UNIVERSITY of RWANDA

ASSESSMENT OF COMPLETENESS OF THE OUTPATIENT'S ELECTRONIC CLINICAL DOCUMENTS IN EMRS (OPENCLINIC) TO ENHANCE PATIENT CARE SERVICE DELIVERY

Case study: University Teaching Hospital of Kigali (CHUK)

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by

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220019899

A dissertation submitted in partial fulfillment of requirements for the Degree of

MASTER'S IN HEALTH INFORMATICS,

In the College of Medicine and Health Sciences

Supervisor: Prof. David TUMUSIIME

Co-supervisor: Mr. Alpha-Arsene MARARA

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Kigali-Rwanda

1. DECLARATION

I, Samson RUKUNDO, solemnly affirm that the research entitled "Assessment of the completeness of the outpatient's electronic documents in EMRS (OpenClinic) to enhance patient care service delivery," carried out at the University Teaching Hospital of Kigali, and submitted in accordance with the academic rules and regulations of the University of Rwanda for the Master's degree in Health Informatics, is my authentic creation. This research has not been presented elsewhere, be it in any universities or institutions of higher learning, for any purpose whatsoever. I further assert that all referenced information is appropriately listed in the provided reference section, serving as clear indications of their respective sources. I hereby grant permission to the University of Rwanda/College of Medicine and Health Sciences for the purpose of academic interest and potential publication.

Samson RUKUNDO

Signature:

Date: 30th August 2023

Supervisor: Prof. David TUMUSIIME

Signature: 

Date: 30th August 2023

Co-supervisor: Mr. Alpha-Arsene MARARA

Signature: 

Date: 30th August 2023

2. DEDICATION

This endeavor is wholeheartedly dedicated to:

The Divine Creator

My cherished family, especially our beloved parents, sisters, and brothers

3. ACKNOWLEDGEMENT

I am profoundly thankful, and I also wish to extend my heartfelt appreciation to the divine presence for His mercy and blessings, through whom this endeavor has been made achievable. I acknowledge with deep gratitude the contributions made by various individuals, instructors, friends, and family members. My profound thanks go to my Supervisors, namely, Prof. David TUMUSIIME and Mr. Alpha-Arsene MARARA. Furthermore, I want to convey my appreciation to the personnel of the University of Rwanda, specifically the Health Informatics department within the College of Medicine and Health Sciences (CMHS), including the Center of Excellence in Biomedical Engineering and e-Health (CEBE). Gratitude is also extended to the government of Rwanda for their support throughout my academic journey, which has provided me with diverse opportunities to acquire these skills.

May divine blessings be upon all of you.

4. LIST OF SYMBOLS AND ACRONYMS

CHUK: University Teaching Hospital of KigaliEMRs: Electronic Medical Records

EMRS: Electronic Medical Record System

EMRs: Electronic Medical Records

MOH: Ministry of Health (Rwanda)

OpenMIA: Open IT Medical Information Architecture

WHO: World Health Organization

ENT: Ear, Nose and Throat

KPI: Key performance Indicators

5. Abstract

Background:

A patient's medical and treatment information is contained in an electronic medical record (EMR), which is a patient-centered record. EMR data completeness is a matter for research, patient data analysis, and disease reporting, as the patients' clinical and medication information is stored in the EMR database.

Aim:

This study mainly aimed to assess the completeness of the outpatient's electronic clinical documents recorded in EMRs in order to enhance patient care service delivery.

Design:

A retrospective quantitative study design using data extracted from the open clinic-EMRs database was conducted.

Setting:

The EMRs data was obtained from Kigali Teaching Hospital, a tertiary hospital in Rwanda.

Main outcome measure(s):

The completeness of data was measured considering if a patient's record file contains all desired types of data (i.e., patients' demographics, clinical patient consultation documentation, Laboratory and Radiology information).

Results:

A total of 104 unique individuals were identified after extracting the data from the EMR database. The study found a frequency of 57.02% for the overall data completeness in EMR-OpenClinic. Furthermore, 87.77% of the patients had complete data in the main six categories (i.e., patient ID, age, gender, encounter type, clinical diagnosis, and treatments). The completeness of the consultation file, which includes vital signs and patient assessment documentation, was determined to be 50.52%. The completeness of the laboratory file was found to be 43.08%, and for the radiology file, it was 44.44%.

Conclusion:

Based on the type of information needed and the type of interaction, the study's findings show that data completeness varies. The EMR-OpenClinic system database can be used to undertake data completeness for patient care service delivery through clinical research, as we largely gathered data on most of the patient demographics, clinical laboratory document, clinical radiology document, and clinical consultation document from the EMRs database. However, further studies are required to investigate the content and completeness of EMRs for specific patient populations to evaluate other dimensions of data quality in Electronic Health Records (EHRs) to ensure their reliability and validity.

Key words: **Electronic clinical document,** Completeness, Outpatients, Electronic Medical Records, and OpenClinic.

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CHAPTER 1: INTRODUCTION

1.1 Background

The medical and treatment details of a patient are stored within an electronic health record (EHR), designed with a patient-centric approach. In numerous recent instances, EHR databases have taken the place of traditional paper-based health records in various hospitals. This shift from paper-based health records to EHR databases has created an exclusive avenue for conducting epidemiological investigations, exploring medication utilization, monitoring medical practices, and conducting quality assessment studies. These endeavors hold the potential to enhance the overall standard of patient care (Alwhaibi et al. 2019). EHRs have been reportedly employed in research conducted across various countries to assess the performance of physicians, gauge the quality of treatment, and predict the utilization of medications during instances of readmission (Alwhaibi et al. 2019) and identify inappropriate prescribing (Buck et al. 2009). The electronic medical records (EMRs) database holds more comprehensive data concerning patients' diagnoses, appointments, laboratory examinations, prescribed medications, results of physical examinations, and additional healthcare provisions (Coorevits et al. 2013).

In sectors with a cautious approach to risk, such as healthcare, where choices can carry life-or-death implications, data recipients have shown significant concern for the thoroughness of data, which constitutes a facet of data quality (Doshi et al. 2017). Despite substantial research conducted over the past thirty years, the attainment of data completeness to enhance patient safety and the standard of care persists as a significant hurdle within the healthcare sector (Liu et al. 2018). Most researchers endorse that EMRs offer correct and complete patient records (Cimino 2013), (King et al. 2014) but most countries appear to struggle to effectively gather comprehensive, precise, and detailed health indicators in order to assess the state of their healthcare systems because of lack of health information registration(Karara et al. 2016). Even if the one of the purpose of using EMR system is to maintain patient data records for secondly use (Köpcke et al. 2013). Globally, numerous research endeavors have highlighted the prevalence of incomplete patient data records, primarily stemming from the realization that the mere existence of an electronic record for an individual patient does not guarantee the presence of sufficient data pertinent to a particular research task or reporting requirement (Nicole G. Weiskopf et al. 2013a) and (Poulos, Zhu, and Shah 2021) which refers to incompleteness of clinical data records.

