countries are characterised as countries with less resources and a slow growing economy. Developing countries are characterised by poor health care, iliteracy for a large part of the population and high levels of premature mortality. South Africa is a developing country and is faced with a poor health status. The South African Department of Health (DOH) has been burdened by diseases which have been fueled by various hazardous factors, including sexually transmitted infections (STIs) resulting from unsafe sexual relations, poor diets and alcohol abuse, which trigger violence plus childhood and maternal malnutrition (Hlafa, Sibanda & Hompashe, 2019).

Health care in South Africa comprises both the public and private sector. The public health sector is funded by the state to provide equitable access to health care to all citizens of South Africa. The public health sector is often used by those individuals who are disadvantaged and those from rural areas. South Africa is burdened with a high infectious disease management load and the high levels of unemployment and poverty which result in the public health sector being the responsibility of the state (Jobson, 2015). These challenges have resulted in South African health care experiencing poor health outcomes despite the total health expenditure (Cline & Luiz, 2013; Rakabe, 2018).

The private health care sector is genarally known for using health information technologies (HITs), however, more public health care facilities are moving towards implementing HISs such as EMR systems. Health care institutions utilise different HIT systems to create and store patient information, for accounting purposes and also to improve access to quality health care. The electronic based system that is commonly used is the EMR. The two main HITs including EHRs and EMRs will be discussed in Sections 2.7 and 2.8. The next section will provide the distinction between the public and private health care sector in South Africa.

2.3.1. Public Health Care

Public health refers to the state of health which a community enjoys. Public health care facilities in South Africa typically provide health services to citizens without charging fees (Mayeza & Maluka, 2018). Patients that do not belong to medical aid schemes are usually the ones who make use of public health care services. However, public health care services are not restricted to those citizens without medical aid schemes, any citizen can make use of the service. The public sector is often criticised for poor service delivery due to shortages of medical personnel and overcrowding of patients (Jobson, 2015). The public health care sector is funded by the state and it is overburdened by a large group of South African citizens (Brauns, 2016). Generally, public clinics are situated at a central location where all the citizens of a community can access them. However, in rural areas, one clinic tends to not be sufficient for the citizens as others reside far from the health care facility. Thus, the expenditure towards public health is generally high. According to Jobson (2015), the national government allocates around 11% of its total budget to public health which is administered by the provincial Departments of Health in each of the nine provinces.

The public health care sector faces numerous challenges which affect the quality of the health services rendered to patients by health care practitioners (Mayeza & Maluka, 2018). The challenges also include under-resourced provider networks, poor health care systems and low staff morale. Health care outcomes differ across health care institutions. The health care outcomes are dependent on the manner in which health services are offered by health care practitioners and depending on the health care institution’s resources. Jobson (2015) found that the main challenges of the public health care sector are that of the burden of diseases such as Tuberculosis, HIV/AIDS and malaria, and the failure to effectively plan strategies for meeting the health needs of the country. Other challenges include a combination of density in urban areas and the percentage of the population in rural areas; geographic factors such as distance from health care facilities; and socio-economic factors including poverty levels (Eagar et al., 2015). Another issue that was identified is that of vulnerable groups not reporting ill-health, which results in the diseases worsening due to lack of treatment (Burger et al., 2013). For example, citizens from rural areas may postpone visiting the clinic due to the distance they have to walk or the travel costs they have to pay. Long queues can also influence individuals not to make use of public health care facilities (Mayeza & Maluka, 2018). Other issues that were found are that staff members at public health care facilities are rude in terms of how they talk to patients and there is sometimes a lack of medicines (Harris et al., 2011; Burger et al., 2013).

2.3.1.1. Primary Health Care

The primary health care (PHC) level is the entry level of health care for most patients. The purpose of PHC is to provide essential health care that is focused on the community level. The primary level of care provides primary care services, population health, health promotion, disease prevention and community development within a holistic framework (Shoultz &

Hatcher, 1997; World Health Organisation [WHO], 1978). The PHC is intended to provide free and equitable access to health care, while encouraging community collaboration and participation. The principles of PHC include sustainability of service provision and the empowerment of people (Keleher, 2001; Van Weel & De Maeseneer, 2010). The PHC provides health care to previously disadvantaged individuals, children and women and is categorised into four sub-levels of care, these include the following (South African Government, 2013):

- **Grade 1 PHC –** this is the biggest group of health care service providers which are an entry level of care and provide health care services to a large group of health care users. The clinics which fall under this category include fixed clinics and mobile satellites which offer services up to eight hours per day, five days per week.
- **Grade 2 PHC –** this category of clinics is sometimes referred to as day hospitals and it includes clincs which operate 24 hours a day, seven days a week. They include obstetric and maternal services.
- **Grade 3 PHC –** this category consists of psychiatric care provided at psychiatric mental clinics in community health care centres. Trained psychiatric nurses provide these services.
- **Grade 4 PHC –** this refers to district hospitals.

According to Dookie and Singh (2012), the PHC levels provide a variety of health services including curative, preventative and rehabilitative care. However, PHC facilities, especially those in rural areas, are faced with variuos challenges such as poor infrastructure, lack of resources, limited number of health care practitioners, the long waiting time of patients before being attended to and transport challenges (Masango-Makgobela, Govender & Ndimande, 2013). There is a chronic shortage of health care practitioners and lack of resources in these PHC facilities due to a shortage of staff and overcrowding of patients. This means that many patients prefer to bypass PHC facilities and rather visit hospitals to seek medical care as they are seen to be more convenient and are perceived as providing better quality care.

2.3.1.2. Secondary Health Care

The secondary level of care is visited by patients upon referral from the primary level of care. The secondary level of care offers health care services at hospitals to patients with more complicated health conditions that cannot be treated at district hospitals. This level includes

Intensive Care Units (ICU), 24 hour casualty services and 72 hour assessment/care admission wards (Bantom, 2016).

2.3.1.3. Tertiary Health Care

Tertiary health care provides specialised health care services to patients. In other words, tertiary level services are provided by physicians with specialised expertise concerning a particular health condition. According to Bantom (2016), the tertiary level of health care includes the provision of health care for specific health care needs, psychiatric care and rehabilitation.

All these levels of health care mentioned above are available both at public and private hospitals. However, the public health care sector is overburdened with patients as it provides health care to approximately 80% of South Africans with limited resources. Often the patients move around the public health care system, but are not able to take their medical record with them as it is in a paper-based format. This means that there is duplication of care and diagnostic tests that need to be done at every new facility that is visited. Medical records can solve some of these problems, but these records need to be complete and accurate in order to facilitate patient care. The medical records of patients are often of poor data quality as health care practitioners work under pressure because of trying to deal with the long queues of patients and limited resources. Thus, even if EMRs are implemented and used in public health care facilities, there is no guarantee that they will be used effectively. This is because some public health care facilities have weak network coverage, therefore, there is a possibilty that the patient electronic records will be of poor quality due to network interruptions. On the other hand, the medical records across all health care facilities may not comply with the required standards which might also compromise the quality of health services. The next section discusses the private health care sector.

2.3.2. Private Health Care

The private health care sector provides better quality health services, better infection control, reduced waiting times and advanced health technologies in clinics or hospitals (Mostert-Phipps, 2011). Private health care is provided by heath care practitioners through private hospitals which are usually located in urban areas. There are a number of reasons why patients choose private care, this includes shorter waiting time, more personal or specialised care and increased confidence in the quality of health care (Basu, Andrews, Kishore, Panjabi & Stuckler, 2012; Harris et al., 2011).

According to Maillacheruvu and McDuff (2013), the number of health care practitioners in the public health care sector is also less than in the private health care sector as most prefer to work in the private health care sector where health care practitioners have greater income returns and a better working environment. Often, experienced health care practitioners prefer to work in urban hospitals rather than in hospitals situated in rural areas. This coud be because urban hospitals offer better salaries and exposure to more advanced health care resources. This means that those health care institutions that are not situated in urban areas experience shortages of staff.

2.3.3. Health care in the North West Province

Health care outcomes differ across the provinces of South Africa as some provinces have better resources and health management than others. The public clinics in rural communities are usually faced with challenges of shortages of medications, poor maternity services, shortages of nurses or doctors and shortages of medical resources, which they often order but have to wait for some time before they are delivered (Chowles, 2015). A further disadvantage of the small clinics in rural communities is that they do not operate 24 hours a day. Thus, the community members are faced with troubles of having to travel to public health care facilities in urban areas of which some are quite a distance away from where the people reside. In cases of emergencies, patients usually suffer as ambulances may take long to reach the patient's home; even in cases where the patient has to be transferred to a secondary health care facility for more complicated conditions, the same can be said (Kostkova, Szomszor & Fowler, 2011).

However, the Provincial Department of Health is planning to increase the expenditure to overcome the challenges in the health care system of the NWP. In a study conducted in the province, the findings indicated that there is a widespread shortage of doctors in rural hospitals in the NWP (Kostkova, Szomszor & Fowler, 2011). There has been strikes concerning the issues that face the health care facilities. These strikes have claimed lives,led to infrastructure damage and crippled the provision of health services; a number of doctors have written a letter in a plea for urgent action to be taken (City Press, 2018). Health care practitioners often prefer working in urban hospitals or other provinces with better opportunities. According to Segalo

(2018), health care service delivery in the NWP is facing a crisis and has a backlog of over 4000 vacant positions. This staff shortage has resulted in health care practitioners working under tremendous and also resulting in longer waiting times for patients to access health care. The North West Provincial Department of Health acknowledges the issue of patients having to wait for longer periods at health care facilities and stated that the Provincial Department of Health plans to address this issue (Chowles, 2015). The plan also includes decreasing the high volume of patients at public hospitals by referring them directly to private health care facilities. The next section discusses the various types of medical records that exist.

2.4. Medical Records

Medical records are important as the record represents information that was captured by a health care practitioner for referencing with regards to a specific patient. For example, health care practitioners create patient records to keep track of the patients' medical history and the patients' health progress. Records are often captured and stored in records management systems. According to Marutha and Ngoepe (2017), records are created, stored and managed to support the accurate and efficient delivery of health care and other services. These services include professional disciplines such as finance, health, auditing, human resources management, accounting and law.

Such EMR systems are a necessity in any health care organisation that aims to provide optimal services. Information is the foundation of medical records. Thus, it is vital for health care organisations to invest in health information systems that ensure the safety of information (health records) while enabling the provision of services that will improve the overall health of the communities (Fichman, Kohli & Krishnan, 2011; Kolodner, Cohn & Friedman, 2008).

Medical records contain patient health information such as medical history, medications, prescriptions and diagnoses. Health care workers often refer to the patients' medical records to make decisions. Thus, it is important to ensure that the medical records are accurate and complete. Despite the importance of the medical records, there are numerous cases of mistakes that occur on the medical records and there are incorrectly managed medical records. The improper management of medical records could result in medical practitioners being unable to access information concerning a patient's prescriptions, treatments and previous diagnoses; it could also result in the permanent loss of the records (Marutha & Ngoepe, 2017). Incomplete and missing medical records can negatively affect the patients. For example, a patient could have an allergic reaction due to an allergy to a prescribed medication resulting in permanent paralysis or loss of life.

In the past, health care institutions used paper-record systems to capture patient information. Nowadays, health care sectors either use paper-based records or digital or electronic record systems to record patient data. More health care institutions are moving towards using electronic systems to create and manage patient records. According to Barry (2001), for records to be meaningful, health care institutions need to implement a digital record system. Barry (2001) describes a digital record system as an option which saves money, energy, time and also ensures speedy retrieval of records. However, some health care sectors still use paper records to capture and retrieve patient information. Below is a discussion of the paper records and the electronic records, after which the challenges of each will be provided.

2.4.1. Paper-based records

The paper records are typically handwritten and are stored in books or files. For instance, in health care facilities that use paper records, these can include log books, patient files and prescription notes. Paper records are not that secure as the ink used to write the notes may fade or the records may be misplaced or lost (Nakasolya, 2019). Paper records do not require Information Technology (IT) infrastructure, additional resources and staff training. In developing countries, clinics are situated in rural areas where there is usually poor network coverage and interrupted water and electricity services (Cline & Luiz, 2013). It is for these reasons that manual paper-based processes are used in most South African public health care facilities to perform administrative tasks and to deliver patient care (Cline & Luiz, 2013).

2.4.1.1. Challenges of paper-based records

Paper-based patient records do not contain all the required information regarding the patient's health. Thus, upon referral from one health care provider to another, a misdiagnoses or incorrect treatment can happen due to missing information. According Mostert-Phipps et al. (2014), paper discharge letters are either not received in time by the primary health care workers or not sent at all; this results in a failure to provide more informed follow-up care to patients. To maintain and improve the quality of care, health care practitioners need a detailed document of the patients' health information. This includes information such as the patient's diagnoses, management plan when needed and the patient's progress (Smith & Khutoane, 2009; Pillai, Thomas & Garg, 2004).

2.5. Electronic Records

In South Africa, some public health care facilities still adopt the paper record system to capture and retrieve patient information. This happens because the staff feel that capturing electronically increases the workload and some health workers are not necessarily computer literate. According to Marutha (2011), a hybrid system is used by the Department of Health in Limpopo to create and manage patient records. However, even though the records are maintained in digital and analogue format, the digital format is not complete as it excludes diagnoses, treatments and prescriptions. The only aspects covered in digital format are the patient's personal details, financial status regarding payments made by patients during consultation and the dates of consultations.

2.6. Personal Health Records

A PHR is an electronic record that contains information regarding an individual. This record contains information that has been gathered from various sources (Tang, Ash & Bates, 2006). The PHRs contain a lifelong summary of an individual's health information and they are typically created, owned and managed by individuals (Mostert-Phipps et al., 2014). Such PHRs enable patients' information to be available in one convenient place. Individuals can access their current and past medical information such as allergies, illnesses, medication and test results (Mostert-Phipps et al., 2014). Individuals are able to monitor their health by analysing the information and can make better decisions that promote good health. Thus PHRs are useful in assisting individuals with chronic condtions to manage their health.

2.7. Electronic Health Records

An EHR is a collection of an individual's health information that has been gathered from different physicians and other sources. Information sharing is beneficial as it allows physicians to interact and obtain a second opinion from other physicians. In other countries that utilise EHRs it was proven that the records have the potential to make workflow more efficient and improve the quality of medical care. However, some physicians still prefer to follow the manual paper system (Mather, 2019). Paper records have various drawbacks such as the ink fading, misplacement of the records, unclear handwriting, or the paper being destroyed by natural disasters such as floods. All these problems with paper records can result in physicians making poor clinical decisions. In South Africa, the expenditure towards health care is much higher than other developing countries, however, the value of implementing automated systems such as EHR is measured against the opportunity cost of improving the basic infrastructure for health care institutions, purchasing medications and medical equipment and reducing the shortage of health workers to improve health care (Cline & Luiz, 2013). Evidence is growing that the use of IT in resource-restricted areas provides benefits such as improved capacity and resource utilisation because other valuable inputs are made available (Cline & Luiz, 2013).

There are disadvantages of IT in health care which cannot not be overlooked. Health information systems were introduced and adopted with the aim of enhancing health care outcomes by improving communication among physicians; however, this is not the case as they increased the gap between the communities (Rajasekar, 2015). The purpose of EHRs is to allow the physicians to share and circulate information to obtain opinions from other professional physicians regarding certain health conditions and thereby avoid medical errors. According to Grober and Bohnen (2005), a medical error refers to a preventable adverse effect of care to patients which may result in misdiagnoses, wrong treatment options for diseases, infections, injuries or other ailments.

2.8. Electronic Medical Records

EMRs are records that contain an individual's health information in an electronic format. EMRs are typically created and managed by health care providers at health care facilities. EMRs contain detail information during a consultation between a patient and a health care provider. This information includes encounter medical histories, summaries, and details of existing allergies (Ludwick & Doucette, 2009; Hartley & Jones, 2005). Usually EMRs are created in the health care practitioner's office and they remain within the organistaion. Other additional functionalities of EMRs include decision support, results management and order entry (Ludwick & Doucette, 2009). The aim of the National Health Insurance (NHI) that is about to be implemented in South Africa is to ensure there is an ability to share the patient records between health care providers at different health care settings (Mostert-Phipps et al., 2014).

EMRs have the ability to simplify patients' records management, lower costs and increase productivity (Bain, 2015). EMRs enables up-to-date patient's information to be easily available to health care practitioners at the point of care, this allows decision support. For EMRs to function properly and to produce appropriate and valuable results, a collaboration from all the departments in the health care facility is required. IT experts which are responsible for implementing the EMR systems should understand the work environment and align the system to the organisational goals. On the other hand, the staff members should be educated about the EMR system and with regards to what is expected from them. The organisations should also invest in training the staff on how to operate the EMR systems. Collective work from the various departments will ensure that there are no setbacks resulting from the system and also achieving patient and employee safety. The following sections will discuss the steering committee and the workgroups, the equipment and furniture needed to accommodate EMR systems, and the facility design and construction.

i) Steering committee(s) and workgroups

It is important for the clinical and the non-clinical staff members to work collectively and share their particular expertise amongst the entire organisation's staff to enable the successful implementation and operation of an EMR system (World Health Organization, 2018) . This is to ensure that no staff member falls behind, thus affecting the performance of the entire organisation. During the course of the EMR implementation in a health care organisation, a steering committee should consist of crucial stakeholders representing IT, Human Resources, Procurement, Operations, Medical Records, Workplace safety, Engineering, Environmental, Health, Infection Control, Management, Physician, Labour, and all the other existing clinical departments (Bain, 2015).

ii) Equipment and Furniture

The necessary furniture, equipment and computer technologies are needed in a work environment when an EMR system is implemented (Boonstra, Versluis & Vos, 2014). The equipment needed to perform the work functions need to be safe and easy to use. The furniture needs to be flexible and comfortable in a way that will allow the health care provider to assist a patient, for example, the chair should have wheels so that the` practitioner can move around freely while capturing patient data and collecting the medication from a cupboard (Jacobs, 2016). According to Bain (2015), the purchasing team is responsible for the furnishings and accessories. The representatives with expertise in different functional areas (for example, IT, purchasing, environment, health and safety) have to participate and collaborate with the purchasing teams to test and review the devices and equipment that will be used. The representitives need to acquire feedback from the users and make collective decisions regrding the equipments, computer technologies and furnishings to be purchased.

iii) Facility Design and Construction

As part of the EMR implementation, the work organisation needs to understand the environment in which the EMR system will be implemented (Hodgkins, 2015). The design and the construction of the EMR systems should follow the work practice and allow the health workers to perform their tasks easily.

2.8.1. Benefits of Implementing Electronic Medical Records

EMRs enable organisations to effectively manage records. EMRs also have the ability to highlight issues that might have been missed when using a paper record system. The EMRs have several benefits, not only for the organisation which uses them, but for the communities. Although EMRs reduce costs incurred by the health care organisations by preventing mistakes that can be avoided, the records also improve the communities' health. Such EMRs provide clinical, organisational, and societal benefits. Firstly, EMRs affect clinical outcomes by improving the quality of care of patients, enable the reduction of medical errors and by increasing safety, efficiency, and effectiveness (Menachemi, & Collum, 2011; Bain, 2015). Secondly, according to Ohuabunwa, Sun, Jubanyik and Wallis (2016), EMRs affect organisational outcomes by averting unecessary costs, increasing revenue and decreasing legal vulnerability of hospitals by ensuring that events that may be harmful to individauls are avoided. Thirdly, EMRs have an effect on societal outcomes by promoting public health by enabling health care institutions to monitor and manage diseases, by facilitating research, and increasing the physicians job satisfaction (Menachemi & Collum, 2011; Forson, Oduro & Forson, 2013; Rockefeller Foundation, 2013).

2.8.2. Barriers to Implementing Electronic Medical Records

The EMRs provide a number of benefits to the organisations that successfully implement and utilise the systems. However, technology may also introduce its own errors which may have negative effects. According to Jawhari, Ludwick, Keenan, Zakus and Hayward (2016), a number of authors have stated that the effectiveness and efficiency of health care cannot be solely improved by EMR implementation. Instead, digital systems tend to introduce complexities which put the personnel under immense pressure because they do not understand the systems, thus aggravating bad workflow. Thus, it is of importance that every organisation that implements an EMR system invests in providing training to the staff that will be using the system. For example, in the United States a hospital uses an Anaesthesia Information Management System (AIMS) for patient records. AIMS is an electronic health record system which is specialised to automatically collect, store, and present data during the perioperative period. The records are perioperative compared to the hand-written charts (Wax, Beilin & Hossain, 2008; Bloomfield & Feinglas, 2008; Douglas & Ritter, 2011). The "technology induced errors" that may occur include opening and charting in a patient record which belongs to another patient. Additionally, if the medical record is retrieved and charted, the patient's information will present an incorrect surgical history which may impact on his or her future procedures requiring anaesthesia (Rebello et al., 2016). It is therefore evident that minor mistakes like opening a wrong record could result in another patient's record being incorrect leaving him or her suffering or even leading to death, in some cases resulting to litigations (Saba et al., 2019).

The EMR systems are introduced in public health care institutions by the government with the aim of improving and providing quality health care to all. A study conducted at two South African medical institutions showed that there were challenges faced regarding EMR systems.

2.9. Factors Influencing EMR Implementation

A number of factors play a part in determining whether health information systems such as the EMR system functions properly and provides organisations with positive results. Organisations may install the best EMR system, however, they cannot reap the benefits if the system is not appropriately operated. A diagram is provided below as a summary of key points that were highlighted from the literature.

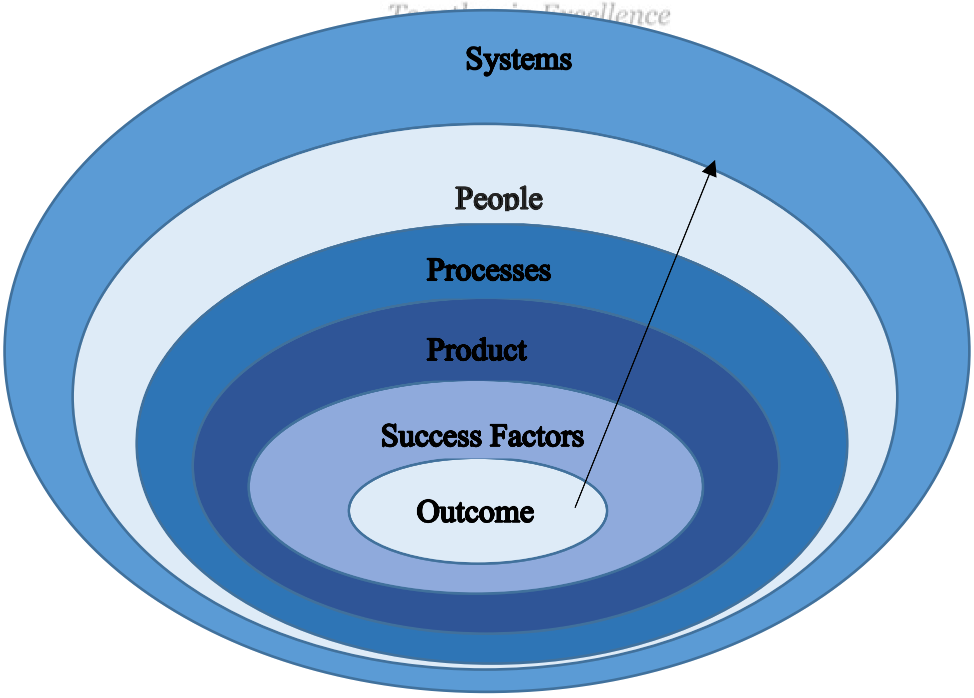

Figure 2.1- Understanding EMR Implementations in Limited Resource Settings (Jawhari et al., 2016)

Figure 2.1 depicts four determinants that have an effect in EMR implementations in resource-restricted settings; these include: i) Systems ii) People iii) Processes, and iv) Products. Each of the determinants will be briefly explained.

i. **Systems** considerations include reliable power sources, networks and strong internet connectivity (Hannan, Rotich & Odero, 2000; World Health Organisation, 2019). Without these, the EMR implementation will not be successful. Organisations should ensure that there are backup options in cases where there are power outages, such as, generators and the technological equipment should be located in a secure environment with protection mechanisms used on both the software (the information) and the hardware (the actual computers and hard drives).

ii. **People** considerations relate to the human resources within an organisation. This includes the training and support that is provided to the personnel (deRiel et al., 2018). This determinant is essential as the people (health workers) are the foundation of health care institutions. The health workers examine the patients, create a diagnoses, create the patients' medical records and recommend treatment options. Thus, it is crucial for the health workers to obtain adequate training and support in terms of how to use the EMR systems and how to integrate the technology within their job functions. The people considerations also includes "how users are influenced by workplace attitudes and leadership" (Jawhari et al., 2016: p. 5). A peaceful working environment promotes an effective workplace, thus, the leaders of an organisation should ensure that workers maintain a healthy work relationship so as to produce great results which will improve the quality of care and public health.

iii. **Processes** considerations includes change management at the time when the EMR systems are introduced to the time when they are used to perform work functions. The personnel should be appropriately nurtured in terms of how to accept and adopt the change within the organisation. The information technology (IT) personnel should dedicate time to guide the health workers to the point where they can operate the EMR systems on their own (deRiel, et al., 2018). Mistakes and failure to operate the EMR systems should be expected since not every individual will get it right at the same time.

iv. **Product** considerations includes the "EMR software and how it inter-operates with other applications" (Jawhari et al., 2016, p. 5). When implementing the EMR system, the organisations should ensure the technology used supports the organisational goals.

These determinants are considered as having a positive or negative effect on EMRs. Therefore, they are considered as the success factors to EMR implementation. According to Jawhari et al. (2016), success factors are emphasised by authors as the determinants of EMR impact consistent with the goals of EMR implementation.

2.10. Retention of Medical Records

Medical records should be kept secure, accurate and up-to-date for the continuity of care of patients. A records management policy is essential for every health care organisation to eliminate the problems associated with medical records (Medical Protection Society, 2013). Poor records management can lead to incidents of patient's health being affected negatively due to misplaced medical records (Marutha & Ngoepe, 2017). Medical practitioners often refer back to patients' medical records such as previous diagnoses and treatments, medications and allergies. Thus, it is essential for every organisation to have a good records management system in place. Problems with medical records have been identified, these include: poor quality information, lack of accessibility, misfiling, poorly organised notes and misinformation (Naidoo, 2017). These problems are known as the root cause of adverse incidents (Medical Protection Society, 2013). As medical records represent the patient's health, it is important to appoint a person who will be responsible for reviewing the organisations records management policy to ensure it complies with legislative requirements (Medical Protection Society, 2013).

2.11. Disposal of Medical Records

Medical records cannot be kept forever in a health care organisations records management system for reasons such as storage space as well as the appropriate management of the records (Naidoo, 2017). For instance, some patients that were recorded in the hospital system may be deceased and others may have relocated to other places or decided to visit other health care facilities. Thus, for accurate records some patient records should be disposed of. However, this should be done appropriately and securely while keeping patient information confidential. According to Medical Protection Society (2013), an efficient records management system should allow for the records to be archived or destroyed when they are no longer useful in order to make space available for new records, mostly in the case of paper records. The Electronic Communications and Transactions Act stipulates that electronical records that are found to be obselete should be deleted or destroyed (Medical Protection Society, 2013). Before the disposal of records, it is essential that the records are analysed to verify that the records are no longer in use and can be discarded. It is therefore necessary for a designated member of staff to be appointed to give authority for the disposals of the records (Medical Protection Society, 2013).

2.12. Conclusion

Medical records are essential, therefore it is necessary that they are of good quality. The information captured on the medical records determines the quality of care provided to patients as poor records could lead to adverse events such as misdiagnoses and in some cases providing the wrong treatment to patients. The EMRs have the potential to store patient data in a single location and allow the sharing of the data among health care professionals. However, EMRs require a collaboration from all health care workers from respective departments to produce effective results. The success of EMR implementation is also determined by four factors including the system, people, processes and the product. These factors influence each other in a way and should not be overlooked during EMR implementation and use. Lastly, it is important for health care organisations to follow the correct procedure in retaining and disposing of the medical records. Medical records contain personal and important patient information and should be retained for as long as the patient is alive. However, should a patient be deceased or change health care facilities, their records can only be disposed of when a designated authority validates that the records are no longer in use.

Chapter 3

Data Quality

3.1 Introduction

Data is essential to any organisation as it is the raw material which produces the final product known as information. According to the Health Information and Quality Authority, data are described as numbers, symbols, graphics, images, words that have to be analysed and organised in an understandable manner. Once the data has been processed to produce something meaningful, it is then referred to as information (Health Information and Quality Authority, 2011). The information can either be useful or it can be regarded as meaningless. Thus, data quality is an important factor as it can determine whether the final product is of poor or good quality. Every organisation should prioritise ensuring their databases and information systems have the necessary data assessment tools which will be able to track data integrity. Several factors can affect data quality including: missing or incomplete data, misinterpreting variable definitions, lack of external audits of data collection or variations in coding practices (Cai & Zhu, 2015). According to Borek, Parlikad, Webb and Woodall (2014), it is indicated that almost every organisation has issues relating to data quality; most organisations do not demonstrate a pattern of managing data as an asset; data quality is often overlooked due to loads of work until problems arise; lack of data quality is often not classified as a business problem, instead it is described as an information technology problem; however, data quality should *never* be considered an IT issue as the owner of the problem is the business.

Data quality can have different meanings to different individuals, based on their perspectives or what they consider important. Data quality refers to data that is accurate, relevant, valid, reliable, legible, complete and available when it is needed by decision-makers for health care delivery and planning purposes (Health Information and Quality Authority, 2011; Dragan, 2018). The quality of the data can be influenced by how it is analysed, interpreted and organised.

3.2. Data Quality Definitions

Data quality has various definitions, depending on what seems appropriate for a particular element. Data quality has different definitions at different periods and in different fields (Sidi et al., 2013). Individuals may have different understandings or knowledge of what comprises data quality. Hence, a definition which is appropriate to one aspect does not entail that it will be appropriate to another. Quality management defines data quality as appropriate for use or to meet user needs or it is the quality of data to meet customers’ needs (Alizamini, Pedram, Alishahi & Badie, 2010).

3.3. Types of Data

Data is classified into different structures to provide insight as to what constitutes data. Batini and Scannapieca (2006) define data as real world objects that are able to store, retrieve and elaborate through a software process and can be communicated via a network. Data can be analysed, cleaned and then transformed into useful and readable information. Researchers have provided different classifications for data in different areas (Sidi et al., 2013). Firstly, they classify data as structured, unstructured and semi-structured. Secondly, another classification of data considers data as a product; within this group, data is classified into three types. Table 4 provides a presentation of the types of data based on the first classification. Conversely, Table 3.1 also presents the types of data based on the second classification. These types of data are provided with defintions and examples.

Table 3.1 - Types of data seen as structured, unstructured and semi-structured (Sidi et al., 2013)

Types of Data	Definition and Examples
Structured data	“Consists of an aggregation or generalization of data items which are described by fundamental attributes that are defined within a domain.”

	For example, *relational tables and statistical data.*
Unstructured data	“This consists of a generic sequence of symbols which are normally coded in a natural language.” For example, *a body of an email, a questionnaire consisting of free text response*.
Semi-structured data	“This consists of structured data that has some degree of flexibility. “ For example, *XML and mark-up language*.

3.4. Data Quality Literature

Information is important in that it supports the operation of services. For example, hospitals or physicians need to acquire or have access to an individual’s health information in order to provide quality health care. The health outcome of patients can be affected by the quality of information which is available to health care professionals. For instance, if the health system in a particular health care institution provides patient health information which is not up-to-date to a health care professional, inaccurate decisions can be made based on the information that is available. Health information is important, thus, it is necessary that the correct measures are taken to ensure that investments are made to ensure that information is managed in the most effective manner. Health care professionals should be able to collect, store and access reliable and complete information in order to provide safe, quality health care services.

A study by Ali et al. (2018) provides an example of the definition, use and quality of data based on the responses received from the study’s participants. The respondants include 42 personnel representing Principal Recipient Unit of the Mercy Corps and Sub-Recipient organisations. The feedback was based on the general understanding that the respondents had with regards to data and their use in the particular organisations.

According to Alpar and Winkelstrater (2014), data quality involves various aspects that make operationalising the concept rather challenging. Actions towards improving data quality should be aimed at meeting user expectations and business needs to form a solid basis for measuring data quality (Silvola et al., 2016). Sundararaman (2011) supports that there are situations that could lead to data quality being experienced as high by some and low by others, for instance, having the same data with multiple uses and users.

3.5. Approaches to Data Quality

There are three approaches that are used to study data quality. These include an intuitive, a theoretical, and an empirical approach (Wang & Strong, 1996). The intuitive approach is taken when the researcher's experience or intuitive understanding is used to identify what attributes are important to ensure data quality (Wang & Strong, 1996). For instance, certain data quality attributes may be found to be important to an organisation, while they are not important in another organisation. This can occur for reasons such as a particular attribute fulfilling certain requirements which place an organisation at an advantage. For example, accuracy is included as either the only or one of several key dimensions in many of the data quality studies (Bailou & Pazer, 1985; Wang & Strong, 1996). On the other hand, in the auditing and accounting literature, reliability is included as the key dimension which is used in studying data quality (Wang & Strong, 1996).

Secondly, the theoretical approach emphasises on deriving attributes based on an established theory (Wang & Strong, 1996). In other words, an existing theory is used to learn about a particular topic and a conclusion can be reached after thorough observation of the theory has been made.

Thirdly, the empirical approach allows the data consumers to determine the characteristics for assessing whether data fits their tasks (Wang & Strong, 1996). For example, the data consumers determine which data is fit for purpose and data quality may be affected by the chosen data.

3.6. Total Data Quality Management

Data quality has been included in the total quality management approach (TQM) model as total data quality management (Kerr, Norris & Stockdale, 2008). The TQM approach is based on the principle of minimising errors and maximising quality performance. The TQM focuses more on quality, meaning the better the quality of a product or service, the better the financial gains. According to Health Information and Quality Authority (2011), TQM "involves creating the culture of quality throughout all levels of an organisation" (p. 9). Thus, investments are made by the organisation to provide necessary training to the staff to improve their performance so that they provide a quality service; in so doing, quality is prioritised over short-term financial gains. Therefore, in order to obtain quality data, Deming's cycle can be implemented, where data is analysed and corrected, if any errors are identified. The necessary changes should be implemented until the data is of good quality. The following section provides a discussion regarding the dimensions of data quality.

3.7. Different Methods of Ensuring Data Quality

Organisations use different information systems to capture and store data. In the health care setting, health care practitioners use health information systems to capture patient information. However, data quality plays a crucial role in determining the quality of health services provided to the patients. Data quality has been examined widely across various business sectors, as a result, its area of knowledge differs due to its cross-disciplinary nature (Sadiq, 2013). The efficiency, effectiveness and reliability of the health services provided to patients is dependent on the quality of the data in health information systems which are used by the managers, decision-makers and health care practitioners. Thus, there are methods of data quality that can be used to measure and analyse the quality of the data stored in health information systems. The quality of the data can be measured against the data quality methods or dimensions to ensure that the information is of good quality. According to the World Health Organisation, information systems in health care institutions usually perform the following four key functions: "(1) data generation, (2) compilation, (3) analysis and synthesis and lastly (4) communication and use" (WHO, 2010, p. 44). These functions are affected by data quality issues due to incompatible data formats, multiple data sources, data defintions (Lee, Pipino, Funk & Wang, 2006) and the techniques in which data are collected and used. Organisations should implement strategies which will eliminate the data quality issues that affect the effectiveness of information systems. The quality of data and the data quality issues cannot be overlooked as they determine the information that is produced. According to Bai, Meredith and Burstein (2018), the widespread application of information systems in various sectors has increased the importance of data quality, as data quality issues have the ability to affect the end result that is reviewed by or presented to the end user. Irrespective of the application of data management programmes, fifty-one percent of the organisations globally consider them ineffective (Experian, 2017). Most organisations are aware of the importance of data quality, however, some organisations have data quality management strategies that are either ineffective or are not properly applied.

When discussing data quality, there are fundamental issues that need to be understood. According to Sidi et al. (2013), the fundamental issues in this field are data quality strategies and techniques, data quality definitions, types of data, and lastly, data quality problems' classification. This research will provide a discussion of the above mentioned issues in the order provided above.