Rwanda is dedicated to incorporating information and communication technology (ICT) across all domains as a means to expedite both social and economic advancement (Frasier et al. 2008). Consequently, the Ministry of Health has incorporated information and communication technology (ICT) into the healthcare sector through the establishment of the "E-Health system." Similar to other developing countries, the Rwandan government opted for the implementation of Open Source

technology as a proficient means of storing and retrieving electronic medical records, aimed at bolstering healthcare provision (Nyssen et al. 2011).

The health sector is presently witnessing increased adoption of Information and Communication Technology (ICT) as a response to the growing need for high-quality, streamlined, and productive healthcare services. Rwanda has notably taken a lead in national efforts to infuse technology into its expanding healthcare framework, particularly in domains like electronic health records and nationwide reporting systems (Frasier et al 2008).

The completeness of EMR data encompasses a range of factors. Initially, the focus could be on either the patient or the medical procedures the patient has undergone. It is crucial to differentiate between having comprehensive data about the patient and having comprehensive data about the patient's medical experiences. In terms of medical processes, a patient without any medical interactions resulting in an empty record could be seen as having a complete record, but from the patient's viewpoint, the record remains devoid of information. The entirety of the record or its individual logical components, each of which may carry distinct requirements or expectations (like comparing patient demographics with the physician's clinical evaluation), can be assessed to determine completeness at different levels of detail (Botsis et al 2010).

The distinction between inherent and external data requirements brings to light an additional dimension of entirety. The least amount of information essential to consider a record as whole (whether concerning the patient or the medical procedure) can be specified, or the assessment of completeness can be customized to match the intended purpose. On the other hand, completeness can also be framed in relation to external necessities or inherent anticipations meaning; derived from the content's inception and determined by its application (N. G. Weiskopf and Weng 2013).

In order to facilitate a seamless shift and ensure uninterrupted care, it is imperative that all essential fields in the clinical documents are duly completed. Incomplete information upon receipt can lead to inconsistent care and redundant examination procedures, occasionally jeopardizing patient safety, outcomes, and leading to unnecessary expenditure of time and financial resources (Kalume et al. 2022). So, assessing the EMRs completeness is vital since EMRs are related to significant economic implications, and impractical EMRs might constitute a waste of the considerable funds required to implement and sustain EMR systems.

1. 2 Problem Statement

Given the significance of the patient problem lists that are mainly observed in EMRs, the incompleteness of patient records is frequently seen in many EMRs clinical documents, thus some stepsshould be taken to improve data completeness and accuracy (Köpcke et al. 2013).

In addition, missing patient data is a well-known problem that might impair statistical analysis and reporting in electronic medical records (EMRs) systems (Martín-Merino et al. 2018a). Furthermore, the demand to access and utilize clinical document data for purposes related to patient care is growing in tandem with the surge in clinical data generated during patient treatment. Significantly, inadequate and unfinished electronic patient information can substantially undermine the continuity of patient care, impacting patient safety and giving rise to a wide range of clinical errors. Therefore, the deficiency in completeness of EMR data raises concerns in the realms of research, statistical patient data analysis, and disease reporting, potentially leading to noteworthy discrepancies in health policy decisions. The issues linked to data incompleteness could result in grave repercussions within healthcare, including an escalation in patient risks and revenue losses. Recognizing the pivotal role of data completeness in healthcare, we have undertaken a research project to delve into this phenomenon. The primary objective of this study is to assess the level of completeness exhibited by electronic clinical documents, primarily within the framework of the Electronic Medical Records System (OpenClinic), in alignment with the standardization of electronic patient records.

1.3 Research Questions

- What are the incompleteness characteristics of patient's electronic clinical documentswithin EMRs (OpenClinic) from CHUK?
- To what extent does the patient data are recorded completely within the ElectronicMedical Records System?
- What are missing data?

1.4 OBJECTIVES

1.4.1 Main Objective

To assess the completeness of the patient's electronic clinical documents recorded in EMRs in order to enhance patient care service delivery.

1.4.2 Specific Objectives

- To identify the incomplete clinical documents recorded in OpenClinic EMRs
- To compute the frequency of incompleteness and inaccuracies of EMR's Clinical documents in EMRs OpenClinic obtained from hospital healthcare providers.
- To determine and define the missing data from EMRs

1.5 Significance of the study

OpenClinic serves as an open-source Hospital Management Information system utilized in Rwanda, notably employed at the University Teaching Hospital of Kigali (CHUK). Despite its deployment, no prior examination has been conducted to evaluate the comprehensiveness of electronic clinical documents for outpatients within OpenClinic, a factor crucial for enhancing patient care service delivery. This study is designed to provide a comprehensive understanding of the system's efficacy, spanning user completeness and usability across different stages of clinical service provision, ultimately impacting healthcare service delivery. The insights gathered through this research will also offer valuable guidance to the hospital management, shedding light on the current utilization of the system by healthcare practitioners in recording patient data and identifying potential instances of data loss due to subpar data recording practices.

In conclusion, this research contributes to an improved comprehension of the significance of data completeness within patients' electronic clinical documents stored in EMRs, serving to enhance the delivery of patient care services.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Data breadth and depth must be sufficient for the work at hand or in the system, and there must be no gaps in the data, according to the definition of data completeness. Data completeness is another aspect of data quality that describes how much of the information users need to do specific tasks is readily available to them, making the information accessible and meeting their needs (Liu et al. 2018).

The electronic medical record (EMR) has existed for well over a decade and is expanding increasingly in the health care setting(Frasier et al. 2008). Since 1995 The EMR serves as a repository for information on patient encounters, problem lists, clinical notes, procedures, and test results. It also helps to address the time-consuming and labor-intensive filing and retrieval inefficiencies associated with paper-based records (Hersh 1995). When well designed and implemented, the benefits of an EMR can outweigh the disadvantages. Recognized benefits include enhancements in patient safety, error reduction (e.g. adverse drug events), promotion of standardized (protocol-based) patient care, portability of information and handling of mundane administrative functions (e.g. automated coding). In contrast, paper records are cumbersome to store/convey, are notreadily transportable, may contain illegible entries, lack 8 select clinical service line documents or may be simply unavailable because of simultaneous provider use. Lost or misplaced documents also characterize paper-based systems and according to one study, paper charts may be missing up to 25%of the time when they are clinically needed. Within the EMR, computerized data input also improves data quality and validity. For example, handwritten records can be associated with poor legibility thatmay contribute to medical errors. Structured data entry and electronic templates prompt clinicians to provide complete information. Electronically stored laboratory data in the EMR can be more easily accessed and managed and offer potential advantages in new designs of innovative clinical patient monitoring and quality improvement reporting. Users can rapidly seek, view, arrange and assemble laboratory information to support trend analyses and clinical decision making (Levy et al. 2010).