3.7.1. Data Quality Strategies and Techniques

There are two strategies that can be adapted to improve data quality, these include data-driven and process-driven, and each strategy employs various techniques that aim primarily to improve data quality (Batini, Cappiello, Francalanci & Maurino, 2009). A discussion of the two strategies with their respective techniques is provided below.

3.7.2. Data-Driven Strategy

Data-driven strategy involves improving the quality of data through modifying the data value directly (Sidi et al., 2013). The following are some of the related improvement techniques of the data-driven strategy: acqiring new data, correcting and localising errors, standardisation or normalisation, record linkage, source trustworthiness, data and schema integration, and lastly cost optimisation (Batini et al., 2009).

3.7.3. Process-Driven Strategy

Process-driven is a strategy that redesigns the overall process which is produced or data that has been modified in order to improve quality (Sidi et al., 2013). The process-driven strategy comprises two main techniques, namely, process redesign and process control. According to Sidi et al. (2013), in the process control stage the data which is used will be checked and managed among the manufacturing process; in contrast, the process control eliminates the causes of low quality data and a new process will be added in order to enhance quality and produce high quality data. The process-driven strategy has the ability to eliminate poor quality data before it can be used or stored. This process can be advantageous for organisations as the elimination of poor quality beforehand will cut off the financial and time costs of having to go through data once it has already been captured and stored. Batini et al. (2009) state that another fact regarding process redesign is that it enables the adding of an activity that can control the data formatting before its storage. The process-driven strategy is more advantageous than data-driven techniques, in that it is better performing in the long term because they completely eliminate the root causes associated with quality problems. In contrast, the data-driven strategy is more costly than process-driven in the long term, however, it is efficient in the short term (Batini et al., 2009).

3.8. Data Quality Framework

According to ACT Government Health (2013), the Data Quality Framework provides an objective approach to assessing and improving the quality of data. The framework contains four main components namely:

- The Data Integrity Strategy;
- Data Quality Policy;
- The Data Quality Improvement Cycle; and
- Data Quality Assessment tool.

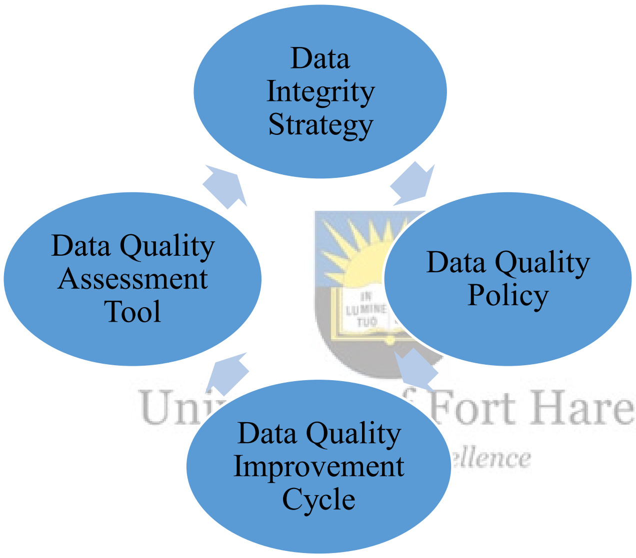

Figure 3.2-Data Quality Framework (ACT Government Health, 2013)

The data quality framework in figure 3.1 provides tools that ensure quality assurance and support the quality process with the input, output, throughput, use, manipulation, or reporting of data (ACT Government Health, 2013). The framework is necessary for the data capturers, administrators and the members of the executive level as they use the data to make organisational decisions.

3.8.1 Data Quality Framework Components

The Data Quality Framework comprises of components which are all essential to ensure that data quality is achieved. The necessary steps need to be followed in order to attain good quality data and skipping some steps may affect the entire plan towards achieving high quality data.

Thus, any organisations with the aim of improving data quality should ensure that the following components: Data Integrity Strategy, Data Quality Policy, Data Quality Improvement Cycle and the Data Quality Assessment tools are in order.

3.8.1.1 Data Integrity Strategy

The Data Integrity Strategy describes and prioritises a number of initiatives that assist with strengthening the Directorates approach to collecting, collating, using and securing information (ACT Government Health, 2013). Having a planned strategy for EMR quality improvement may help ensure data integrity. A proactive data management strategy prepares an organisation or health care practitioners to address any data quality issues as they arise. Sutherland (2018) states for guaranteed data integrity, there is a need for health care organisations to implement strong quality management practices to help maintain and protect data during collection, processing and storage. Strong quality management practices can help stimulate EMR data integrity by ensuring complete, correct, consistent and timely data from its collection to its storage and use.

3.8.1.2 Data Quality Policy

The DQ Policy is there to provide guidance to staff members in an organisation by focusing on their roles and responsibilities to ensure that "data are accurately recorded, updated and maintained over time to support a credible, rigorous source of information" (ACT Government Health, 2013, p. 10). The DQ Policy supports organisations by ensuring that they follow a data-driven culture that focuses on consistently improving data quality. Organisational decisions are done based on the data that is collected, captured and stored. Thus, it is necessary that there should be a Data Quality Policy in place at every organisation aiming to produce good quality data. The EMRs contain patient health information, it is therefore crucial for an effective DQ Policy to be in place to ensure that the health care practitioners follow good quality data practices. A DQ Policy will provide health care practitioners with direction in terms of what standard of quality the EMR data should contain.

3.8.1.3 The Data Quality Improvement Cycle

The data quality improvement cycle is a continuous process that is undertaken by the social and health care organisations which intends to analyse and improve any data quality issues. This is an iterative approach that eliminates the data quality issues through phases or stages by identifying, analysing and bringing about solutions to improve the quality of data (ACT Government Health, 2013). The quality of EMRs can be improved through a repetitive process of analysing and rectifying data. In other words, data capturers need to validate the EMR data received from physicians all the time before closing off the patient's file. Cross-examination of the EMR data will highlight any data quality related issues at an early stage. Therefore, measures can be taken to improve the quality of the data preventing adverse events from occurring. Figure 3.2 below shows the five stages of the Data Quality Improvement Cycle. A discussion of the stages is provided below it.

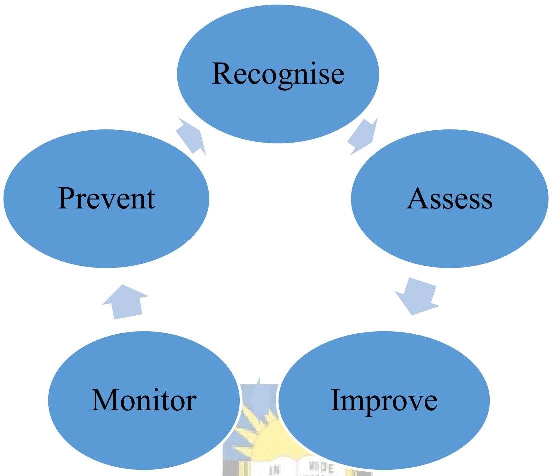

Figure 3.2- Data Quality Improvement Cycle (ACT Government Health, 2013)

The data quality improvement cycle consists of the following stages/phases (ACT Government Health, 2013):

i. **Recognise:** This is the beginning of the improvement cycle whereby any issues related to data are identified.
ii. **Assess:** This involves making the necessary preparations to improve the identified quality issues whilst designing any changes that are needed.
iii. **Improve:** This stage involves the implementation of the planned quality improvements by applying them as a resolution to the quality issues identified in the first stage.
iv. **Monitor:** The outcomes of the applied quality improvements strategies should be monitored to assess whether they are effective and whether there is a need to repeat the cycle. The implemented resolution should be maintained in order to prevent issues of the same kind from re-occurring in the future.

v. **Prevent:** The organisation aiming to improve quality should ensure that the cycle is maintained on a continuous basis, this will help with recognising any arising issues. The constant maintenance of the cycle will ensure a constant improvement process.

For any organisation aiming to improve the quality of data, the above mentioned stages/phases are essential as they can ensure good quality data if appropriately applied within an organisation's business processes. However, the cycle needs to be repeated to ensure positive results that lead to high data quality.

3.8.1.4. Data Quality Assessment Tools

The purpose of the Data Quality Assessment Tool is to assess data and to validate whether it is fit for the purpose for which it was collected. The Canadian Institute for Health Information (CIHI) highlights the data quality assessment tool that organisations can use to comprehensively assess its data sources. The data quality assessment tool provides criteria and characteristics that serve as a guide to organisations in terms of how to conduct the assessment of data quality.

3.8.1.4.1. Dimensions of Data Quality

1) **Relevance**–Relevant data refers to data which is useful when used for the purpose for which it was intended. In EMRs, the relevant data may include a patient's demographic information, diagnoses and examination results. For instance, a physician or health care practitioner should be able to treat or monitor a patient's health using the information that has been stored. Thus, it is essential that EMRs contain relevant data at all times.
2) **Accuracy and Reliability–**The accuracy of data refers to the truthfulness of the data and how closely it describes the purpose for which it was designed to measure. Reliability refers to whether the data accurately represents the reality that it was designed to represent. The accuracy and reliability of data in EMRs is dependent on what the health care practitioner enters into a system or database. The level of correctness leads to accurate and reliable electronic records. On the other hand, entering erroneous EMR data could lead to data that is inaccurate and unreliable, which in turn could lead to poor decisions.

3) **Timeliness and Punctuality**–Timely data refers to data that is collected within an agreed upon time period and is made available when it is required. Punctuality refers to availing or reporting the data within the promised or planned time frame. Patient data should be easily available when they are needed. For example, during an emergency, a health care worker should not struggle to obtain patient data from the EMR system. Any delay could result in the patient receiving treatment that might impact negatively on them.
4) **Coherence and Comparability–**This refers to data which remains consistent over time and across providers and can be combined with different sources. Reliable data is data which remains the same over time, whether transferred from one physician to another. Therefore, EMRs can maintain their coherence and comparability if they are kept accurate and up-to-date at all times. This can make sharing the EMRs across providers and different sources easier.
5) **Accessibility and Clarity**–This refers to data being easily available and presented in a way which is easily understandable. The EMRs allow for data to be easily available through searching by a unique identifier and the medical data can be accessed anywhere, at any time as long as the user has access to a computer or a mobile phone. The health system may also present the data in a manner which is clear and easy to understand with an option to select the preferred language of the user.

3.9. Application of the Dimensions of Data Quality

Many organisations have data quality issues, however, some lack data quality assessment tools or data quality improvement strategies. Some organisations may refer to other dimensions as more logical descriptions of data quality, more than others. With reference to the study conducted by Ali et al. (2018), the respondents were presented with 11 practical cases or data quality issues in which the dimension receiving the most responses were considered for inclusion in the data quality framework. From the responses received, six dimensions were highlighted, these included completeness, accuracy, consistency, vagueness, duplication and uniqueness, and timeliness. These dimensions will be discussed in detail below.

Completeness

Completeness refers to having all the necessary information included in a document or entity**.** Additionally, poor data quality was related to incomplete documentation in 6 studies (Byrd et al., 2013; Forberg, Johansson, Ygge, Wallin, & Ehrenberg, 2012; Inan, & Dinc, 2013;

Puttkammer et al., 2016; Spuhl et al., 2014; Wang, Yu, & Hailey, 2013). Problems regarding incomplete documentation were found due to either lack of comprehension on what to document, disagreements among providers, lack of association between the narrative electronic notes and the fields that were built to be completed within the EHR chart and lack of training. For a detailed explanation of the data quality dimensions, examples from practical cases will be provided below. These cases describe the data quality issues that were identified through the collection of responses from participants in a study by Ali et al. (2018).

Accuracy

"Accuracy of data refers to how closely the data correctly captures what it was designed to capture" (Health Information and Quality Authority, 2011: p. 11). Data accuracy refers to when the data is correct and matches the necessary requirements. According to Pratiwi and Anawar (2015), an issue of accuracy occurs when a value does not match or is not close to an actual value. Patient medical data were found to be inaccurate due to a number of issues including omitted information, duplicate notations, a lack of standardised language within the facilities, lack of training, the use of varied terminology by health care providers, lack of awareness regarding the functionalities of EHRs, or failure to recall in exact detail the tasks that were performed at the patients' bedside.

Consistency

Consistency is defined as data values which remain the same in multiple data items in multiple locations (Almutiry, Wills, Alwabel, Crowder & Walters, 2013). The term consistency refers to keeping to the same style or format of capturing data across different locations. Once the data values portray a difference, the data values are said to be inconsistent. According to Ali et al. (2018), a case for the Pakistan's TB Control Program revealed that consistency had the least reported issues, with only one issue found in the paper-based records. Similarly, in a study by Ali et al. (2018), one practical case reported one issue concerning consistency and it was revealed that (40%, 17 out of 42) records showed that Patient ABC is registered as a pulmonary case, whereas the patient was recorded as an extra-pulmonary case on a follow-up visit.

Vagueness

"If a statement is unclear or unspecific, it is regarded as vague" (Pratiwi & Anawar, 2015:p. 135). To avoid vagueness in data or medical records, data capturers should avoid using complex terms or languages. Similarly, a medical record should contain descriptive details which will eliminate the chances of making decisions which are inappropriate. The ICD was developed by the World Health Organisation (WHO) and it was mandated to be used by all health care practitioners in South Africa since 1 January, 2005 (Van Der Merwe, 2010). "In the case of delirium, its transitory nature coupled with it being a change in mental status, as opposed to physical ailment" (Spuhl et al 2014:p. 1067), which lead to a vague and uncertain view regarding the quality of mental health data. As a result the illness is commonly undiagnosed and untreated.

Duplicate and Uniqueness

Duplication refers to the repetition of the same instance more than once. For example, capturing the same patients name twice in a record is regarded as a duplication concern. Batini, Cappiello and Francalanci (2009), identified the number of duplicates as a "uniqueness" concern. In a practical case, one instance was identified as a "uniqueness" issue.

Timeliness

According to Orfanidis, Bamidis and Eaglestone (2004), timeliness is defined as shared data that should be as near real-time as possible. The data should be timely, in the manner in which it is usable and relatable to the present. Data which is outdated may lead to unfavourable results when shared or used. For example, if a patient's health or medical record shows negative results for a diabetes test that was done 2 years ago and the current status of the patient record changes to postive (diabetic), but is not updated on the medical record, the patient may not receive the necessary treatment which could result in their health deteriorating or even in the loss of their life. Thus, timeliness refers to data which relates to the present and is a crucial data quality dimension. Futhermore, poor data quality related to timeliness was found in four studies (Inan et al., 2013; Puttkammer et al., 2016; Sockolow, Bowles, Adelsberger, Chittams, & Liao, 2014; Wang et al., 2013). A patient's data were entered late due to a lack of a standardised language, flaws with the nursing assessment, the gap between the times when the nurse was at the patient's bedside and the time when the task was actually documented, finally, due to inadequate training. In a study by Byrd et al. (2013), completeness and timeliness were improved in a cohort study after implementing a clinical assessment tracking system, compared to a retrospective study by (Wang et al., 2013) in which completeness, timeliness, and the quality of nursing electronic documentation scores were not improved.

Various dimensions of data quality exist, Weiskopf and Weng (2013) described the dimensions of data quality of EHRs, these include: completeness, concordance, correctness, currency, and plausibility. The EHRs are used interchangeably with EMRs as they are very similar. Thus, the dimensions of EHRs can be applied to EMRs.

3.10. Data Quality Problems Classification

Data is susceptible to quality issues and these have an impact on the functioning of information systems. According to Sidi et al. (2013), data quality problems are generally divided into two classes such as single-source and multi-source problem. Some research has identified that there are four categories of data quality and they are shown in a table below.

Table 3.4-Data Quality Problems Classification (Sidi, et al., 2013)

Data quality problem	***Category***	***Definition***
Single-source problems	Schema level	Lack of integrity constraints, poor schema designer Uniqueness constraints Referential integrity
	Instance level	**Data entry errors**-for example, recording incorrect information or leaving out some crucial patient information. **Misspelling**-for example, spelling a patient's name or the patient's address street name incorrectly. **Redundancy Duplicates**-for example, having the same patient recorded in two different medical files **Contradictory Values**-for example, in an EMR, Patient ABC was registered as a pulmonary case, whereas on follow-up visits, it was recorded as an extra-pulmonary case. These contradictory values can lead to poor decision making

Multi-source problems	Schema level	Heterogeneous data models and schema design **Naming Conflicts**- for example, health care practitioners using different languages or medical terms to record patient information.
	Instance level	Overlapping contradicting and inconsistence data **Inconsistent aggregating-**for example, health care data can be different across the different departments (pharmacy or radiology), that is having the same information in different formats which makes the data aggregation inconsistent. **Inconsistent timing**-for example, some health care practitioners may records a patient's information later rather than immediately during the consultation.

The data quality problems' classification shown in the table above represents the issues that are often found in information systems or records concerning data. These problems often occur as a result of mistakes made by the users of the systems, for example, the data capturers. Necessary training and complying with the necessary policies or standards may alleviate or eliminate such problems. A variety of data quality requirements are essential for ensuring high or good data quality, these include definition, measurement, analysis and improvement (Wang, Wang, Ziad & Lee, 2001). Data capturers need to be cautious when capturing data as this has the ability of determining the quality of the data. Failure to comply to certain definitions, standards and formats can lead to poor quality data.