2.2 EMR-OpenClinic GA

OpenMIA-based medical information architecture, known as Open Clinic, forms an integrated hospital information system. This system comprises various modules and effectively automates essential functions for small to medium-sized hospitals (with bed capacity ranging from 50 to 1,000). Open Clinic was conceived by a collaboration between computer engineers and highly trained physicians in advanced ICT, all boasting over 15 years of combined experience. These experts, hailing from MXS in Belgium, brought Open Clinic into existence. The initial release of Open Clinic was in 1990, remaining operational until 2001. Then, in 2004, a complete rethinking and reprogramming of the OpenMIA architecture and OpenClinic modules occurred, utilizing the Java programming language. Java stands as one of today's most extensively utilized programming languages across the globe (Morrison, Iosif, and Danka 2010).

Open Source software titled EMR-OpenClinic GA serves as a solution for overseeing the flow of hospital information. It encompasses the management of administrative, financial, clinical, laboratory, x-ray, pharmacy, and meal distribution aspects, along with robust statistical analysis and reporting functions(Nyssen et al. 2011). A collaborative effort between physicians and IT experts at the Belgian Enterprise Medical Exchange Solutions has been actively crafting this program since 2006. The source code was made publicly available in December 2008, entering the public domain (Karara et al. 2016). Starting from that point in time, the OpenClinic software has been available for unrestricted download. The EMR-OpenClinic software suite has been implemented across over 25 locations in Africa, encompassing hospitals within the Sub-Saharan region. This deployment spans countries like Rwanda, Burundi, Democratic Republic of the Congo (DRC) with 5 sites, Mali with 4 sites, and an additional 5 sites in Burundi. These installations cater to hospitals with user counts ranging from 5 to 700. Beyond the African context, the EMR-. Its presence is also observed in Albania, Bangladesh, Belgium, Brazil, and various other locations (Karara et al. 2016).

2.3 Features of EMR-OpenClinic GA e-Health system

EMR-OpenClinic caters specifically to hospitals with constrained resources, offering support in multiple languages: English, French, Dutch, Spanish, and Portuguese. It provides extensive customization options through Java class extensions. The software seamlessly integrates billing and insurance management. Furthermore, it boasts advanced statistical capabilities for analyzing mortality rates, co-morbidity, and care expenses. Notably, it includes a human resource management component within its framework. The software features a comprehensive scheduling system as well. Its components encompass a 3BT clinical thesaurus, equipped with validated coding assistance for ICD-10 and ICPC2, along with SNOMED CT coding for diagnoses starting from version 4.0.

The EMR-OpenClinic system facilitates complete lab order entry and results management, with support for LOINC coding. It effectively manages x-ray and pathology results as well. Additionally, the software comprehensively handles ADT (Admission, Discharge, Transfer) processes. It even accommodates multimedia content, including images, videos, and audio files. The software incorporates fingerprint identification using the Digital Persona library. Efficient database connection pooling is achieved through the Primrose engine in version 4.0 and onward. Notably, the software's usage is unlimited and free, offering unrestricted access for users, patients, beds, and more (Nyssen et al. 2011).

2.4 Importance of Completeness in EMR

Completeness refers to the extent to which an EMR system contains accurate and comprehensive patient information. A complete EMR is crucial for ensuring high-quality patient care, facilitating efficient communication among healthcare professionals, and supporting clinical decision-making. According to (Jacobs et al. 2007), a comprehensive EMR can significantly improve patient safety by reducing medication errors and enhancing care coordination among different healthcare providers but did not prevent overall medication error reporting rates (Barkley et al. 2017). Numerous studies have highlighted the benefits of having a complete EMR system in enhancing patient service delivery. The study conducted by (Follen et al. 2007) found that a comprehensive EMR enables healthcare providers to access patient data in real- time, leading to improved diagnosis accuracy and timely interventions. Additionally, completeness in EMR promotes seamless communication and collaboration among healthcare teams, resulting in enhanced care coordination and improved patient outcomes (Chen et al. 2020). Moreover, a complete EMR system provides valuable data for research and quality improvement initiatives, enabling evidence- based decision-making and the implementation of best practices (Alwhaibi et al. 2019a).

There may be additions or functionalities in OpenClinic that improve data collection, management, and storage. Healthcare professionals can access complete and current patient data via this system, including medical histories, test results, treatment plans, and progress notes. Making informed clinical decisions

and delivering appropriate care can be made easier with the help of this comprehensive and accessible information (Liu et al. 2018). Also, OpenClinic might have features or communication capabilities that make it easier for healthcare practioners to communicate with one another. Collaboration, information exchange, and care coordination can all be made easier as a result (Chen et al. 2020). Healthcare professionals can discuss treatment plans, transmit pertinent patient information swiftly and securely, and respond to any questions or updates in a timely manner by using a single platform for communication.

A more thorough awareness of each patient's situation by healthcare professionals can result in more precise diagnoses, suitable treatment strategies, and prompt interventions. It is possible to promote coordinated and high-quality care by ensuring that all members of the care team are aware and on the same page through effective communication amongst healthcare providers.

2.5 Challenges in Achieving EMR Completeness

While the benefits of a complete EMR system are clear, there are several challenges associated with achieving and maintaining completeness. Data entry errors, lack of standardization, and interoperability issues are common challenges faced by healthcare organizations (Bhartiya, Mehrotra, and Girdhar 2016). Additionally, information overload and resistance to technology adoption can hinder the completeness of EMR systems. Addressing these challenges requires a multi-faceted approach, includingtraining programs for healthcare professionals, standardization of data entry practices, and interoperability initiatives.

2.6 Strategies for Enhancing EMR Completeness

To improve the completeness of EMR systems, various strategies and best practices have been identified. The implementation of data validation techniques, such as real-time prompts and alerts, can help reduce errors and improve the accuracy of entered data (Martín-Merino et al. 2018). Standardization of data elements, terminologies, and documentation templates ensures consistency and facilitates data sharing and interoperability (Jardim 2013). Furthermore, integrating artificial intelligence and natural language processing technologies can automate data capture and improve data completeness (Li et al. 2020).