3.11. Data Quality of Paper Records

In the past, health care institutions mostly used paper-based information systems to capture and store patient health records. Today, the paper-based format is used in low-resourced settings for documentation (Agyeman-Duah, Theurer, Munthali, Alide & Neuhann, 2014; Ogunsola, Aburogbola, Olajide & Ladi-Akinyemi, 2015). Thus, it is essential that institutions have data quality management planning as documents are susceptible to errors which might result to poor quality data. Paper-based records tend to produce poor-quality data as there are usually no data quality assessment tools present to ensure records maintain good quality data. Other issues that may impact on paper records quality include huge quantities of operational processes and tasks that health workers have to perform daily. Paper-based information systems are usually affected by issues, such as, incompleteness, illegibility and poor organisation (Pourasghar, Malekafzali, Koch & Fors, 2008). Human error in the paper records usually results in issues that may impact on the use of data. For example, when health practitioners work under pressure, they are likely to make mistakes of recording incorrect information or leaving out some crucial patient information. Paper records are susceptible to getting lost either by being stolen, misplaced or due to adverse events, such as, the health care facility getting flooded or catching fire. Improving health care data quality is very crucial as it does have an impact on the overall health care of patients and the community at large. Thus, it is important that policy makers review the health care systems used in the health care institutions to ensure they are effective. The benefits of improving the quality of health care data includes: ensuring patient safety; making informed decisions regarding the health of patients; providing informed feedback to the patients regarding their illness and care; conducting research; and allowing for the measurement of the effectiveness of the clinical pathways (Ali et al., 2018). The sharing of data within and across departments or organisations can enable health care institutions realise the health care quality issues from a third party's perspective. Sharing data can also provide the needed evidence regarding health care community needs, providing a relaible summary that shows the true health status of patients and the community, and also providing guidance to the policy makers with regards to making adjustments to the health care system as necessary (Ali et al., 2018).

The majority of public health care institutions still adopt the paper-based record system and this comes with challenges that could be improved by a digital health information system. There are benefits to maintaining digital health records. These include: a rapid data sharing; lower incidences of medical errors; reduced paperwork and cost savings (Wager, Lee, White, Ward & Ornstein, 2000; Ammenwerth, Eichstadter, Haux, Pohl, Rebel & Ziegler, 2001). Digital records provide secure safeguards to data and by implementing the appropriate safeguards, patient data can be maintained with confidentiality and privacy. This is something that paper records may fail to do in that it is not easy to protect the privacy of patient data in paper-based systems as anyone can gain access to the patient paper record.

3.12. Data Quality of EMRs

The EMRs are easier to manage and to retrieve as they are normally stored in an organised manner. For instance, when a practitioner needs information during a consultation with a patient, the practitioner can just insert a unique identifier code or name to retrieve the particular patient's overall health information. Generally, the EMRs contain information from past visits, the medications that were prescribed to the patient, examination results and any health concerns. The EMRs present up-to-date information regarding a patient to the practitioner in one view. The practitioner can easily share the medical records across the health care facility or with other practioners for a second medical opinion. The practitioner can also access the medical records outside the premises in which the consultation with the patient took place.

For example, a study evaluating the quality and accuracy of electronic pre-anaesthesia evaluation forms revealed that there is an importance in implementing a pre-anaesthesia evaluation to help reduce surgery cancellations. The lack of pre-anaesthesia evaluation resulted in incomplete medical examinations which were the most common cause of surgery cancellations, therefore confirming the importance of pre-anaesthesia evaluation (Farasatkish, 2009). Surgery cancellations may mean that the patient's treatment is being delayed, which may result in the patient's condition worsening or the patient losing their life. Thus, it is important that the practitioners follow the necessary procedures when examining patients and recording patient data. Miller and Sim (2004) learned that quality improvements are determined by the physician's use of the EMR. In other words, the quality of the EMRs is determined by what the physicians put into the record. If the physician's omit certain details, the quality of the entire medical record will be affected as it will be incomplete. The application of quality improvement strategies can guide the physicians on the standards that should be followed when making use of an EMR. For instance, the design of the electronic health information system should not allow the omission of all the important information regarding a patient. The EMR system should be designed to not allow the physician to proceed to the next step without entering all the required patient information. In this way, the quality of the EMRs would be enhanced. The study by Miller and Sim (2004) established that the greater the quality improvements, the better the financial benefits. In a study conducted by Pourasghar et al. (2008) in an Iranian hospital regarding the implementation of an EMR system, it was found that the documentation quality of the medical records was improved in areas where the nurses were involved, compared to when the physicians were involved. The cause of such results was due to factors such as high workload, the lack of software features and the shortage of hardware. Physicians are often swamped with work as they have patients' visitations on a daily basis. The high workload results in the physicians working under pressure and being prone to making errors. Therefore, poor data quality may occur if the issues resulting in the EMR users' poor performance are not alleviated.

3.13. Comparison of the Paper-Based and Digital Records

In health care institutions today, paper documentation is rapidly being replaced by electronic documentation. This shift is due to the many benefits that electronic records provide to not only the health care workers, but also to the patients. The user usually has options to customise the settings to fit their requirements. Therefore, the nurses or administration workers can quickly assist the patients by collecting the necessary information before they get referred to a practitioner. This has the ability to reduce the long queues that are usually at health care institutions, especially at public clinics or hospitals. Paper-based records are still used at health care institutions, however, compared to electronic records, paper-based records can be easily lost, destroyed or not easily accessible (Farasatkish, 2009). According to Bosch (2014), it can be very difficult to read handwritten documentation and handwritten notes may increase the risk for error and overlooking of important factors because the notes are illegible. During an emergency, paper records may delay the patient from being attended to immediately as the health care workers first have to check for the patient's file, which may take long. Finding the patients record before they are attended to is important, because the health care workers have to be up-to date regarding the patient's history, for example, existing allergies, medications, previous operations, diagnosis and treatments. In another case, a nurse describes how she had to request a paper-based medical record and had to wait to get it, sometimes to be told it is unavailable because it is locked up in another practitioner's office who is not available and that was a huge problem because during that time the nurse was busy with the patient of the file she was requesting (Bosch, 2014). On the other hand, electronic records can be acessed from anywhere (from any computer, tablet), at any place (different locations in the health care facility) and at any time. It is evident that electronic records can improve efficiency and provide the practitioners with patient records when they need them. However, efficiency cannot improve unless the users of the EMR systems use them as intended and provide feedback regarding the problems they face with the health information system. Regarding patient access, the patients can access parts of their medical records and update their own medical history, patients can also ask questions and make appointments using the EMR (Bosch, 2014). This is advantageous to both the patient and the practitioner in that the medical records of the patient will be accurate and complete, which will improve the patient's safety; on the other hand, the practitioner will spend less time on the records trying to update them after attending to the patient. Another advantage with using an EMR is that practitioners can share the electronic medical records among themselves and other health practitioners for a second opinion. Bosch (2014) states that the EMR increases their ability to interact with one another, by allowing the sending of a secure email with questions to another specialist who is following one of her patients. The email will be directly linked to the patient's medical record, reducing the risk of mistaking a patient with a similar name or a typing error in the medical record number causing frustation.

Table 3.5- Summary of EMR Problems found in literature

Data Quality Dimensions	EMR Problems
Completeness	• Delayal of treatment due to missing information. • Not entering data due to inadequate training. Thus resulting to an incomplete patient record.
Accuracy	• Misdiagnoses due to errorneous medical data.
Timeliness	• Entering patient information late into the EMR system due to a lack of using a standardised language or format. • Untimely data due to the gap between the times when the nurse was at the patient's bedside and the time when the task was actually documented.
Integrity	• Having an inaccurate and incomplete EMR which compromises data integrity.

Conformity	• Health care practitioners not conforming to national data standards. Thus, not having integrated medical information across different health care settings.
Consistency	• Lack of consistent standards in the form of different abbreviations used in various health care departments.

3.14. Conclusion

Data is an asset to each and every organisation. Thus, it is crucial to ensure that it is fit for the purpose for which it was collected. Regular data assessments can identify poor quality data and this will enable the organisations to apply strategies to improve the data. Organisations make decisions based on the data which is available and the quality of the data can be improved through applying the CIHI Data Quality Framework.

Chapter 4

Research Methodology

4.1. Introduction

This chapter focuses on the research methodology used in this study. The research methodology and research design were chosen based on the problem identified in Chapter 1. Research evolves from an identified problem of a particular field of interest that needs a solution (Gregor, 2006; Rajasekar, Philominathan, & Chinnathambi, 2013). There are numerous methods that can be used to investigate a study which assist with reaching a conclusion regarding a particular topic (Hofstee, 2006; Sutton, & Austin, 2015). Individuals have different interpretations of the "social world". Thus, the researcher needs to adopt a particular research philosophy in order to be able to interpret the "social world" from the perspective of other individuals and to understand the nature of the research project being conducted (de Vos, Strydom, Fouché & Delport, 2005). This chapter discusses the research process applied in this study.

This chapter begins with an explanation of the research process of this study, this is followed by a discussion of the research philosophies. The next section discusses the research approaches. Following is a discussion of the research strategies. This chapter discusses the research choices. This chapter also discusses the techniques and procedures, in other words, the data collection methods and the data anlaysis methods. Section 4.7 discusses data trustworthiness. The deliminitation of the study is dicussed in Section 4.8. Section 4.9

discusses the ethical considerations. Finally, the conclusion of the chapter is provided in Section 4.10.

4.2. Research Philosophy

This section discusses the research philosophy which consists of different paradigms that are commonly used in research. A paradigm can be defined as an individual's assumptions associated with the nature of knowledge (epistemology) and the nature of the reality (ontology) (Oates, 2006; Niehaves, 2007). According to Creswell (2009), an individual's worldview is influenced by their beliefs, the discipline area and the previous research conducted in that particular research area. Thus, the research paradigm of a study will be chosen based on the researcher's view. According to Hofstee (2006), the research paradigm that a researcher can use to conduct a study is determined by the data collection methods that will be used.

There are three research paradigms that are most commonly used in Information Systems research. These paradigms include positivism, interpretivism and critical theory (de Vos et al., 2005; Zukauskas, Vveinhardt & Andriukaitiene, 2018). The discussions regarding each of the research paradigms mentioned above will follow in the next sections.

4.2.1. Positivist Paradigm

Positivism focuses on the facts associated with the occurrences of social phenomenon (Collins & Hussey, 2013). In other words, the research is conducted objectively and through measurable properties. According to Klein and Myers (1999:p. 69), the positivist paradigm uses "hypothesis testing, quantifiable measures of variables and drawing inferences about the phenomenon from a sample to a stated population". Oates (2008) provides an outline of the features of the positivist paradigm:

- **The world is independent of people –** The existence of the social and physical aspects is not dependent on the human mind. The aspects can be measured.
- **Measurement and modelling –** The researcher studies and quantifies a scenario or the world using observations, procedures and models.
- **Objectivity –** The facts regarding the world are independent of the researcher's personal beliefs or perceptions.

- **Hypothesis testing** – The foundation of the research is based on the experimental testing of hypotheses.
- **Quantitative data analysis** –This approach often uses mathematical and statistical methods - the results of the research are acquired logically and objectively.
- **Universal laws** – The findings of the research are concluded based on patterns, simplifications and facts.

4.2.2. Interpretivist Paradigm

The interpretivist paradigm focuses on understanding the perceptions of the social world to construct meaning of the reality (Kaplan & Maxwell, 1994). The meaning of the social phenomenon is obtained through the researcher's interaction with individuals. Removing the human aspect from the social world would be removing the actual meaning of the reality, as the reality of the social world is dependent on the human interaction (Creswell, 2009; Blumberg, Cooper & Schindler, 2008; Chetty, 2016). Inductive reasoning can allow for a false conclusion since the conclusion is not logical. New theories can be developed based on the results obatined from observations, whereas the deductive reasoning uses facts to construct meaning of the reality (Blumberg, et al., 2008). A research question of a study can be answered through the perceptions of the participants who consent to participate in answering questions (Deetz, 1996; Sutton, & Austin, 2015).

4.2.3. Critical Theory Paradigm

Critical theorists tend to rely on combining observations, by conducting interviews using approaches which encourage engagement and conversations. This theory allows the researcher to observe an environment and make a judgement; and to also engage in conversations with people.

The appropriate research paradigm for this study is interpretivism since the data quality challenges in electronic medical records will be investigated through interviews with data users, such as, the nurses and IT experts who are responsible for implementing electronic medical records in health care institutions.

4.3. Research Approach

Research approaches involve plans a researcher makes to begin a study. The researcher starts a study on broad assumptions regarding a research problem, then moves to using existing theories or developing new theories from patterns. The research problem of a particular study determines the research approach that can be used by the researcher, the audiences for the study, and the researchers' personal experience (Babbie, 2005). Different approaches can be used by a researcher to conduct research. The research approaches comprise deductive reasoning and inductive reasoning. These research approaches will be discussed below and the applicable approach will be applied to this study.

4.3.1. Inductive and Deductive data approach

Deductive reasoning aims at understanding and testing an existing theory and then conceptualises a specific subject of focus (Wills, 2007). Conclusions are reached based on available facts and deductive reasoning moves from generalisation to observations and confirmation of the hypothesis (Babbie, 2005). If a researcher's arguments are based on rules, laws and widley accepted principles, it can be best done deductively (Soiferman, 2010). Figure 4.2 illustrates the process followed when conducting a study.

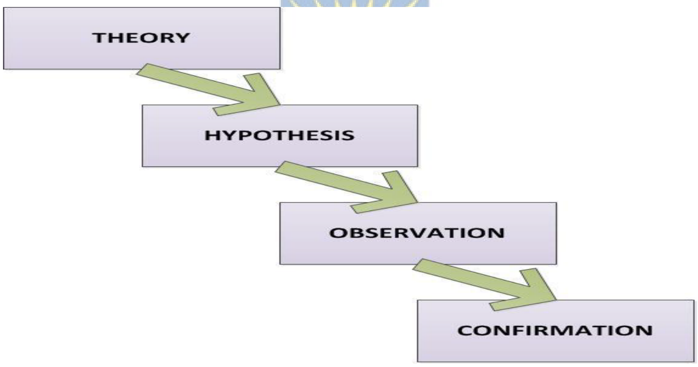

Figure 4.3: Deductive Research Approach (Trochim & Donnelly, 2007)

Inductive reasoning refers to starting with a specific observation and then moving to a broader general theory (Wills, 2007). With inductive reasoning the researcher observes data and draws a pattern. Once a researcher has a pattern, a generalisation is made and then a conclusion is reached (Bradford, 2017). According to Trochim and Donnelly (2007), another term used to describe inductive reasoning is "bottom-up research approach".

This study makes use of the inductive research approach to investigate and understand the challenges experienced by data users (nurses and IT experts). According to Bradford (2017), unlike deductive reasoning which uses facts and existing theories, inductive reasoning draws a conclusion from a pattern. Below is a description of the inductive reasoning approach provided in Figure 4.3:

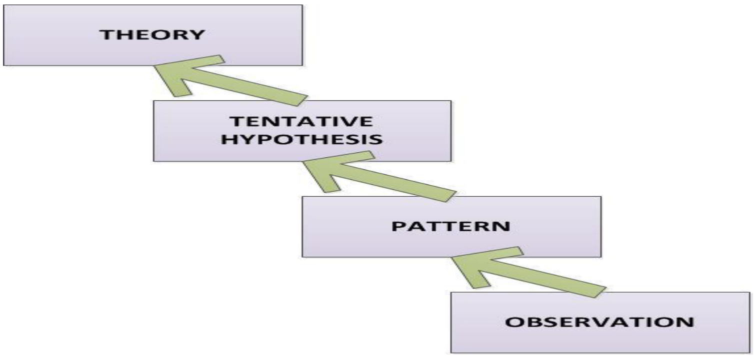

Figure 4.4: Inductive Research Approach (Trochim & Donnelly, 2007)

This study made use of the Inductive Research Approach in the following manner:

Observation: The researcher conducted interviews to obtain the factors to improve data quality in EMRs and observations were made of the interviewees' responses to draw a pattern.

Pattern: A pattern was drawn based on the participants' responses and a link was created between the responses.

Tentative hypothesis: From the pattern drawn, the researcher formulated a hypothesis of the factors that could impact on the data quality of EMRs.

Theory: After a thorough observation of the participants' responses overall, a conclusion was reached on the factors to improve data quality in EMRs.

4.3.2. Quantitative and qualitative data approach

When conducting research, three research choices can be used. These choices can be to use a qualitative method, or a quantitative method or the mixed method. Each of these research methods make use of different research strategies. The research methods will be discussed and the research strategies will be highlighted. Many authors refer to the qualitative research as positivist research, while they refer to the quantitative research as interpretivist research.

Table 4.1- Research strategies with research designs (Ahmadnezhad, 2009)

Qualitative Research	**Quantitative Research**	**Mixed Methods**
Uses **non-statistical methods** to gain understanding about a research question.	Uses **statistical methods** to gain understanding about a research question.	Uses both qualitative research and quantitative research to gain understanding about a research question.
Interviews	Experiments	Sequential Procedure
Case Studies	Surveys	Concurrent Procedure
Ethnography study		Transformative Procedure
Phenomenological study		
Grounded theory study		
Content analysis		

4.3.3. Qualitative Research Methodology

Qualitative research is a holistic approach that enables a researcher to be involved in the discovery of facts about actual experiences (Creswell, 1994). The researchers are involved in the research process by interacting with participants who have knowledge regarding a specific topic or social phenomenon. The most common methods used in qualitative research include: observations, experiments, social interaction surveys, Delphi technique, theories, expert reviews, relevant literature and action research and interviews. There are several methods that can be used to conduct qualitative research. These methods each have different functions and can be used based on their appropriateness to a study. Creswell (2003) explains the different functions theses methods perform. Case studies and phenomenological studies are used to study individuals, whereas ethnographic studies analyse cultural-sharing behaviours of a group of people or individuals. Grounded theory and case studies are used to investigate events, processes and activities. Each of the methods will be discussed below.

4.3.4. Quantitative Research Methodology

According to Leedy and Ormrod (2001), quantitative research builds upon existing theories, thus its experimentation and surveying are specific. The researcher is independent of the quantitative research as it relies on facts. In quantitative research, meaning is created objectively from the collected data (Williams, 2007). Quantitative research "intends to establish, confirm, or validate relationships and to develop generalisations that contribute to theory" (Leedy & Ormrod, 2001, p.102).

The quantitative approach was not considered appropriate for this study as it aims to discover the factors which affect data quality in EMRs by obtaining data through interviews conducted with a study's participants' behavioural patterns instead of using existing facts or statistical methods.

4.3.5. Mixed Methods Research Methodology

Mixed methods approach to research uses both the qualitative and quantitative research approaches to collect and analyse data in a single study (Creswell, 2003; Johnson & Onwuegbuzie, 2004). In other words, the researcher uses both numerical data, which is vital for quantitative research, and narrative data, which is in another term referred to as qualitative research, in order to answer a research question for a particular study. Mixed methods approach to research is often used when the data collected through one of the research methods is not useful. For example, if a researcher does not acquire adequate data through qualitative research (narrative data) to help address a study's research question, a researcher can perform data collection and analysis adopting both the quantitative and qualitative research approaches.