2.7 Data completeness in EMR case studies, examples and findings

Several healthcare organizations have successfully implemented OpenClinic EMR or similar systems to enhance completeness and improve patient service delivery. A study conducted by (Lin et al. 2020) examined the completeness of medication information in EMRs during hospital transitions. The researchers found that medication reconciliation, the process of comparing a patient's medication orders across different healthcare settings, was often incomplete or inaccurate in EMRs. It highlighted that missing or incomplete medication data can lead to medication errors, adverse drug events, and

compromised patient safety (Lin et al. 2020). In the study investigated the completeness and accuracy of allergy and adverse reaction documentation in EMRs, the researchers discovered that a significant number of patient records had incomplete or missing information regarding allergies and adverse reactions. It highlighted that incomplete data in this area can result in potential allergic reactions and adverse events if healthcare providers are not fully aware of a patient's history (Taylor et al. 2022).

In the study review focused on the completeness of clinical documentation in EMRs in 2011, the researchers identified various areas of incomplete documentation, such as patient history, physical examination findings, and progress notes. It concluded that Inadequate clinical documentation can lead to fragmented patient records, compromised continuity of care, and difficulty in tracking disease progression (Stephens, Gimbel, and Pangaro 2011).

Concluding, a study conducted by Alwaibi et al. in Saudi Arabia delved into the evaluation of quality and completeness of EHRs, with a specific focus on patients' medication-related information. The findings of this research revealed that 89.9% of the patients possessed comprehensive data encompassing age, gender, marital status, nationality, encounter type, and clinical diagnosis. Additionally, the study found that 83.1% of the patients had complete medication-related information available within their EHRs (Alwhaibi et al. 2019). These instances underscore the significance of evaluating data completeness within EMRs and shed light on the obstacles healthcare providers encounter in accomplishing it. Guaranteeing exhaustive and precise data entry, enhancing data capture methods, introducing uniform documentation practices, and furnishing comprehensive training to healthcare practitioners all stand as potential measures to bolster data completeness in EMRs.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Study Area

The research was carried out at the University Teaching Hospital of Kigali (CHUK), which was the inaugural site for implementing OpenClinic tools in 2007. This hospital is recognized as the largest referral facility in the country, boasting a bed capacity of 519. CHUK plays a pivotal role in furnishing top-notch healthcare services to the populace, while also facilitating training, clinical research, and offering technical assistance to district hospitals. Situated in the Nyarugenge sector of Kigali-Nyarugenge district, CHUK serves as a cornerstone of healthcare provision in the region.

3.2 Study Design

A retrospective quantitative study approach was employed to examine the extent of completeness evident in the electronic clinical documents documented within OpenClinic-EMRS. Information was extracted

from the OpenClinic EMRs database spanning the period from October 1st to December 31st, 2022. The research honed in on two representative definitions of completeness that embody a conceptual framework for assessing EHR completeness; **Documentation:** a record contains all observations made about a patient and **Breadth:** a record contains all desired types of data (Nicole G. Weiskopf et al. 2013). **Documentation** is the process of recording and maintaining accurate and comprehensive records of a patient's medical information. Breadth refers to the wide range of relevant data types that are included in these records to provide a holistic view of the patient's health and medical history. Both concepts are critical for ensuring effective patient care, communication, and compliance with medical standards.

Here are the key components of documentation in healthcare:

Patient Information: This includes the patient's personal details (name, age, gender, contact information) and demographic information.

Medical History: This includes information about past medical conditions, surgeries, allergies, medications, and family medical history.

Patient Observations: These are records of what healthcare professionals observe about the patient's current condition. This might include vital signs (temperature, blood pressure, heart rate, respiratory rate), physical examination findings, and any visible symptoms.

Diagnoses: Documentation includes the results of diagnostic tests, assessments, and the official diagnosis given to the patient.

Treatment Plans: This section outlines the treatment the patient is receiving or needs to undergo, including medications, therapies, surgeries, and any other interventions.

Breadth in this context refers to the comprehensiveness of the information captured in a patient's record. It indicates how wide a range of relevant data points are included in the documentation. A record with breadth includes a wide variety of data types to provide a holistic view of the patient's health status and

medical history. For instance, a medical record with breadth might include:

Clinical Data: This includes medical history, diagnoses, treatments, lab results, imaging reports, and surgical history.

Vital Signs: Regularly measured vital signs like blood pressure, heart rate, respiratory rate, and body temperature.

Medications: A list of current and past medications, dosages, and administration instructions.

Progress Notes: Ongoing notes on the patient's condition, treatment responses, and any changes.

Communication Records: Relevant emails, messages, or conversations among healthcare providers regarding the patient's care.

Imaging and Test Results: X-rays, MRI scans, blood test results, and other diagnostic findings.

3.3 Study Population

The study encompassed individuals from the medical patient pool, identified by their outpatient ID numbers, who sought medical attention at Kigali University Teaching Hospital (CHUK) within the three-month span from October 1st to December 31st, 2022, and had their health information documented within OpenClinic-EMRs. The data was extracted from open clinic database.

3.3.1 Inclusion Criteria

All outpatients with clinical document(s) in the OpenClinic-EMRs system in period between October 1st to December 31st,2022.

3.3.2 Exclusion Criteria

Outpatients 'electronic files without clinical document in the system

All inpatients 'electronic files clinical documents

All patient's clinical documents recorded in OpenClinic before 1st October and afterDecember 31,2022

All patient 's data recorded in OpenClinic which are not related to clinical documents suchas bills, insurance documents etc.**…**

3.4 Sampling Method

The retrospective systematic sampling will be used to review data throughout the system. The three months' (October 1st to December 31st,2022) clinical documents were collected from the OpenClinic.

3.4. 1 Sample Size

The total sample of 104 outpatient's medical ID was sampled in period between October 1st and December 31st, 2022 and their electronic clinical documents were assessed for their completeness. The sampling interval was calculated from the total number of outpatients with clinical documents (12523) in that 3 periodic months from the system divided by 100, the number of samples that were at least needed and checked for completeness. Using the Microsoft Excel, the every 120th medical patient ID were systematically sampled and assessed for completeness.

3.5 Data Collection

Data was collected from the OpenClinic EMRs database where different outpatients' electronic documents were assessed. The file was marked complete (when document data is filled), incomplete (When no data filled) and document were marked as partially completed when document is partially filled (not found throughout the research). Then the data was collected and recorded on Excel documents and maintained there for analysis.

3.6 Confidentiality and Privacy

Confidentiality of the data collected should be maintained throughout the research process and onwards. Excel files were used to store and save retrieved data. The retrieved data were kept on a safe computer with password protection and restricted access. Only patients' electronic medical ID were recorded and taken into consideration.

3.7 Data Management and Analysis

In order to characterize the data a descriptive analysis was employed. Categorical variables were defined using frequency and percentage. Moreover, the percentage of variables containing missing (incomplete) records was calculated. Subsequent analyses were conducted to ascertain the of completeness within the EMRs OpenClinic system. All statistical analysis was carried out using MS Excel.