Johnson and Onwuegbuzie (2004) state that the mixed methods approach is not a replacement of the two research approaches, quantitative and qualitative; instead it is an extension to ensure that researchers are not restricted to acquire the necessary data should one of the research approaches be of little use. By using the mixed methods research approach, researchers attempt to draw from the strengths and lessen the weakness of the qualitative and quantitative research approaches (Johnson & Onwuegbuzie, 2004). Williams (2007) provides examples of how the two research approaches can be used together. The research strategies of mixed methods are discussed below:

- **Sequential Procedure** is a research strategy which uses "joint research designs or research designs" to address a particular research question (Botha, et al, 2015). In other words, a researcher can conduct a study by firstly using the qualitative, then follow with the quantitative method to generalise the findings (Creswell, 2009).

- **Concurrent Procedure** is a research strategy which uses two methods at once. According to Creswell (2009), “qualitative and quantitative methods are used concurrently, but may be used to answer different research questions”. The research findings are combined and presented overall (Botha, et al., 2015).
- **Transformative Procedure** is a research strategy which is based on a theoretical perspective and it is used as a framework for a study (Botha, et al., 2015). This research strategy uses mixed methods to support the theoretical background. The researcher can use either a sequential approach or a concurrent approach in transformative procedures (Creswell, 2009).

The mixed methods approach was not appropriate for this study because the qualitative approach is used. The mixed methods approach is not appropriate as the factors which affect the data will be obtained through interviews. Thus, there is no need for using the quantitative approach since this study is not investigating facts, instead it attempts to discover behavioural patterns and then develop a theory.

4.4. Research Design

The purpose of the research design is to provide an appropriate framework for a study (Sileyew, 2019). The research design process is crucial as it determines the selection of an appropriate research approach that will be used to obtain important information for a study. This section provides a description of the various research designs that can be used to obtain information for a study.

Ethnography study

The focus of the ethnographic study is on the daily activities in order to draw patterns which will help with identifying the changes that have occurred in a certain culture over time. Creswell (1998) states that in this study, a researcher must become involved in the daily lives of the participants. This will enable the researcher to observe and interpret the behaviour and culture of the social group. In order to appropriately obtain data regarding the behaviours and cultures of the social group, the researcher has to build relationships with the participants and gain their trust (Leedy & Ormrod, 2001).

Case study

Creswell (2003) defines a case study as “a process that a reseacher performs to explore one or more individuals, an event, program, activity or a process” (p.15). A case study allows the researcher to learn about the history of an event. The researcher attempts to learn more about an event or situation to better undestand it. The researcher obtains data through interviews and the interviews can be conducted with multiple sources and they can be direct or participants observations can be done (Williams, 2007). According to Williams (2007), the data collection for a case study is drawn from archival records or documents, audiovisuals and physical artifacts. The report of the case study includes patterns found and these are linked back to relevant theories (Williams, 2007).

Phenomenological study

Phenomenological study is a study in which a phenomenon is identified, based on the perceptions and understandings of people regarding that particaular phenomenon (Lester, 1999). According to Lester (1999), epistemologically, phenomenological approaches are based in a paradigm of subjectivity and personal knowledge, and the importance of personal interpretation and perspective is emphasised. Williams (2007) states that in this instance, data collection is done by engaging with participants and observing them.

Content anaylsis study

Leedy and Ormrod (2001) define content analysis study as “a detailed and systematic examination of the contents of a particular body of materials for the purpose of identifying patterns, themes, or biases” (p.155). This research method enables the researcher to review human communication. According to Williams (2007), content analysis reviews various forms of human communication including films, newspapers, and books in order to identify themes, patterns, or biases.

This study made use of the content analysis study to analyse the contents of the literature review and the data obtained through interviews with nurses and IT department staff. The literature was collected through books, journals and conference proceedings. Therefore, to gain an understanding of the content of the literature and to be able to draw patterns, an analysis had to be done. On the other hand, the transcibed notes from the interviews were analysed in order to reach a conclusion.

Grounded theory study

Grounded theory research is defined as the process of collecting data, analysing the data, and repeating the process (Williams, 2007). From the collected data, a researcher attempts to derive a theory of an action, process, or interaction grounded in the views of the participants of a study (Creswell, 2003). According to Oates (2008), grounded theory research includes field research that is conducted to ensure that a theory in the field is true. The term “grounded” stipulates that this research method requires the theory to emerge from the data collected in the field instead of using a theory from the research literature (Leedy & Ormrod, 2001). Data is collected through an examination of people’s actions and their interactions (Williams, 2007).

4.5. Data Collection Methods

During data collection, various tools can be used to conduct research. However, it is important that the researcher selects the appropriate data collection tools in order to acquire the necessary data that will help in answering a research question. The data collection tools used to conduct this research included a semi-structured questionnaire which was used as an interview guide by the researcher to acquire data that would meet the research objectives.

4.5.1. Population

In order to obtain answers regarding a research problem of a particular study, there is a need for data collection from a targeted population (Hunt & Lavoie, 2011). The target population for this study was the nurses (registered nurses or nursing sisters, enrolled nurses and enrolled nursing auxiliaries) and IT staff working in the North West province public health care institutions in South Africa. The sample consisted of 8 health care professionals, but the interviews continued until a saturation point was reached and no new information was reported by the participants (Olson, 2010). Experts from the IT department and the nursing department were interviewed as they might have had different insights regarding the quality of EMRs, based on their different work experience. The interviews was analysed after which themes were developed from the literature presented in Chapter Two and Three and the quality problems identified by the health care practitioners making use of EMRs.

The purposive sampling technique was used in this study through interviews with professional nurses and a participant from the Information Systems (IS) field to help clarify the challenges concerning data quality in EMRs. Snowball sampling was used in this study through conducting an interview with a participant from the IS field as that person was reachable.

This study made use of a literature study to identify the factors which affect the data quality of EMRs. Nurses that are qualified at different levels in the public health sector and IT specialists were approached to acquire the factors which, from their experience, are found to affect the data quality of EMRs. The data obtained from the nurses and IT specialists were analysed to discover whether they are supported by the literature studies.

4.5.2. Secondary Data

Secondary data refers to data that has been collected by another person and made available on public platforms in the form of publications (Allen, 2017). This study examined literature studies such as books (both electronic and hard copies), electronic journals, conference proceedings and academic websites. Secondary data is collected and analysed to draw a pattern which will lead to identifying a problem of a particular subject (Ainsworth, 2019). On the discovery of a problem, a research question and research objectives can be established. The secondary data is essential as it provides a body of knowledge that can be used as a basis for obtaining answers to a research question (Allen, 2017). This study analysed the secondary data in an inductive form to establish whether the conclusion was against or favouring the supporting theories.

4.5.3. Primary Data

Interviews are a data collection method which involves oral questioning of respondents (Denscombe, 2001). Interviews involve one or more individuals having a conversation, these individuals are referred to as the interviewer (the person asking questions) and the interviewee (the person responding to questions). Unstructured interviews are time-consuming since questions build from the previous questions. The interviewer can ask questions based on the responses received, therefore unstructured interviews are difficult to manage as they lack predetermined interview questions. Their use is found significant where depth is required or where little is known about the subject area (Gill et al., 2008, p.291).

This study used in-depth interviews to acquire information. The interviews involved oral questionning and the questions included open-ended questions. In-depth interviews are unstructured interviews and are personal, their aim is to acquire information from participants based on their feelings, emotions and opinions regarding a particular research subject

(Langkos, 2014). Personal interviews are advantageous in that the interviewees provide detailed responses which provide the interviewer with the opportunity to generate a conclusion. The interviewer may also acquire new information that was not included in the questionnaire. However, if the interviewer is not careful, there is a risk that the interview may diverge from the pre-specified research objectives (Gill & Johnson, 2002). The research interviews in this research study attempted to investigate data quality challenges in electronic medical records in South African public health care institutions. The interviews were conducted with IT experts and nurses to acquire information. A questionnaire that was previously published by Botha et al. (2015) was used to develop the current research instrument. The interview tool was piloted with 5 nursing students that did not participate in the present study to make sure that the questions were not ambigious and would provide the relevant information. The feedback obtained from the pilot study was incorporated into the final interview tool (see Appendix D). The questionnaire used in this study consisted of the following sections: the demographics of the participants, the participants' perceptions of the current quality of electronic medical records and what factors they deemed necessary to ensure quality in EMRs.

4.6. Data Analysis Methods

Various methods and techniques are used during a study's data collection. However, there is a need to analyse and interpret the collected data to construct meaning of the data. Qualitative data analysis requires a systematic process to be followed that indicates how the collected data was analysed (Silverman, 2011). Qualitative data analysis refers to the process of interpreting the qualitative data collected to derive an explanation or understanding of the data (Lacey & Luff, 2007).

The qualitative data of this research study was analysed by means of thematic analysis, while the information obtained from the primary and secondary data was analysed inductively. According to Crowe, Inder and Porter (2015), thematic analysis is the process of interpreting data and analysing it to find a pattern which will provide meaning to the data. The data is analysed to ensure that it supports the literature review or the secondary data which was collected through desktop research; this is done in order to reach a final conclusion so as to develop a solution to the research problem. Thematic analysis was found appropriate for this study as it is the most compatible to the method of data collection that was used in this study. Thematic analysis consists of 6 steps, these steps will be shown in Table 4.2 below.

Table 4.2- Steps in Thematic Analysis (Kofod-Petersen, 2014)

	Steps	**Description**
1	**Familiarisation with the data**	At this step, the researcher familiarises him or herself with the data by reading all the available data.
2	**Coding**	At this step, labels are developed to highlight the important features in the data set that may help with answering a research question.
3	**Searching for themes**	This step involves finding patterns from the codes (potential themes). It is followed by the collection of all data that aligns to each theme to determine the importance of each theme to the research question.
4	**Reviewing themes**	This step involves checking whether the selected themes address the research question as well as to identify if the datasets are accurate. At this stage, themes are refined and any related themes are merged.
5	**Defining and naming themes**	This step is about conducting a thorough analysis of each of the theme identified in step 3. This is done in order to determine the scope of each of the themes and is often followed by naming the themes.
6	**Writing up**	This final step involves combining all the analytic narrative and the data extracts. It involves a discussion of the findings of the analysis in context of the data used.

The credibility of this study was checked through member checks. The researcher provided the participants with the opportunity to go through their responses in order to verify whether the questionnaires reflected what the participants actually meant. The questionnaires reveal their true nature and no changes were done on the participants’ responses.

Dependability involved the having the participants' evaluate the findings, interpretations and recommendations to confirm whether they are supported by the data collected from the participants of the study. Having the participants and auditors re-evaluate the data received from the participants will provide stability to the findings over time.

Confirmability concerns neutrality. The researcher stored the participant's questionnaires as is and the subjectivity of the data was kept. The researcher made use of the information provided on the questionnaires for interpretations. This was to ensure that the results from the data analysis were not influenced by the views of the researcher in any way.

4.7. Data Trustworthiness

To ensure that the data collected for research is valid, certain measures should be taken. According to Mertler (2015), credibility refers to acceptability of the results obtained from a qualitative research from the participants' perspective. To ensure the credibility of the data obtained, IT experts were approached to critically review and refine the data. The qualitative data was also cross-checked against the secondary literature to verify its credibility.

According to Mertler (2015), confirmability refers to the ability of the researcher to make the collected data available to its source, in the process the logic that is used to interpret the data should be clarified. Therefore, the researcher archived all the gathered data in a well organised format that can be explicitly available to help establish that the study's findings portrayed the participants' responses. The next section discusses the delimitations of this study.

4.8. Delimitations of the Study

In order to put focus on the important factors of the study, the researcher has to identify the significance of the study to help narrow the research area. According to Hofstee (2006), paramaters can be created around the study to clearly state what is included and what is excluded in the study. This is referred to as the delimitations of the study.

1. This study focused on electronic medical records (EMRs) and not electronic health records. This researcher chose to focus on the EMRs after investigating and discovering that there is an issue at health care institutions regarding the data quality of EMRs. The researcher also discovered that some health care institutions have functioning EMRs compared to EHRs.

2. The data collected through interviews were only related to data quality challenges in electronic medical records at public health care institutions within the North West Province only. The researcher attempted to compare the data obtained from both health care institutions to determine whether or not either of them had experienced the issues identified in the literature review. If not, the researcher wanted to identify the factors that affect the data quality of EMRs in the respective health care institutions.
3. Only the nurses (registered nurses or nursing sisters, enrolled nurses and enrolled nursing auxiliaries) and the IT experts responsible for the implementation of EMRs were interviewed to validate the factors developed from the literature review. The nurses and IT experts were chosen as they are the data users. The nurses capture the patient data during a consultation and a minor mistake could lead to data quality problems, such as, an incompleteness and inaccuracy of the patient data. On the other hand, the IT experts implement the EMR systems and they have some knowledge of the issues that may have arisen from the health care institutions regarding the EMR systems. Hence, the researcher felt it is important to investigate from both the nurses and IT experts' perspectives. This would provide this study with some form of credibility.

4.9. Ethical Considerations

When conducting a study, it is important that the researcher becomes as direct and as open as possible and ensures that all participant's rights are not violated (Olivier, 2009). Taking into consideration the ethical issues, this study was conducted in compliance with the University of Fort Hare's ethical regulations. Ethical approval was applied for by the researcher and was granted by the University's Research Ethics Committee (see Appendix A). As identified by (Oates, 2006), the following rights ensure that a study's participants are treated in an ethical manner. The ethical clearance certificate is attached as an appendix. Prior to the data collection, the researcher explained the objectives and significance of the study to the participants and also presented the participants with the rights below:

- **Wilful Participation** – the participants' were not forced to partake in this study against their will; instead, they were encouraged to participate willingly.
- **Informed Consent** – prior to the data collection, informed consent was obtained from the participants by sharing all the information about this study and the research objectives. The participants were fully informed as to how the data would be collected

and how it would be used, as well as any third parties who would have access to the data.

- **Withdrawal** – the participants who wished to withdraw from participating in this study were given the freedom to withdraw from the study when they felt that their rights were being infringed upon.
- **Anonymity** – the participants were ensured that their identity and location would not be disclosed unless permission is granted by them for it to be disclosed. The feedback received from the participants did not disclose any names or the location (for example, the venue) where the interview took place.
- **Confidentiality –** the participants were guaranteed that the information provided would be kept confidential and anonymous. The questions were constructed in a manner that was not directed towards any individual or their work performance.

The participants included nurses at different levels such as registered nurses or nursing sisters, enrolled nurses and enrolled nursing auxiliaries and the IT specialists who are responsible for implementing of the electronic medical record systems. The information collected by the researcher consisted of the data quality challenges experienced by data users at public health care institutions. Patients were not included in the interview process and no patient data was requested.

4.10. Conclusion

The research design and the methodology of a study are important as they determine how a study will be conducted. Selecting a research design and methodology is determined by a research problem at hand. Selecting a methodology that does answer a study's research question will lead to a researcher choosing research philosophies, research approaches, research strategies, research choices, and the techniques and procedures (data collection and data analysis methods) that is inappropriate to the study. This chapter provided a detailed description of the manner in which this study was conducted. This chapter discussed the different research philosophies, research approaches, research strategies, research choices, the techniques and procedures (data collection and data analysis methods) adopted in this study. This chapter ended with the delimitations of the study and the ethical consideration.

Chapter 5

Data Analysis and Discussion

5.1. Introduction

The objective of this study is to examine the factors to improve data quality in Electronic Medical Records in Public Health care institutions in South Africa. In order to achieve this, data collection was conducted through interviews with 8 nurses from Klerksdorp in the North West Province. This chapter covers the analysis and discussion of the data that was collected. The aim of this chapter is to draw a pattern from the data that was collected and to reach a complementary conclusion. The data collection process involved open-ended questions, to which various participants responded based on their own opinions. Thus, it is necessary to present the socio-demographic information of the participants.

5.2. Socio-demographic Information of the Participants

The table below provides socio-demographic information of the participants. This includes information regarding the age, gender, workplace details, professional title, the length of time in the health care field, the participants' highest qualification, and the health information system to which the participants has access. This information is necessary to better understand the interviewee and also to have an age group or gender on which to base the conclusion of the study, instead of providing a generalised conclusion. The information below was obtained from the participants through the interview questionnaires.

Table 5.3: Socio-Demographic Information of Participants

Interviewee	Age	Gender	Race	Workplace geographical area	Workplace Facility	Professional Title	Length of time in the health care field	Participants Highest qualification	Health Information Systems Participants have access to
1	32	Female	White	Urban	Hospital	Information Systems	10 years	Information Systems	Administrative systems
2	40	Female	Indian	Rural	Hospital	N/A	>15 years	Masters	Other - (Nil at the moment. The only way we communicate is via group Whats App methods)
3	45	Female	African	Urban	Clinic	Professional Nurse	5 years	Diploma in Nursing Management	Electronic Health records and Electronic Medical Records
4	33	Female	African	Rural	Hospital	(Operating)-Registered Nurse	13 years	Diploma in Operating theatre	Handled by clerks only. We do not have anything

5	41	Female	African	Urban		Professional Nurse	14 years	B.Tech Degree in Nursing	Electronic Health records and Electronic Medical Records
6	44	Female	African	Peri Urban	Hospital	Registered Nurse	15 years	Diploma in General Nursing	Other- Manual Data Recording
7	48	Female	African	Rural	Hospital	Professional Nurse	16 years	Diploma in Community, Midwifery. General and Psychiatric Nursing Science	Electronic Medical Records
8	55	Female	African	Rural		Professional Nurse	33 years	Diploma in Midwifery	Radiology systems, Pathology systems, Administrative systems

From Table 5.1 it is was found that 25.0% of the participants were aged between 32-33 years, while 62.5% of the participants were between the ages of 40-48 years. Lastly, 12.5% of the participants were above the ages of 50 years. On the other hand, all of the participants were females (100%). However, this does not meant that there are no male nurses, instead the sample size for this particular study did not include males in the study. In the race category, 12.5% of the participants were White, while another 12.5% were Indian, the majority (75.0%) of the participants belonging to the African race. According to the responses, 37.5% of the participants work in the urban area, while 50.0% of the participants work in the rural area, the remaining 12.5% of the participants work in the peri-urban area. An urban area denotes the region surrounding a city, it can also refer to suburbs, towns and cities, while a rural area is the opposite of an urban area with a low population density and large amounts of undeveloped land (National Geographic, 2011). A peri-urban area is defined as an area which is located in an area immediately next to a city or urban area (Iaquinta & Drescher, 2000).

The next category consists of the type of facility in which the participants work, whether it be a hospital, a clinic or other facilities. Here it was found that 62.5% of the participants work in a hospital facility, while 12.5% of the participants stated to be working in a clinic. Some clinics operate for approximately 8 hours on week days, while hospitals operate for 24 hours, 7 days a week. The role of hospitals is to cater for those patients who require emergency medical attention and for critical conditions such as surgical procedures (Disabled World, 2013). As mentioned in the methodology chapter, the population for this study is nurses and IT personnel from public health care facilities. From the interviews, the majority of the participants were nurses because only 1 IT individual agreed to participate in the interviews. Of the responses received from the interviews, 12.5% of the participants were IT personnel, 50.0% of the participants were professional nurses (PNs), and 25.0% of the participants were registered nurses (RNs). According to Awases, Bezuidenhout and Roos (2013), a professional nurse can be defined as a person who is registered with the nurse regulatory and registering authority of their country, and works in clinical nursing services and educational, for instance, as a lecturer at a nursing college. On the other hand, Ericksen (2015) states that registered nurses have the responsibility of assessing the symptoms and medical history of patients, planning and implementing recovery measures based on diagnostic tests, and providing medications and treatments to patients. These RN also consult with other health care professional and physicians. The next category comprises the number of years that the participants have worked in the health care field. The greater the number of years a nurse has worked in the health care work field, the better the experience. The participant with the least (12.5%) number of years had worked for 5 years in the health care field. Secondly, another participant (12.5%) had 10 years in the field. Thirdly, participants that had worked 13-15 years in the field made up 37.5%. Then 25.0% of the participants had worked for at least 15-16 years. Lastly, only 12.5% had worked 33 years in the field, which signified the highest number of years of service.

Lastly, the participants were asked to identify the health information systems to which they had access within their workplace. Based on Table 5.1, Participant One has access to Administrative systems, while the majority of the participants (25.0%) have access to both Electronic Medical Records and Electronic Health Records. As discussed in Chapter 2, there is a difference between EMRs and EHRs. However, these terms can be used interchangeably. The EMRs are defined as patient medical information which is created and stored in an electronic or digital format during a doctor's visitation (McMullen, et al., 2014), while EHRs contain a wide range of patient information such as laboratory results, allergies, examinations, medications and treatments (Bowman, 2013). Participant 7 only has access to Electronic Medical Records, while Participant 8 identified that they have access to Radiology systems, Pathology systems and Administrative systems. On the questionnaire, the participants were provided with an option to identify other health information systems to which they have access. The response received from Participant 2 was quoted as follows "Other-(Nil at the moment. The only way we communicate is via group What's App. methods)", while Participant 4 responded as quoted "Handled by clerks only. We do not have anything". Participant 6 responded as having access to Manual Data Recording.

Below, a section discussing the emerging themes that were identified from the literature and the data are provided. However, most of the themes were developed using the data quality framework model.

5.3. Defining data quality of EMRs

This theme covers the personal understanding that the participants have regarding data quality. In order for any organisation working with data or health care providers to understand the issues that lead to poor data quality, they first have to know and understand the definition of data quality. Data quality does not have a single standardised definition. However, when defined in a broader context, data quality identifies more attributes of data quality besides accuracy and completeness that were highlighted as the main attributes of data quality in health care research (Sebastian-Coleman, 2012). According to Health Libraries Group (2019), data quality is defined as data which is complete, error-free and absent of inaccuracies, useable, useful and fit for purpose. This definition of data qulaity was used in a study by Health Libraries Group (2019), to evaluate the impact that the introduction of EHRs has had on data quality.

The response received from one of the participants (Participant Eight) regarding their understanding of data quality in EMRs was stated as follows:

"It is the Electronic Health Records system used by many institutions these days to keep data or information that is complete and accurate in an electronic server to ensure quality patient's care".

From the narrative above, it is thus evident that, as mentioned earlier in Section 5.3, completeness and accuracy are the main dimensions that are considered to define data quality. However, this does not entail that other dimensions of data quality are less important. According to Terry et al. (2019), EMR data quality is still an ongoing issue. Current information regarding Canadian primary health care data suggests there is inconsistency in levels of quality across health care systems (Terry et al., 2019). The issues that have been identified regarding EMRs data quality include the completeness of risk factor information (Greiver, Barnsley, Glazier, Harvey & Moineddin, 2012; Tu, Widdifield & Young, 2015), socio-demographic data quality (Laberge & Shachak, 2013), recording of weight and family history (Tu et al., 2015), and lastly, chronic disease documentation (Singer, Yakubovich, Kroeker, Dufault, Duarte & Katz, 2016). Thus, from a research perspective, EMR data quality has been conceptualised within four domains. These domains include comparibility which is aligned with the concept of reliability (Last, 1995; Vindigni, 2004); this concept can be extended to mean the degree to which EMR data are consistent with, or comparable to, an external data source (Faulconer & de Lusignan, 2004; Hassey, Gerrett & Wilson, 2001). Secondly, its completeness includes filling in or recording all the required data in EMRs. Thirdly, its correctness has been defined as the degree to which data are a representation of the true state of the world (Terry et al., 2019). This dimension reflects the concept of validity which is defined as "the degree to which a measurement measures what it purports to measure" (Last, 1995; Vindigni, 2004: p.4). Lastly, the fourth dimension consists of currency or timeliness (Williams, 2003; Weiskopf, Hripcsak, Swaminathan & Weng, 2013), the latter enquires whether an element in the EHR is a relevant representation of the patient state at a given point in time (Weiskopf, Hripcsak, Swaminathan & Weng, 2013).

5.4. Challenges in quality of EMRs

The quality of data in any system is essential, as it contributes to decision support of health care practitioners when diagnosising and treating patients. In the health care setting, clinical data and medical records enable clinical decision support. For instance, EMR systems are required to alert the health care providers of abnormal vital signs; to highlight abnormal test results; alert the health care providers if a known allergic drug or medication is prescribed to a patient or in cases where a known drug or medication interaction is likely to occur, to alert them to that; and also to provide reminders regarding recommended care, such as, when medication is due or tests need to be done (Kane & Chesanow, 2014). Nonetheless, despite the number of benefits EMR systems provide, they are not without issues. This is supported by a study conducted to review the impact of EMRs on health care delivery in Kisii Teaching and Referral Hospital. According to Waithera, Muhia and Songole (2017), some drawbacks were raised. Firstly, it was identified that the EMR systems could lead to health issues, such as, eye impairment from the computer work entailed with capturing and backing up of data and back pain from the sedantary seating position. Secondly, the systems were susceptible to security breaches as it is easy for another person's account to be manipulated. A common drawback that was identified was that the system was failing and that there was a network breakup. Lastly, it was identified that some functions of the EMR system were not accessible.

It would seem that EMRs are vulnerable to providing poor quality data for a number of reasons. Poor quality data can be the result of human-error or due to the systems failure or design. One participant (Participant Ten) expressed their views regarding the data quality challenges encountered in EMRs in two points. The responses were as follows:

"Mixed entries by multiple users can lead to duplication of data of the same patient, but with different findings (human error)".
"Poor electronic health record system design and improper use can cause errors that can destroy the integrity of data".

The data quality challenges in EMRs are influenced by the users of the system and to some degree by the standards of the health care institutions. According to the repondents from the Pentecost hospital, the hospital lacks consistency standards in the form of abbreviations used in all departments (Darko-Yawson and Ellingsen, 2016). For instance, when attending to a patient's health care, practitioners write short notes summarising the patient's reason for consultation, sometimes leaving out the necessary details for decision making. Secondly, the participants also identified poor user participation and acceptance of the system as other related challenges of data quality restraining the hospital's health system from achieving the accuracy of data. Here, the participants explained that the majority of the users were not involved during the decision making process of which system to purchase and during the actual implementation stage of the health information system. It is thus evident that user involvement and user satisfaction are important factors that can affect the quality of data in a system. Therefore, organisations should not overlook the users as they make use of the systems in the course of their work duties. Thus, their opinions and involvement should be prioritised. A participant (Participant Five) delineated that nursers or users of an EMR system,

"Demand a substantial amount of time for electrical type data entry. Contribute to lower job satisfaction, increased stress and decreased quality of patient care. Reduced patient safety."

Another issue that was identified as impacting on data quality is that EHR or EMR users expect much from the systems. Among the various health care professionals who use the different components of EHR systems, the users include physicians, nurses, patients and other stakeholders (Boonstra & Broekhuis, 2010; Kruse, 2016; Scott, 2015; Vishwanath & Scamurra, 2007). The users have an exaggerated expectation that the systems would replace paper documents and result in a perfect work set up at the hospitals or their workplaces, which in turn makes them relax (Darko-Yawson & Ellingsen, 2016). Users of the system have the expectation that their jobs will be made easier. Instead, they still have to put in effort to capture information which is as complete, accurate and timely as possible. This adds pressure on the tasks that the physicians should perform, because they do not have to worry only about providing the best quality care to the patients, but also ensuring the patients' information is correct. The researchers also identified that the problem of "I have more important duties" indicated by the Pentecost hospital respondents is the cause of the majority of the data quality related problems the hospital faces (Darko-Yawson & Ellingsen, 2016). This is supported by Boshnak, Gaber, Abdo and Yehia (2019) who highlighted the major concerns among physicians: their concerns include the disruption of clinical workflow resulting in loss of productivity or effeciency; increased physician workload and resistance of using the electronic systems; the negative impact on the interaction between physicians and patients, such as, loss of eye contact while typing notes and loss of communication with the patient. Physicians indicated that the process of having to capture notes electronically is more time-consuming for each patient then writing notes on paper. For instance, not every physician is skilled with typing quickly and it may pose as a challenge to pay attention to the patients while recording data.

Some respondents stated that the time spent on a patient was not enough to type unecessary patient details as there are many patients to attend to and the main aim of the hospital is to save lives and not to manage data or do research (Darko-Yawson & Ellingsen, 2016).

5.5. Consequences of Poor Data Quality in EMRs

The quality of data in EMRs is crucial as it impacts on the decisions made in any particular health care organisation. Poor data quality in EMRs can occur as a result of errors created by the health care workers or a system that does not function appropriately. Poor quality data could lead to a number of consequences which may affect the overall health care delivery and patient safety. Alotaibi and Federico (2017) defined patient safety as the "avoidance, prevention, and enhancement of adverse outcomes or injuries stemming from the health care" (p.5). During the data collection interview process, Participant Two had the following statement to make regarding the consequences of poor data quality: "1) wrong diagnosis 2) an increased number of litigations 3) broken trust between patients and health care workers". Electronic data can provide a number of benefits such as reduced paper usage, ease of exchange of data between physicians, stakeholders and other related health care professionals. However, there can be unintended negative consequences that occurr even among the highest-functioning health information systems due to certain errors (Scott, Rundall, Vogt & Hsu, 2005; Ward, Froehle, Hart, Collins & Lindsell, 2014; Ward, Landman, Case, Berthelot, Pilgrim & Pines, 2014). Data should be collected and stored with a purpose in mind, that is to stimulate good decision making and to improve health care outcomes. Data should be accurate, complete and reliable so as to impact positively on the overall health care.

5.6. Barriers to data quality of EMRs

The design of health information systems, specifically EMRs, does impact on the use, acceptance and data quality of the electronic records. According to Boonstra and Broekhuis (2010), EMRs are hi-tech systems which include complex software and hardware and therefore a certain level of computer skills is required from both the suppliers and users (physicians, nurses) of the information systems. So EMRs may present some technical problems which may make it difficult for the physicians to create and store reliable and accurate data. There are numerous barriers that have the capability of impacting on the effectivenes and efficiency of EMR systems, such as, the technical capabilities of the users and the suppliers, and the technical issues of the systems which have been grouped into categories (Boonstra and Broekhuis, 2010; Najaftorkaman & Ghapanchi, 2014). Below, a discussion of the seven barriers is provided.

Barrier 1: Lack of computer skills by users and/or staff members

Computer users require various skills, such as, the technical skills and the software skills to operate EMRs effectively. Not all physicians or health care staff workers are equipped with the knowledge and skills to deal with EMRs (Boonstra and Broekhuis, 2010). Good typing skills are a necessity for capturing patient medical information. However, EMR use has introduced errors that impact on the quality of data. According to Boonstra and Broekhuis (2010), EMR providers seem to underestimate the level of computer skills required from physicians to perfom successfully. These systems are complex and add to the challenges experienced by health care practitioners; these increased challenges lead to resistance towards the use of the EMR systems. Participant Nine supports this sentiment with the following statement: "Not all staff are IT literate. It is expected of only one clerk to do all the work alone for the department. All employees must be computer literate".

To address this issue of computer skills by staff members or users, health care organisations should consider investing in training staff members and users and equipping them with the necessary computer sills to be able to operate EMR systems effectively.

Barrier 2: Lack of technical training and support

In every workplace, the training of workers is a necessity as people need to be taught and introduced to how tasks should be done. Implementing an EMR system in hospitals triggers a change that affects the nurses, physicians and every staff member that interacts with the system. According to Chow, Chin, Lee, Leung and Tang (2012), it has been shown that using EMRs in a hospital does impact on nursing work. Therefore, enough training and awareness will improve the health care professionals' performance and also enable them to use the EMR system efficiently ((Lee, 2005; Aldosari, Al-Mansour, Aldosari & Alanazi, 2018). Technical training and support gives the physicians and nurses confidence in using the EMR systems as being computer skilled becomes an additional skill to their medical skill. The EMR system introduces new challenges, therefore it is important that physicians are supported by the vendors and technically orientated personnel. Adequate technical training and support will enable the physicians with the skills to incorporate their medical knowledge or skills with EMR use. This will improve the physicians' satisfaction while reaping the benefits of using computerised services and also improving patient safety. Futhermore, substantial evidence supports that the nurses' attitude towards the EMR system is linked to the success of EMR implemention (Huryk, 2010; Chow, Chin, Lee, Leung & Tang, 2012).

Barrier 3: Complexity of the system

The EMRs are machine-based systems, created and programmed by IT companies (Najaftorkaman & Ghapanchi, 2014). Like any system, EMR systems can be limited by space and time. In other words, over time they can run out of space due to storing too much data or they can become outdated as new systems are introduced. Once the systems have no storage space, some organisations eventually remove data from the systems after a number of years to make storage space available for new data. Some physicians worry that EMR systems may become obselete over time or may reach their limitations and not be useful (Boonstra & Broekhuis, 2010). This is supported by Participant Six who expressed: "Yes, In some institutions they are still using the old electronic health records system that are not modernised so they don't have enough server system to store safely all data records, thus the quality of data and integrity become inaccurate."

Barrier 5: Lack of customisability

According to Zahabi, Kaber and Swangnetr (2015), customisation is the capability of an EMR interface to be modifiable based on the needs of different health care practitioners. Some health care practitioners acquire different computer-literacy skills. Thus, the program of an EMR should allow users to adjust the functions based on their needs. Many surveys reveal that one of the reasons why physicians are reluctant to adopt EMRs is that they fail to find a system that they can use to meet their requirements and that also meets their special needs (Boonstra & Broekhuis, 2010). Flexibility works together with customisation in a sense that an interactive system should be modifiable, when necessary. Users should not be mandated to use an EMR sytem which is complex and leaves them dissatisfied. The lack of interface customisability was identified by Chen and Akay (2011), as a major issue in developing countries. When capturing and storing patient information, health care practitioners who interact with an EMR system should have the ability to modify the content of the information. For instance, a template should allow the option to be customised and aligned to the health care workers' requirements. Thus, it is critical that the system developers and vendors take into consideration the user's requirements or needs and allow flexible templates and systems to address the lack of customisability problem.

Barrier 6: Lack of reliability

"Reliability is the dependability of the technology systems that comprise the EMRs" (Randeree, 2007, p. 493). High reliability is crucial when dealing with patient information as the physicians need to gain easy access, whenever it is needed. Any glitches may impact negatively on the user's perception of the EMR system adoption and the overall health care provided to patients. Many physicians are concerned about the reliability of the EMR system, such as, when the power fails, viruses attack or the computers crash (Boonstra & Broekhuis, 2010). These reliability problems could result in the resistance of physicians to change from using paper-based systems, which are not susceptible to virus attacks or affected by power failures, unlike EMR systems. The temporary loss of access to EMRs can delay health care delivery to patients and that can impact negatively on their health. Therefore, other alternatives should be available which will ensure health care delivery is executed, regardless of the temporary loss of access to the EMRs. Furthermore, Boonstra and Broekhuis (2010) state that some physicians have had the fear of the possibility of medical record loss as a result of an unknown technical defect in an EMR system. Additionally, it has been identified that reliability problems will lead to financial loss, for instance, in the form of an increase in ongoing costs.

Barriers 7: Interconnectivity/ Standardasation of the EMR

In order for EMRs to function effectively and effeciently in a workplace, the EMR system should be standardised to support the operations performed by the health care workers. It is felt that "EMR hardware and software cannot be used straight out of the box" (Boonstra & Broekhuis, 2010, p. 9). The EMR system has to interconnect with other devices that are in use in the work environment to help generate the benefits EMRs provide. The EMR system should enable the physicians to perform their daily tasks without any negative impact. Interconnectivity problems have also been identified. Evidently, Participant Two supported with the following expression, "Yes. The system's design must be the same across, it must be clear, errors to be rectified and must be improved to better the lives of patients and health care practitioners." Participant Three also added: "Yes, data should be done in a standardised manner. No discrepancy, and there should be no hazards."

5.7. Quality characteristics of EMRs

Understanding the data quality related problems and the causes of the data quality problems is crucial. When the cause of a problem is known and understood, measures can be taken to avoid the issues that lead to poor data quality. The quality of data in a database is likely to be with problems caused by human error or by the machines used to capture and store data. Before taking measures to solve the data quality problems in any organisation, it is important to understand the problems that exist. Participant Two responded with the following statement:

"So that we can rectify our mistakes, by filling in the information needed, in order to render quality care to our patient".