3.8 Ethical Consideration

The research study has been granted both scientific and ethical approval by the UR CMHS Ethical Committee. Additionally, permission to collect data was duly obtained from the CHUK Ethical Committee. With ethical clearance from CHUK management in place, the data collection process was initiated. Subsequently, the gathered data underwent analysis and assessment to facilitate the research objectives. For this study, data was exclusively collected from outpatient sources. Emphasis was placed on upholding the confidentiality and privacy of all clinical data, encompassing patient names and other medical information. The study employed patient medical IDs to ensure anonymity and safeguard patient identities. The research findings are intended for presentation solely within the confines of CHUK (University Teaching Hospital of Kigali) and the University of Rwanda/College of Medicines and Health Sciences. Any dissemination of the information to external entities or individuals beyond those specified, necessitates authorization from CHUK management.

CHAPTER4: RESULTS

4.1 Description of the data

During the three-month period, a total of 130 outpatient records were identified. After removing duplicateentries, the final study population consisted of 104 unique individuals. Most of the study population were women, accounting for 56.73%, while men comprised 43.27% of the population. Various electronic clinical documents were assessed, including consultations (88.18%), radiology reports (2.73%), and laboratory records (9.09%) **(Figure 1).**

Data collection was conducted across ten different clinical departments and sub-specialties. The distribution of data from these departments is as follows: outpatient department (OPD) accounted for 28.85% of the data, internal medicine contributed 21.15%, ophthalmology 0.96%, pediatrics 3.85%, dermatology 8.65%, ENT (ear, nose, and throat) 9.62%, surgery 19.23%, human genetics 0.96%, emergency 3.85%, and radiology 2.88% **(Table1).**

Figure1: Patient's electronic document types and their data frequency in EMRs-OpenClinic

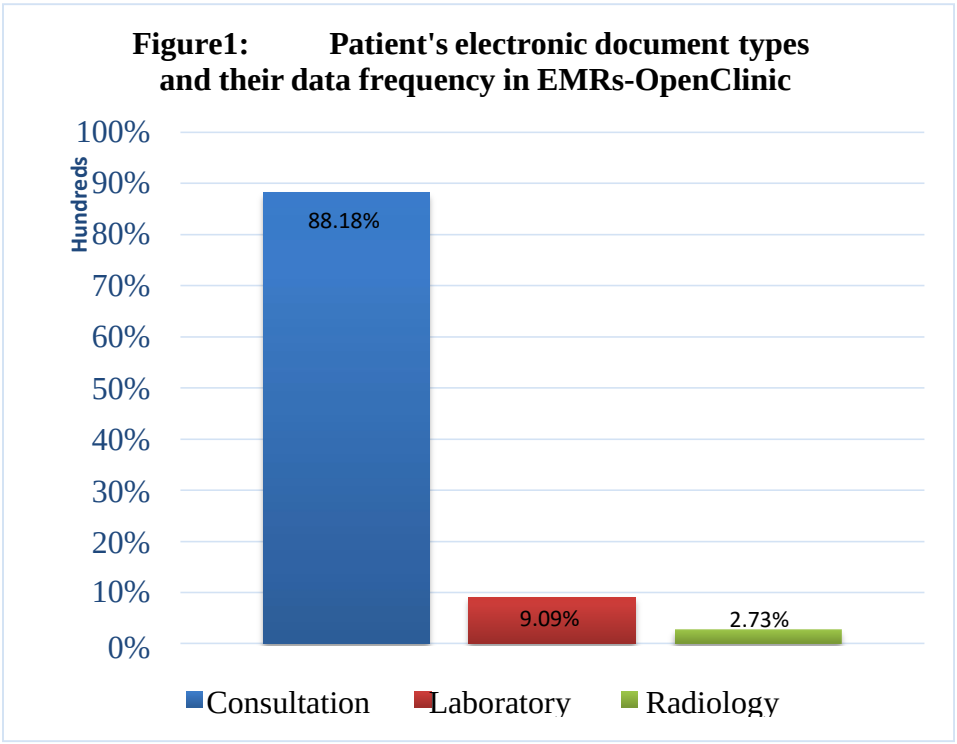

Figure1*: *These percentages represent the distribution of different types of electronic clinical documents collected in the study from EMR-OpenClinic system of CHUK hospital.

Table1: Represent the percentages data distribution frequency from assessed clinical departmentsand sub-specialties of CHUK hospital.

Department	Number of representative samples	Percentage of representative samples (%)
OPD	30	28.85
Internal Medicine	22	21.15
Ophthalmology	1	0.96
Pediatric	4	3.85
Dermatology	9	8.65
ORL	10	9.62
Surgery	20	19.23
Human Genetic	1	0.96
Emergency	4	3.85
Radiology	3	2.88
TOTAL	104	100

4.2 Completeness of the data

From our study sample, a total of 2,413 data variables considered in the clinical documents (the total count of fields needs to be filled with patient medical information from all 104 sampled outpatients) were reviewed. Among these variables 57.02% were found to be complete (data completed in the field), while 42.98% were identified as incomplete (no data completed at all) (**Figure2).**

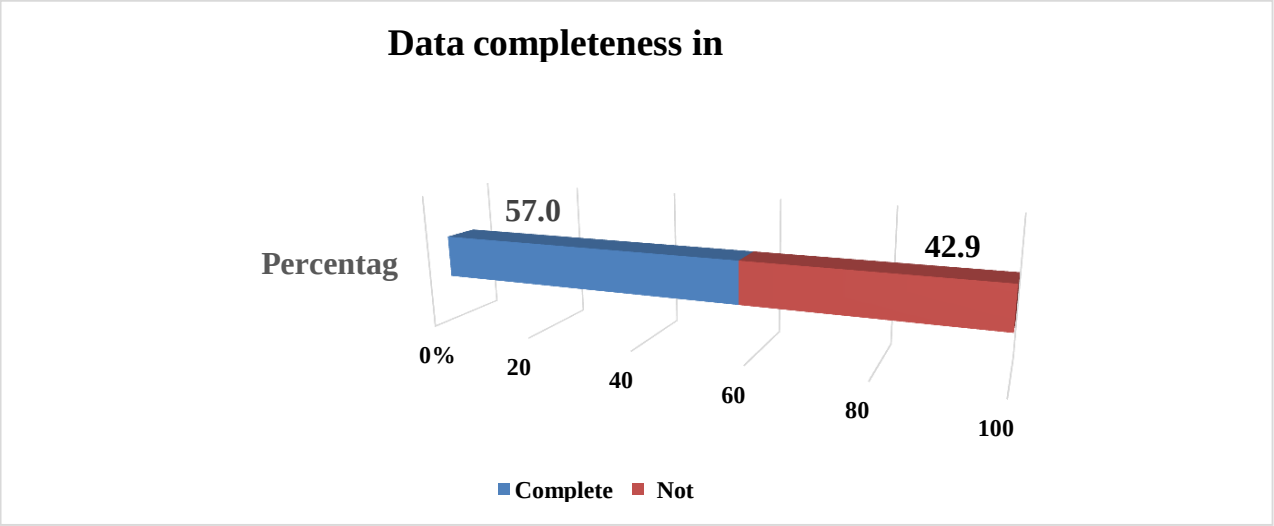

Figure2: Represent the distribution percentages of the data frequency of the overall data completeness in EMR-OpenClinic.