Participant Six also expressed these thoughts:

“Because I can be able to identify incorrect data entry and invalid patient’s information to prevent medical local hazards that may occur when a patient is not taken care of while using electronic medical record system”. The following discussion will present the various characteristics that were identified during the interviews.

5.7.1. Characteristic 1: Completeness of data

Completeness refers to the degree to which data is properly documented and all the essential properties are accurately captured (Ali, 2018). Completeness is an essential concept of the data quality framework which entails that, in order for a record to be complete, all the required information should be recorded. In most cases, incomplete data may fail to serve its purpose and may not be usable. When interviewed, the majority of the participants revealed just how important the completeness of data in the case of a medical record is. The participants were asked how they think completeness leads to poor data quality in EMRs and how it is appropriate. One of the participants (Participant Four) stated that, “Data that is not entered immediately- if you enter it later, it will be incomplete; might miss important information and data will be meaningless”. According to Taggarta, Liawa and Yua (2015, p. 1095), completeness is defined as “a patient having at least one record for a particular attribute”. Entering patient information immediately is crucial as the missing information could lead to an incomplete record. An incomplete record could result in improper decision making regarding the patients’ health.

Another participant (Participant Six) stated that, “When there is a gap or incomplete data from what is expected can lead to poor or delayed patient’s care that can lead to death e.g. wrong results to wrong patient”. Improving medical records’ completeness is vital as this affects the overall quality of health care. According to Tola, Abebe, Gebremariam and Jikamo (2017), a complete medical record can provide valuable information to help measure progress and effectiveness. Tola, et al. (2017) further state that a good medical record can also be useful for legal purposes, such as, protecting the patient and the hospitals from litigation. Therefore, it is evident how important the completeness of medical records is. Incompletness may affect data quality by overlooking important factors.

5.7.2. Characteristic 2: Consistent data

Data consistency refers to the degree to which data values are the same across different systems or databases in which they are captured or stored. Consistent data is represented by the absence of differences between data items representing the same objects based on specific information requirements (Raza, 2018). Consistent data contains the same data values when compared between different databases. Participant Seven expressed that, "Different institutions with different systems especially with referral of patients. Collection of information is not always the same". According to Howe (2016), data consistency may be popularly used when people are referring to results of a survey or a particular study. During the presentation of the data, if the results are similar or exact throughout, then it is consistent. Consistency can also be analysed when a patient is transferred from one institution to the other. Consistency is defined as having the same patient data across all health care institutions, while inconsistency refers to having different data, for example, having blank spaces where there is supposed to be information. Participant Four also stated that, "Cannot be easily followed-up; must be able to link information of the last time with the present one; nursing is in continuity". In other words, with each consultation, physicians should make notes containing the patient's health and progress in order to achieve consistent information across all the systems used to store the patient's medical records. Omitting some information or having inconsistent data could lead to poor data quality of the medical records, such as, having an incomplete record due to recording information differently.

5.7.3. Characteristic 3: Data conforming to the same standards

Most organisations stipulate policies and standards which they use as guidelines to operate daily. These standards ensure that tasks are performed appropriately and to provide order within the organisation. Participant Six expressed that, "For the data to be accurate and valid, certain guidelines need to be followed by all electronic health system users for quality data interpretation; if those guidelines are not followed, that data won't be accurate and standardised". This is supported by Participant Three who stated that to achieve data conformity, "Should be having guidelines or policies so that it can be captured in the same standard way".

Data conformity refers to having the same format of capturing and storing data. The data quality dimensions are interrelated, for instance, failure to conform to the same data capturing standards could lead to incomplete data which could result in inconsistent data. In a study by Chen, Hailey, Wang and Yu (2014), there is a case in which the same attributes were sometimes given different meanings by different researchers. This inconsistency could have led to a conformity problem where the data entry did not follow the same standard process.

5.7.4. Characteristic 4: Accuracy of data

Accurate data refers to data which is free of errors and which is correct; the data measures that which it is intended to measure (Measure Evaluation, 2008). To maintain accuracy, data should be recorded as close to its original form as possible. In this theme, the participants were asked how they think accuracy, or the lack thereof, leads to poor data quality in EMRs. Participant One responded with the following statement: “It refers to whether the data values stored for an object are the correct values”. Participant Two also expressed a similar perspective saying that, “Every time when a person provides his or her identity number, the same information should appear exactly as it was captured last time”. For example, when a patient provides his or her information, the person responsible for capturing the data should record the data as it is stated and should not alter the data. The data should be captured as provided and should reveal its truest value. According to Chen, et al. (2014), different attributes can have the same meaning. For example, the ME DQA defined accuracy as “validity”, which is one of the attributes of data quality stated in Centers for Disease Control and Prevention (CDC’s) Guidelines (Centers for Disease Control and Prevention (CDC), 2001; Measure Evaluation, 2008).

Data accuracy is achieved if none of the examined variables in the site report are missing (Makombe et al., 2008). This refers back to completeness, which entails that for data to be accurate, it should be complete. The EMRs are believed to improve patient information and improve patient health and safety, however, a study by Hong, Kaur, Farrokhyar and Thoma (2015) indicates that inaccuracies and incompleteness are a frequently occurring problem. They found that four fields were inaccurate (1.48%) and sixty-six (24.4%) incomplete, out of 270 EMR information fields from the reviewed cases. Accuracy does affect data quality in that inaccurate information could lead to wrong treatments and inadequate patient care.

5.7.5. Characteristic 5: Integrity

Data should be trustworthy and accurate at all times. Data should reveal a pattern of consistency, for example, when comparing the data in one database to that of another database, there should be some level of similarity in the data to prove the data has integrity. The participants were asked how integrity affects data quality. From the interviews conducted, Participant Five expressed that, “ Poor EMR’s system design and improper use can cause EMR-related errors that jeopardise the integrity of information in the EMRs, leading to errors that endanger patient safety or decrease the quality of care.

Software flaws in EHRs have a great potential of affecting health care outcomes of patients. For example, if the information system has set a default for a term which is not intended to be used by the health care provider, the wrong results or impression could be provided regarding a patient. On the other hand, a free text option which allows the health care providers to add their own words in wrting is susceptible to human mistakes. Participant Three stated that for data to have integrity "it should have the correct name of a patient with no discrepancy". This is supported by Participant One who states that data integrity " is indicated by the absence of alteration in the data record, meaning data is intact and unchanged". Data integrity is essential because, for data to be , it needs to be truthful with no alterations of any kind.

5.7.6. Characteristic 6: Timeliness

Timeliness is one of the important data quality dimensions. Data timeliness refers to data that are up-to-date, and easily accessible and available on time (Measure Evaluation, 2008). Health care providers and patients should be able to access health information whenever they require it. Data that is not timely could affect health care outcomes by delaying decision making by health care providers, which could further affect treatment time for the patient. Participant Six expressed that, "Data is subject to be delivered in time as expected and delays makes data to be ineffective and delays decision making for commencement of treatment and surgical procedures". The majority of the participants agreed that the timeliness of data is important. In EMRs, data should be available at the click of a button and the point of care. A health care provider should be able to acquire an up-to-date patient medical record when entering the patient's details on the health information system. The health care provider should be able to search for the patient file by either using the patient's demographic information or a unique identifier number.

In order to achieve timeliness, the health care workers need to work hand in hand. For instance, the physician should enter patient information into the medical record immediately during the consultation period; while on the other hand, the information systems personnel should ensure that the program or system is functioning well at all times. The physician and the pharmacist should correctly record any prescribed medication so as to keep track of the treatment results. Another participant (Participant Two) explained, "Data should be obtained immediatelty as it is needed and not at a later stage to avoid inconsistency". This entails that the EMR system should produce the patient's medical record as soon as it is requested. Any delays could cause adverse effects on the patient, for example, death in emergency situations, especially in cases where a patient is in need of medication, but treatment is delayed due to allergies being unknown. The next section will present the critcial success factors that were developed for this study.

5.8. Criticial Success Factors

Data quality is an aspect which affects every organisation. Data that is of high quality, reliable, accurate and complete is critically important as the decisions regarding a patient are made based on the data's results. The reliability and accuracy of data are critical tools to success and to achieving good quality data. Thus, it is essential that physicians and any other staff members reponsible for capturing and managing data do not overlook the common data quality issues. Nichols (2016) states that it is important to recognise that data quality is more of a human challenge than a technological challenge. The technology can have the necessary properties to avoid the data quality issues, but it cannot do much to prevent humans from creating typographical errors when documenting data manually. Nichols (2016) further adds that even the most sophisticated technology cannot compensate for the lack of human observation and documentation. This section provides the Critical Success Factors (CSF) that health care workers can follow to ensure high data quality in the patients' medical records and other health related records or documents. Spacey (2017) defines Critical Success Factors as a capability, condition or activity that is required for a mission to be successfully accomplished. The CSFs do not necessarily entail that an objective will be achieved successfully. However, they provide a guide as to what steps organisations can follow to achieve goals. Success factors need to be performed at the highest level of excellence to achieve the intended objectives (Business Dictionary, n.d.). Below, a discussion of the data quality problems experienced in health care institutions and strategies to improve data quality, are provided.

The first two CSFs refer to the completeness of the EMRs, while the other characteristics identified in the previous section each have one CSF that addresses the barriers in these areas.

CSF1: Assign data focal personnel to demonstrate to staff members how to fill in data in specific fields

A case revealed that in the address field, a name of a town was recorded instead of the patient's complete residential address which inludes the street name, house number, and postal code (Ali, et al., 2018). Incorrect or missing information may make it difficult for health care professionals to follow up on patients or to get into contact with them.

CSF2: Train staff members on how to use data capturing tools and on how to identify and rectify missing information

For example, a contact number was recorded as ten digits yet a complete number was considered to be eleven digits. Training staff members will ensure that the rules of capturing complete and accurate data are applied; then staff members will be able to instantly realise when there is missing information and correct the issues before saving and closing the patient's medical file. With reference to Barrier 2 in Section 5.6, it was identified that substantial evidence has shown that the nurses' attitude towards the EMR system is linked to the success of EMR implemention (Huryk, 2010; Chow, Chin, Lee, Leung & Tang, 2012). Therefore, training the staff is crucial to prevent them from making avoidable mistakes, such as, typing errors and leaving a record incomplete.

CSF3: Install a system that identifies and eliminates duplications

One case revealed a consistency issue in a hospital's records and it was shown that 40% of the records registered Patient ABC as a pulmonary case, whereas on follow-up visits, it was recorded as an extra-pulmonary case (Ali, et al., 2018). A system which reveals duplicated data can assist with ensuring that different information is not recorded under the same patient's name.

CSF 4: Set mandatory policies and standards which will be applied to EMRs

Conforming to the same standards will result in the avoidance of many errors such as duplication of data, capturing incorrect spellings, and using inaccurate formats. Setting and complying with policies, such as the Data Quality Policy for instance, will help ensure that EMRs are of good quality and that they are consistent across health care departments or institutions.

CSF5: Data Cleansing

According to the Data Quality Assessment, data should be cleansed through both manual and automated processes to ensure completeness, accuracy, consistency, integrity and controlled accessibility of data (Ali et al. 2018). Data cleansing will ensure that errors are rectified before resulting in adverse effects. Data cleansing will ensure that data integrity is maintained by assuring the accuracy, consistency and reliability of data over it's life-cycle. Copy and paste features found in EMR systems enable physicians to copy notes from a patient's previous visitations, but at times they may mistakenly not adjust all variations between the copied and the current visit (Kessler, 2018).

CSF 6: Audit the EMR on a regular basis

In a study, the coding scheme did not match the national coding system and the results presented were not accurate (Ali et al., 2018). Auditing the EMR on a regular basis will reveal any errors that exist in the medical records and rectifications can be done before presenting the final outcome.

CSF 7: Constantly assess and reasses the timeliness of data

The relevant data focal personnel should constantly assess the timeliness or currency of data. Data that is out-of-date may lead to inappropriate decisions. In a study by Ahn et al. (2016), timeliness was investigated through electronic nursing documentation using entry times in the EMR system. The hospital departments were divided into two, including the surgery and the internal medicine department. In the study it was shown that more time was taken to capture patients of the surgery department compared to the internal medicine department. Thus EMR data timeliness should be constantly assessed to avoid delays in the decision making process.

5.9. Chapter Summary

This chapter covered the analysis and discussion of qualitative data on the factors to improve data quality in Electronic Medical Records in Public Health care institutions in South Africa. The results revealed the importance of data quality in EMRs and the importance of understanding the data quality problems found in EMRs. It showed that in order to improve the overall health care system and patient safety the data quality problems found in EMRs should always be addressed.

CHAPTER 6

Conclusion

6.1. Introduction

Chapter 6 discussed the data analysis process used in this study. The results received from the collection of data were presented with the discussions being highlighted. The results highlighted the factors that could improve data quality in Electronic Medical Records in Public Health care institutions in South Africa. The factors that would improve data quality were obtained from the Data Quality Framework and previous studies that used the framework were analysed to get an in-depth view of the factors. This chapter is divided into seven sections. These provide summaries of the sections which are crucial to this study. Firstly, a summary of the literature is provided. Secondly, a section discussing the summary of the research problem is provided. The third section presents the research questions. In the fourth section, the summary of the theoretical framework is provided. The fifth section covers the summary of the research methodology. The sixth section discusses the recommendations and the contribution made by the study. In the final section, the limitations and direction for future research are provided.

6.2. Literature

The literature section began by discussing the current state of data quality in electronic medical records in the public health care sector in South Africa. The benefits and the barriers of EMR implementation were discussed. The factors influencing EMR implementation cannot be overlooked as they can have a significant effect on the data quality of EMRs. The literature further discussed the factors that are required to ensure data quality in an electronic medical record system. The data quality dimensions provide the theoretical background that describes the important factors that determine the quality of data. The data quality dimensions help with ensuring that data is of good quality and it improves the effectiveness of the health care delivery system. Health care practitioners should comply with the data quality assessment guidelines to ensure high quality data.

The second part of the literature highlighted the Data Quality Framework (DQF) and explained the practical cases of the data quality dimensions. Furthermore, the different methods of data quality were discussed. The DQF provides tools that support and ensure quality assurance. The DQF comprises components that ensure quality in data, these include: the Data Integrity

Strategy, the Data Quality Policy, the Data Quality Improvement Cycle and the Data Quality Assessment tool, which all provide guidelines that can assist health care practitioners to prioritise and understand the importance of data quality in health care. Based on the literature's findings, it is evident that data quality is important as it can have an effect on the decision making concerning patients' health care and medical records.

6.3. Research Problem

One of the challenges that is facing the health care system in South Africa regarding EMRs is how to ascertain or evaluate the data quality of an electronic medical record (Botha, et al., 2015). Critical health information tools can be deployed to measure the performance of systems at all levels in terms of costs, quality and individual clinicians to national network (Seahloli, 2016). The problem identified regarding EMRs is that they lack consistency in terms of how the data is documented across different health care institutions by health care workers. The inconsistency is caused by the different understandings that the health care professionals have regarding the importance of capturing the necessary information that is collected at various points in health care institutions, thus affecting data quality (Anthony, 2014). The common problems identified regarding data quality in EMRs include misspelled words, inconsistent word strings, inaccurate information entered in the record and incompleteness of the record (Singer, Yakubovich, Kroeker, Dufault, Duarte & Katz, 2016).

6.4. Research Questions

The primary research question that was investigated in this study is as follows:

How can data quality be improved in electronic medical records in public health care in South Africa? The objective of this study is to discover the factors that are required to ensure data quality in an EMR to promote public health care in South Africa. In order to achieve that goal, the following sub-questions were formulated:

i. **What is the current state of data quality in electronic medical records in public health care in South Africa?**

Chapter Two investigated the factors that affect data quality in EMRs. The chapter also identified the different types of health care available in the health sector. Furthermore, the question looked at the benefits and the barriers of EMR implementation. The chapter concluded with a discussion of the factors that influence EMR implementation and how medical records should be retained and disposed of so as to ensure patient safety.

ii. **What factors are required to ensure data quality in an electronic medical record system?**

In Chapter Three, a detailed description of the data quality definition was provided. Further, importance of data quality was discussed and the Data Quality Framework that comprises the tools that support data quality was also provided. The DQF has the potential to ensure quality in data when applied appropriately within any organisation.

This study developed factors to ensure data quality in EMRs. The factors can be used as a strategy towards achieving high quality data. The DQF was used as a basis for developing these factors. Thus, a summary of the DQF is provided in the following section.

6.5. Theoretical Framework

This study adopted the Data Quality Framework (DQF) developed by Wand and Wang (1996). The purpose of the DQF is to assess, analyse and use clean data with poor quality in Data Management Systems (DMS) (Corrales, Ledezma & Corrales, 2018). The DQF must provide a general structure for analysing and solving data quality problems found in DMS (Eppler & Wittig, 2000). Data are essential to any organisation and it is necessary for appropriate measures to be taken to ensure that the data are correct and cleaned of any data quality issues. The purpose of the framework is to provide a short and medium term solution by identifying specific initiatives to address priority data quality issues, while the framework provides for the continuous improvement and maintenance of data quality in the long term (Ministry of Justice, 2008). The Ministry of Justice (2008) further states that the Six Sigma methodology makes up the foundation of the DQF and it is focussed on the continuous improvement of data quality and also supports the theory that data quality is a journey, not a destination.

Both humans and Information Systems (IS) contribute to the data quality of records stored in DMS. Humans can create errors such as capturing duplicate data, leaving blank spaces on a particular row or column, creating a typing error and failure to comply with the appropriate format or standard. On the other hand, IS also has an effect on data quality through the failure to highlight an incomplete record, inconsistencies, and inaccurate data. Several studies provided DQF in health systems. The studies have presented the data quality issues found in the related works and these include illegible handwriting, incompleteness, unsuitable data format and heterogeneity (Reimer, Milinovich & Madigan, 2016; Almutiry, Wills & Alwabel, 2013; Arts, De Keizer & Scheffer, 2002). It must be remembered that the DQF is built from health systems. A DQF for matching records from multiple sources of EMR data was proposed by Reimer, et al. (2016). Similarly, Almutiry, et al. (2013), suggested a framework for cloud-based health care systems which was aimed at gathering electronic health records from different sources. Gathering EHRs/EMRs from different sources to integrate them as a single record can potentially improve the data quality problems discovered. Lastly, Arts, et al. (2002), suggested a framework of procedures for data quality assurance in medical registries and they are aimed at addressing data quality problems such as incompleteness, illegible handwriting and unsuitable data format. The findings from the studies indicate that the DQF has the capability of improving data quality in EMRs.