Specifically, the data pertaining to patients' demographic information, including patient ID, age, gender, district of origin, and the medical department where patients were assigned, as well as the responsible doctor, were found to be complete for 100% of the study population. These details are mandatory requirements that need to be fulfilled before proceeding with other patient care service delivery.

In terms of specific electronic medical record (EMR) files, the completeness of the consultation file, which includes vital signs and patient assessment documentation, was determined to be 50.52%. The completeness of the laboratory file was found to be 43.08%, and for the radiology file, it was 44.44%.

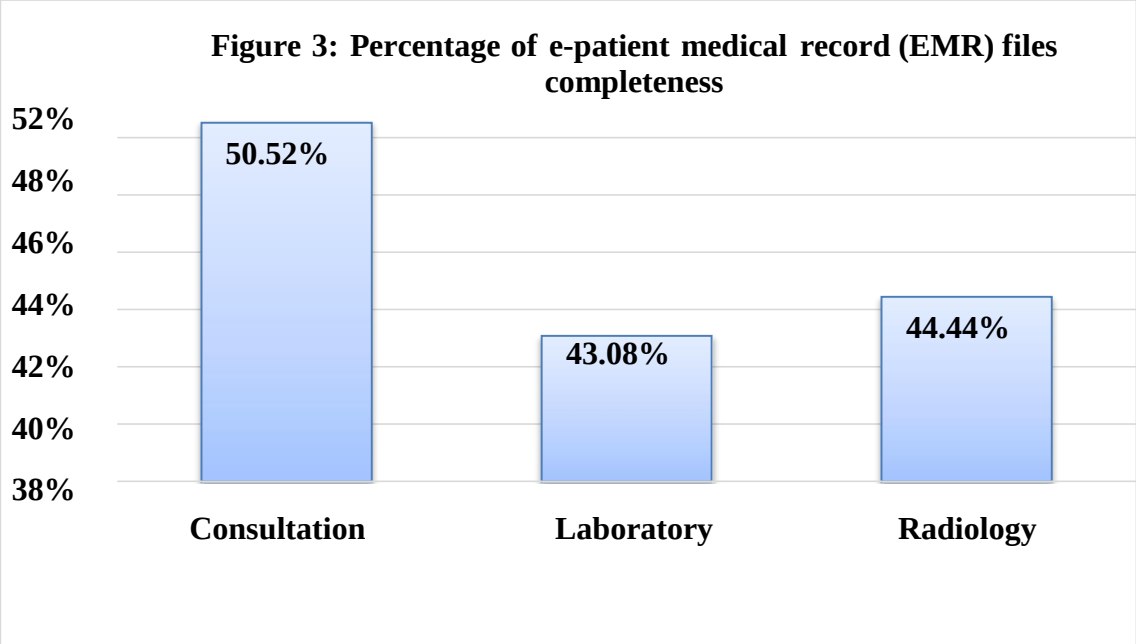

Figure 3: Represent the percentage of completeness within each respective e-patient's file

Among study sample, the completeness of patient vital signs (Temperature, Heights, Weight, SPO2, Blood pressure, Respiration rate and heart rate) data recorded in the EMR-OpenClinic's vital sign clinical form (Table 2) was 55.53%. Among these vital signs, Oxygen saturation (SPO2) exhibited the highest completeness at 70.1%, whereas temperature displayed the lowest completeness with only 36.08% complete data, leaving 63.92% data missing.

Table2: Vital signs completeness in EMR-OpenClinic

Vital signs variables	**Completeness data in Percentages (%)**	**Missing data (Incomplete)data in Percentage (%)**
Temperature	36.08	63.92
Height	48.45	51.55
Weight	52.58	47.42
SPO2	70.1	29.9
Blood Pressure	64.95	35.05
Respiratory rate	47.42	52.58
Heart rate	69.07	30.93

Based on patient assessment documentation (**Table 3**) like Patient type on arrival, Doctor‘s call, Doctor‘s arrival, History and anamnesis, Physical exam, Differential diagnosis, Clinical summary, Technical Exams and result, Treatments, Final diagnosis, Patient follow-up or Education and doctor‘s comment; It was found that 45.52% of the study population had a complete data where patient type on arrival and history and anamnesis have high complete data (96.87%) than others. The incomplete was mainly found on the time of doctor‘s call and doctors‘ arrival with 0% complete data (100%missing data), patient follow-up with 17.19 complete data (82.81% missing data), final diagnosis with 16.19% complete data (83.81% missing data) and doctor‘s comment and/or observation with 4.76 % complete data (95.24 % missing).

Table 3: Data Completeness on patient assessment documentation

Patient assessment documentation variables	**Completeness of data in Percentages (%)**	**Missing data (Incomplete)data in Percentage (%)**
Patient ID	100	0
Type of patient on arrival	96.87	3.13
Doctors' call	0	100
Doctors' arrival	0	100
History and anamnesis	96.87	3.13
Physical exam	68.57	31.43
Differential diagnosis	54.29	45.71
Clinical summary	17.14	82.86
Technical exam and results	47.62	52.38
Treatments	72.38	27.62
Final diagnosis	16.19	83.81
Patient follow-up	17.14	82.86
Doctors' comment/ Observation	4.76	95.24

The completeness of laboratory electronic file is **43.08%** where the majority of completed data was found on 5 elements such as patient ID, sample name, sample time, document ID and clinical information with 100% complete data. The missing data was mainly found on patient contact with 40%(60% missing), the information about sample storage (freezer, box and position) with 100% missing, conclusion and lab analyst comment data were also 100% incomplete and the way of communication with the patient data through sending SMS or via email was complete at 20% (i.e. 80% missing) **(Figure 4).**