With regards to this study, the DQF comprises strategies and data quality dimensions which can improve the data quality in EMRs in public health care in South Africa, considering that the medical practitioners and the overall health care structure complies with the data quality improvement life cycle. The outcome of implementing the DQF will determine the factors which can improve data quality in EMRs in public health care. Therefore, the DQF was able to provide a better basis for explaining the factors which can improve data quality in EMRs.

6.6. Research Methodology

Before proceeding with a research study, the researcher has to understand the research problem together with the research questions. Once the research problem is clear, the researcher can then decide which research design to follow. The research design refers to the overall strategy that is chosen by the researcher to integrate the different components of the study in a logical way, thereby ensuring that the research problem is effectively addressed (De Vaus, 2001; Trochim, 2006). The research design constitutes the process of collecting, measuring and analysing data (De Vaus, 2001). This study adopted the qualitative research approach. The qualitative approach provided in-depth detail of a specific procedure based on the meaning people gave to them (Mertens, 2010). According to Mertens (2010), the qualitative approach builds on inductuve logic, contextual, discovery, complexity, exploration and the selection of a variety of empirical materials.

The population of this research project comprised nurses and an IS professional in Klerksdorp, South Africa. This study adopted thematic analysis to investigate the factors to improve data quality in EMRS in public health care in South Africa. The data provided by the study's participants during the interviews were summarised and grouped into relevant patterns or themes to obtain an answer for the main research question. The sample size for the participants of the study consisted of 8 health care professionals, such as, nurses and one particpant from the IS department in Klerksdorp, South Africa. With regards to the analysis of data, thematic analysis was adopted for this research project. Thematic analysis is appropriate for data analysis in qualitative studies. According to Braun and Clarke (2006), thematic analysis is generally used for documenting themes or patterns, examining and identifying meanings within data.

Interview: This study used a semi-structured interview process to obtain in-depth information regarding the factors that could improve data quality in EMRs in public health care in South Africa. The researcher established a set of questions to further provide information on the issues relating to data quality in EMRs. The interview questions were adapted from a study by Botha, et al. (2015) as a guide to answer the respective research questions. The respondents for the study were recruited through emails and through distributing the questionnaires to participants who willingly agreed to participate in the interviews.

Literature search: In addition to the interviews conducted, a literature search was also conducted for this study to help with answering and analysing the research question. To conduct the literature search, this study's researcher used documents, reports, both electronic books (e-books) and printed hardcopy books, journals and conference proceedings. Several electronic databases were used to find the significant literature, these included: Google Scholar, ACM Digital Library, Research Gate and other academic sources.

6.7. Contributions Made by this Study

This study developed critical success factors that might assist with improving data quality in EMRs in South Africa's public health care sector. The data quality issues that result in poor data quality in EMRs were identified and were common across different health care institutions. The quality of EMRs will always be compromised if the issues are not dealt with from the outset. From these problems, a total of 6 themes were identified as factors that impact on the quality and effectiveness of data. Furthermore, the study made recommendations of steps that can be taken to eliminate these problems, thus enhancing the data quality of EMRs in the public health care sector. The critical success factors were developed from the said recommendations.

6.8. Limitations and Directions for Future Research

This was exclusively a qualitative study, which contains a small sample size. Therefore, the findings of the study cannot be generalised. Although the study covered a small population, some understanding was acquired by the researcher regarding the factors that influence data quality in EMRs. For more generalisable findings, future studies should consider covering a larger sample size. The study was limited to evaluating data quality in EMRs in Klerksdorp, South Africa. Therefore, the researcher suggests that future studies should consider looking at other factors that could impact on the quality of data in the overall health care. Additionally, future studies should look into other factors that influence data quality such as user's satisfaction or user's acceptance towards using electronic health information systems (EHIS) from having used manual paper systems before.

6.9. Summary

The study developed critical success factors for improving data quality in EMRs in South Africa's public health care sector. From the literature and the analysis chapters, it was revealed that the following issues, such as incompleteness, duplications, inconsistencies and typographical errors, were identified as the factors that impact on the data quality of EMRs. These are general human-errors and the health care personnel should receive adequate training on using electronic health information systems (e-HIS) such as EMR, EHR and other related technologies.

This study made use of the DQF as a theoretical basis and six data quality dimensions were identified. The data quality dimensions are of importance as they were identified as the factors that could improve data quality of EMRs in South Africa's public health care sector. The six dimensions include: completeness, consistency, conformity, integrity, accuracy and timeliness. Health care organisations need to perform regular data quality assessments and implement improvement strategies to ensure that the quality of data is of a high standard to improve health care. Recommendations to improve data quality in EMRs have been provided and the researcher anticipates positive outcomes when the health care personnel workers collectively address the data quality problems they encounter in their workplaces. Finally, investments should be made in training and equipping South Africa's public health care personnel with the necessary computer literacy skills to use and accept EMR implementation and thereby avoid switching between manual paper-based record systems and electronic based systems.

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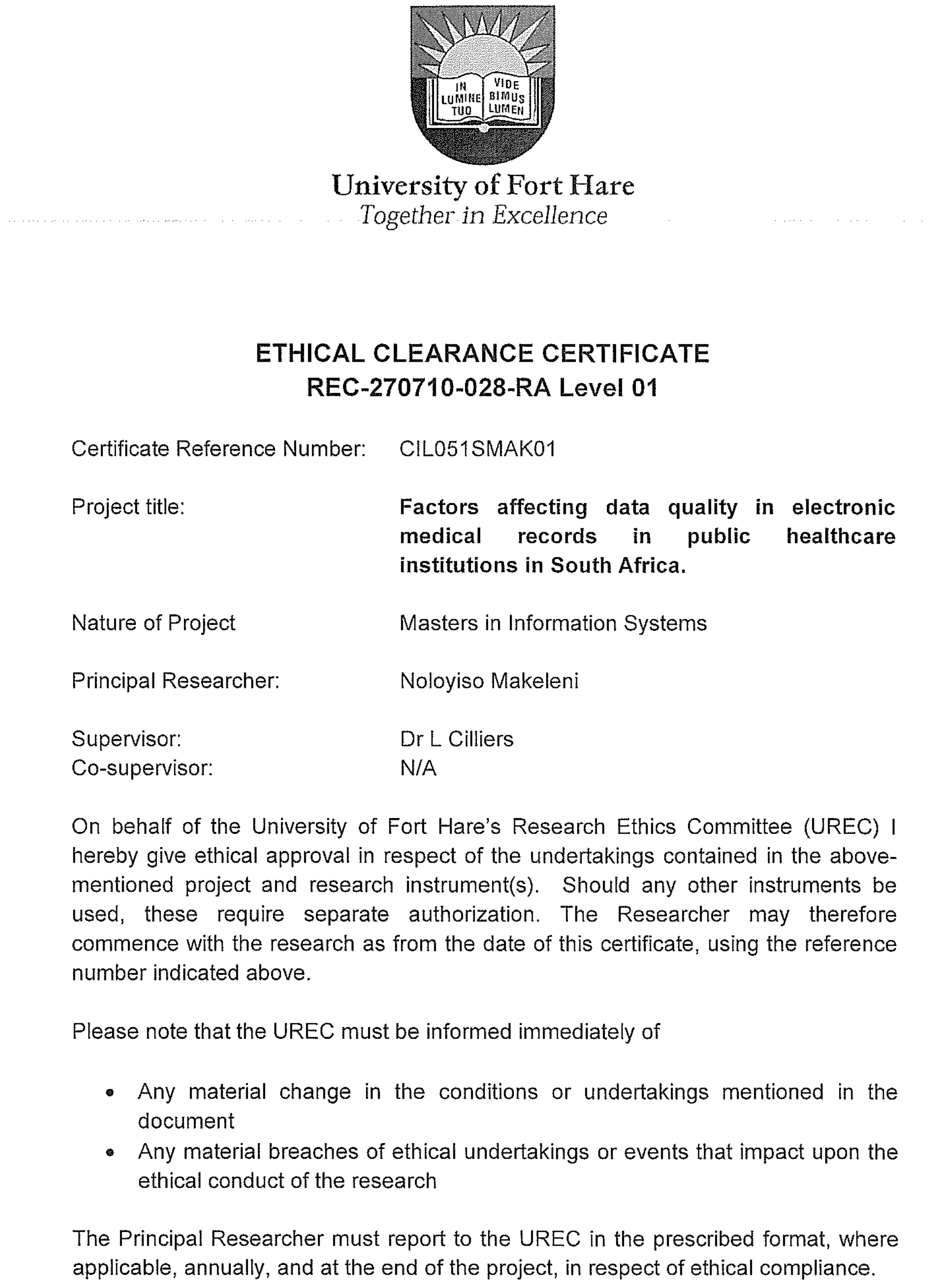
Appendices

Appendix A- Ethical Clearance Certificate



University of Fort Hare
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ETHICAL CLEARANCE CERTIFICATE
REC-270710-028-RA Level 01

Certificate Reference Number:	CIL051SMAK01
Project title:	**Factors affecting data quality in electronic medical records in public healthcare institutions in South Africa.**
Nature of Project	Masters in Information Systems
Principal Researcher:	Noloyiso Makeleni
Supervisor:	Dr L Cilliers
Co-supervisor:	N/A

On behalf of the University of Fort Hare's Research Ethics Committee (UREC) I hereby give ethical approval in respect of the undertakings contained in the above-mentioned project and research instrument(s). Should any other instruments be used, these require separate authorization. The Researcher may therefore commence with the research as from the date of this certificate, using the reference number indicated above.

Please note that the UREC must be informed immediately of

- Any material change in the conditions or undertakings mentioned in the document
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research

The Principal Researcher must report to the UREC in the prescribed format, where applicable, annually, and at the end of the project, in respect of ethical compliance.

Special conditions: Research that includes children as per the official regulations of the act must take the following into account:

Note: The UREC is aware of the provisions of s71 of the National Health Act 61 of 2003 and that matters pertaining to obtaining the Minister's consent are under discussion and remain unresolved. Nonetheless, as was decided at a meeting between the National Health Research Ethics Committee and stakeholders on 6 June 2013, university ethics committees may continue to grant ethical clearance for research involving children without the Minister's consent, provided that the prescripts of the previous rules have been met. This certificate is granted in terms of this agreement.

The UREC retains the right to

- Withdraw or amend this Ethical Clearance Certificate if
    - Any unethical principal or practices are revealed or suspected
    - Relevant information has been withheld or misrepresented
    - Regulatory changes of whatsoever nature so require
    - The conditions contained in the Certificate have not been adhered to
- Request access to any information or data at any time during the course or after completion of the project.
- In addition to the need to comply with the highest level of ethical conduct principle investigators must report back annually as an evaluation and monitoring mechanism on the progress being made by the research. Such a report must be sent to the Dean of Research's office

The Ethics Committee wished you well in your research.

Yours sincerely

Professor Pumla Dineo Gqola
Dean of Research

05 March 2018

Appendix B- Proofreading Certificate

TO WHOM IT MAY CONCERN

I have 42 years’ experience in the teaching profession, both at high school and tertiary level. In my last position before retiring in December 2016, I was a Teaching and Learning Consultant and had acted as Manager of the Teaching and Learning Centre (TLC) of the University of Fort Hare on three different occasions. As a consultant, I facilitated modules on the Post Graduate Diploma in Higher Education and Training (PGDHET) and also evaluated lecturers’ teaching and their courses. My skills set allowed me to focus on management, language, research and student development. Activities which speak to this include being the Co-ordinator of the Language and Writing Advancement Programme (LWAP) and the Supplemental Instruction Programme (SI) for two years plus being the Editor of the TLC’s bi-annual newsletter for approximately eight years.

For the past three years I have been proofreading and editing for academics on a time-on-task basis. I hereby certify that I have proofread a Master’s thesis submitted to me by the corresponding author, Noloyiso Anele Makeleni, Student Number 201214129, whose study’s research topic is:

Factors to Improve Data Quality of Electronic Medical Records in Public Healthcare Institutions in South Africa’.

I have corrected superficial errors in spelling, grammar, syntax and punctuation in the abstract and the body of the manuscript. I have checked the balance required between in-text referencing and endreferencing, where the one needs to be a mirror image of the other, according to APA referencing guidelines. I trust that the aforementioned will meet with the examiners’ approval and that the language used accurately reflects the author’s intended meaning. Furthermore, I have made every effort to ensure that the manuscript is clear, reads smoothly and avoids confusion or misunderstanding. The principles of anonymity, confidentiality, accountability and reliability have been respected by all researching parties.

DISCLAIMER: The proofreader cannot be held responsible for any errors introduced after the proofreading has been completed, due to changes being made during the corrections’ process.

Should there be any questions that arise from this exercise, kindly contact me on lscheckle@gmail.com.

Linda Scheckle (Private Editing Service) 14 November 2019
Address:
20 Klein Bron Mews
Moepel Crescent
Klein Bron Estate
Cape Town
7560

Appendix C- Ethics Research Confidentiality and Informed Consent Form

University of Fort Hare
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Ethics Research Confidentiality and Informed Consent Form

The University of Fort Hare / Information Systems Department is asking nurses from different levels and experts from the field of health informatics to be interviewed to evaluate and refine the data quality factors that will be identified in the secondary literature to answer some questions, which we hope will benefit your community and possibly other communities in the future.

The University of Fort Hare's Information Systems Department is conducting research regarding Factors to improve data quality in electronic medical records in Public health care institutions in South Africa. We are interested in identifying factors for improving the data quality of electronic medical records in the Public health care sector in South Africa. We are carrying out this research to help with maintaining the data quality of electronic medical records that will assist in the success of the national health insurance initiative.

The study will be conducted according to the International Declaration of Helsinki for research on human subjects. The University Research Ethics Committee has approved this research project and the Ethical Clearance number is CIL051SMAK01. The Committee reserves the right to inspect the research records collected during this research project in order to ensure that the project is being conducted ethically.

Please understand that you are not being forced to take part in this study and the choice whether to participate or not is yours alone. However, we would really appreciate it if you do share your thoughts with us. If you choose not take part in answering these questions, you will not be affected in any way. If you agree to participate, you may stop me at any time and tell me that you don't want to go on with the interview. If you do this there will also be no penalties and you will NOT be prejudiced in ANY way. Confidentiality will be observed professionally.

I will not be recording your name anywhere on the questionnaire and no one will be able to link you to the answers you give. Only the researchers will have access to the unlinked information. The information will remain confidential and there will be no "come-backs" from the answers you give.

The interview will last around 40 minutes *(this is to be tested through a pilot).* I will be asking you questions and ask that you are as open and honest as possible in answering these questions. Some questions may be of a personal and/or sensitive nature. I will be asking some questions that you may not have thought about before, and which also involve thinking about the past or the future. We know that you cannot be absolutely certain about the answers to these questions but we ask that you try to think about these questions. When it comes to answering questions there are no right and wrong answers. When we ask questions about the future we are not interested in what you think the best thing would be to do, but what you think would actually happen.

If possible, our organisation would like to come back to this organisation once we have completed our study to inform you and the organisation of what the results are and discuss our findings and proposals around the research and what this means for the employees of the organisation.

You can contact me or my supervisor if you have any further questions:

Ms Noloyiso Makeleni
University of Fort Hare
Telephone number: 0653771545
E-mail: 201214129@ufh.ac.za

Prof. Liezel Cilliers
Information Systems Department
University of Fort Hare
Telephone number: 0437047067
E-mail: lcilliers@ufh.ac.za

If you have any further queries regarding the ethical clearance process please contact the Dean of Research.
GMRDC
University of Fort Hare
Telephone number: 0437042319

INFORMED CONSENT

I hereby agree to participate in research regarding Factors to improve data quality in electronic medical records in Public health care institutions in South Africa. I understand that I am participating freely and without being forced in any way to do so. I also understand that I can stop this interview at any point should I not want to continue and that this decision will not in any way affect me negatively.

I understand that this is a research project whose purpose is not necessarily to benefit me personally.

I have received the telephone number of a person to contact should I need to speak about any issues which may arise in this interview.

I understand that this consent form will not be linked to the questionnaire, and that my answers will remain confidential.

I understand that if at all possible, feedback will be given to my community on the results of the completed research.

……………………………..
Signature of participant **Date**:…………………..

I hereby agree to the tape recording of my participation in the study

……………………………..
Signature of participant **Date**:…………………..

Appendix D- Interview Guide

Factors to improve data quality in Electronic Medical Records in Public Health care institutions in South Africa

Section 1: Demographic Information Form

This section aims at obtaining the basic information of the respondent.

1. What is your age? __________

2. What is you sex?

Female ○ Male ○

3. With which racial or ethnic category do you identify?

African ☐ Colored ☐ Indian ☐ White ☐

4. In what geographical area do you work in?

Urban ○ Peri Urban○ Informal settlement○ Rural○

5. Please describe the facility you work in e.g. clinic, hospital

____

6. What is your professional title: __________________________

7. How long have you been working in the health care field? _______________________

8. What is your highest qualification? _________________________________

9. What health information systems do you work with or have access to?

Electronic health records

Electronic medical records

Radiology systems

Pathology systems

Administrative systems

Other (please specify)

Section 2: Substantive Questions

1. In your understanding what is data quality in electronic medical records?

2. In your experience what could be the data quality challenges encountered in electronic medical records (EMRs)? Please explain.

3. Which of the following factors do you think lead to poor data quality in EMRS? Please elaborate why you think a factor is appropriate.

Completeness of data

Consistency of data

Conformity of data

Accuracy of data

Integrity of data

Timeliness of data

4. What are the consequences of poor data quality in EMRS affect health care outcomes?

5. Based on your opinion. Do you believe that the health information systems design has an impact on the data quality of EMRs?

6. Why do you think it is important to understand the data quality problems in EMRs?

7. Closing

- We have reached the end of the questionnaire. The confidentiality of the information gathered will be maintained. Thank you for your time and have yourself a blessed day.