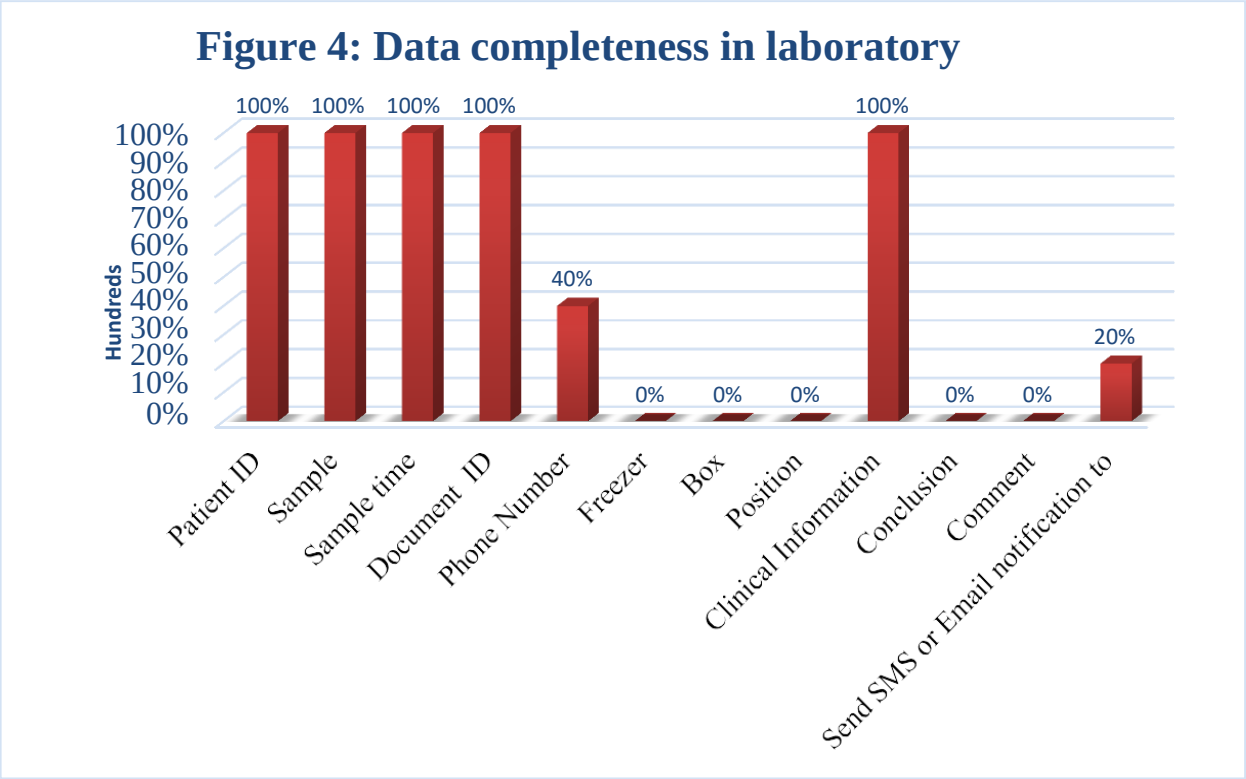

Figure 4: Represent the data completeness of clinical document in laboratory from EMRs (open clinic)

The completeness of radiology electronic file is 44.44 % where the majority of completed data was found on 5 elements such as patient ID, date of exams, sample type, emergency request and exam specification with 100% completed. The missing data was mainly found on original order modified, the reasons, exam reported, report, nothing unusual and abnormalities found with 100% missing. And also missing data found on exam performed with 33.33 % completed (66.67% missing) **(Figure 5).** But this missing information may be considered as not important as it doesn't not have direct effect on patient treatment.

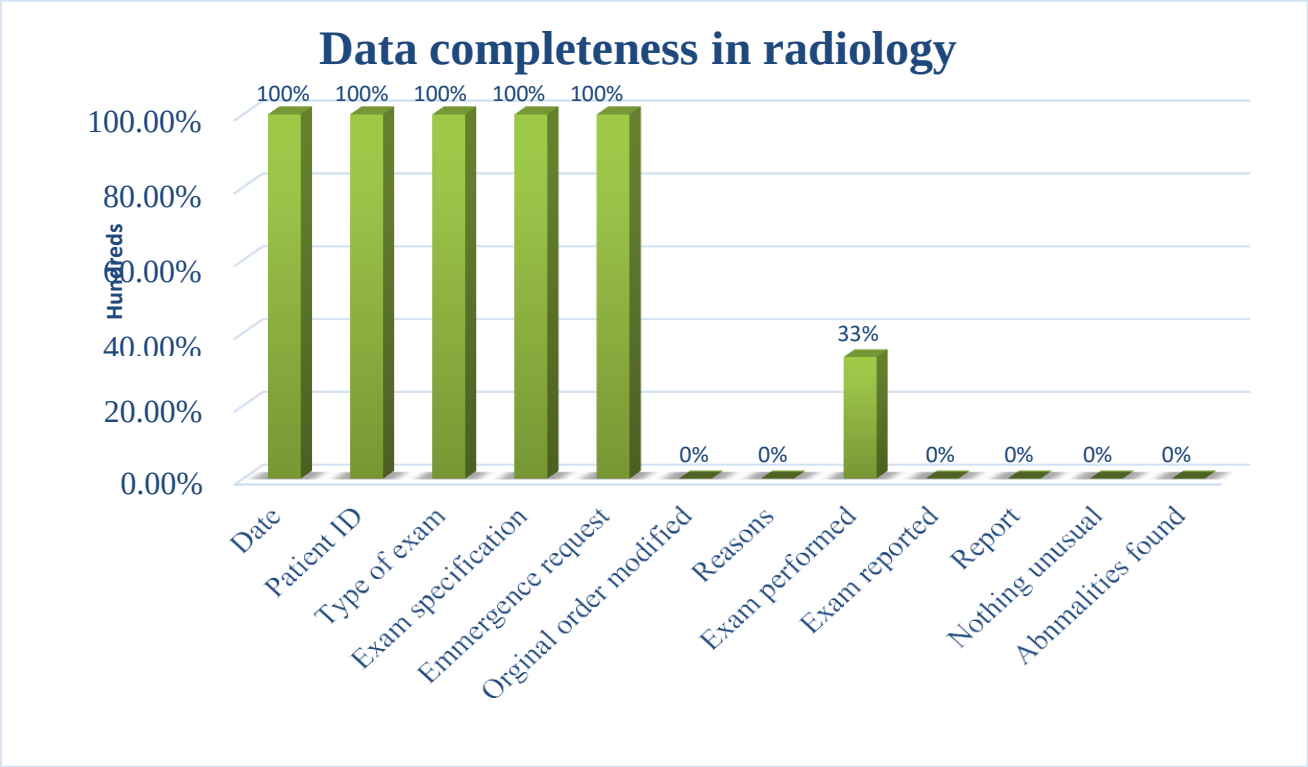

Figure 5: Represents the completeness of clinical document in radiology from EMRs (OpenClinic).

CHAPTER5: DISCUSSION

5.1 Introduction

In this investigation, we focused on studying outpatients who sought medical care at a tertiary teaching hospital, CHUK, throughout a span of three months. The aim was to assess the comprehensiveness and substance of the EMR-OpenClinic database. Our discoveries indicate that the EMR-OpenClinic database encompasses essential categories of data, including demographics, clinical consultations, laboratory tests, serology, and therapeutic interventions, thereby facilitating patient care.

5.2 Completeness of the EMRs (OpenClinic)

Our analysis revealed that the assessment of data completeness in patients' EMRs is contingent on the data specifications within the system. For instance, 87.77% of patient records were complete when we defined completeness as the absence of any missing data for six categories, including patient ID, age, gender, encounter type, clinical diagnosis, and treatments because certain pieces of information are likely to be crucial like clinical diagnosis and treatments, other are potentially mandatory, including patient identifiers (ID), age, gender, and encounter type.

Our finding can be compared to one of the study conducted in Saudi Arabiaby (Alwhaibi et al. 2019) sought to evaluate the extent of completeness in patients' medication-related information within EHRs. Their investigation unveiled that, based on their definition of completeness as the absence of any missing data across seven variables (namely age, gender, marital status, nationality, encounter type, and clinical diagnosis), a substantial 89.9% of the patients possessed comprehensive data.

The percentage of incomplete data in our study was primarily caused by the incomplete data on the differential diagnosis (45.71% missing) and treatment (27.62% missing). We could potentially speculate that healthcare professionals might refrain from entering these characteristics into the system due to the prevailing tradition of using paper-based methods for medical prescription notes. Furthermore, it's worth noting that the EMR-OpenClinic database doesn't necessitate the reporting of this information as obligatory, in contrast to the demographic details of patients. However, it's crucial to acknowledge that the absence of data regarding differential diagnosis and treatments could have implications for patient care and clinical research. For instance, a study by Lin in 2020 that assessed the completeness of medication information in EMRs during hospital transitions highlighted the significance of complete medication data. The research emphasized that missing or incomplete medication information can result in medication errors, adverse drug events, and a compromise in patient safety (Lin et al. 2020).

For consultation clinical document assessed throughout the study, we have noticed the missing data on many points such as doctors call and doctors arrival with 100%missing data, patient follow-up with 82.86% missing data, final diagnosis with 83.81% missing data and doctors comment and/or observation with 95.24% missing. Missing data on the time of doctors call and doctors arrival (100% missing data) has not proved to affect the patient treatment in anyway but the time took by patient waiting for the doctor may

affect negatively the patient and it indicate poor services. According to the study conducted by Hill and Joonas in 2015, longer wait times of the patient do seem to have had a detrimental effect on patient's perceptions of the general quality of the health services being rendered, as well as the various quality aspects such as responsiveness, reliability, assurance, empathy, and tangibles, which collectively contribute to the overall service experience, were all negatively affected by extended waiting times. This, in turn, heightened the probability of respondents hesitating to revisit the doctor and had a detrimental impact on their overall satisfaction with the service (Hill and Joonas 20015). Achieving optimal efficiency in outpatient treatment requires finding a delicate equilibrium between patients' waiting times and doctors' periods of inactivity. This balance ensures that the process remains efficient while also remaining acceptable to patients.

Missing data on patient follow-up indicate the possibility of poor healthcare service delivery as doctors do not contact their patient to ensure the effect of provided treatment to the patients and patients recovery progress. The incompleteness was also found on treatment of the patients which may affect the future patient care where there is possibility of continuous treating the patient with the same cure while itis delivering nothing to the patient in terms of treatment. However, there is a study conducted in 2019 by Alwhaibi that indicate that 7% of EHRs have insufficient information about medications, which is in line with rates already documented in the literature among Canadians (Alwhaibi et al. 2019). It is possible that the type of medical treatment given to these individuals explains the incompleteness rate of pharmaceutical use. One-day surgery patients, for example, may not need any treatment interventions at the time of admission if their procedures were mild.

In addition, individuals who have sought consultation with clinical practitioners, yet haven't shown any definitive signs of illness during the appointment, health care provider are allowed to document the visit in the system as a medical note. However, it's important to note that doctors are not permitted to prescribe or administer any treatment protocols unless there is a corresponding diagnosis associated with the patient's condition. In other words, treatment orders are contingent upon a proper medical assessment and identification of the patient's health issue. To assess possible factors contributing to the incompleteness of medicine usage data, it might be necessary to validate these assumptions through the collection of primary research data (Alwhaibi et al. 2019).

For laboratory clinical document assessed throughout the study, we have noticed the missing data on different point such as sample storage, comment and conclusion with 100% data missing. We also found 60% missing information on registered patient 's contact and 80% missing data on the way of communicating with the patient either via SMS or Email. As per Weiskopf et al., the level of completeness exhibits variability based on the specific types of data incorporated. Within their research, they defined completeness in terms of the presence of five distinct categories of information commonly found in patient records. These categories encompassed laboratory results, medication orders, diagnoses, gender

information, and date of birth (Nicole G. Weiskopf et al. 2013).

Missing data about sample storage in a clinical laboratory document within an Electronic MedicalRecord (EMR) can have significant implications. It raises concerns about result reliability, as proper storage conditions are vital for maintaining sample integrity and ensuring accurate test results. Missing data hinders quality control efforts and compliance with accreditation standards, compromising the validation of laboratory results(Chan, Fowles, and Weiner 2010). It also affects result interpretation and clinical decision-making, making it challenging to assess patient conditions accurately. Investigating inconsistencies becomes difficult without knowledge of sample storage conditions, hindering issue resolution. Additionally, missing data limits the usefulness of laboratory data for research and retrospective analysis, introducing biases (Kift et al. 2015).

For radiology clinical document assessed throughout the study, we have found 100% missing data on 6 variables such as original order modified, reasons, exam reported, report, nothing unusual and abnormality found and also, we found 66.67% missing data on exam performed. It is exceptionally uncommon for a radiologist to alter an examination request, which might occur when, for instance, the patient is pregnant, and this detail hasn't been communicated to the physician. And normally the radiology reports at CHUK are conducted through an alternative system known as PACS. As a result, this data is not present in the medical imaging request/result form. Consequently, the findings can be accessed using a distinct clinical document referred to as an "archive document" (report), as well as through a "PACS study" which encompasses medical images.

Missing data in clinical radiology documents within an EMR can have significant effects. It can result in incomplete diagnostic information, hindering accurate diagnosis and compromising patient care. Treatment options may be limited due to missing data, leading to suboptimal treatments or delays in necessary interventions. Delayed or missed follow-up can occur, affecting timely detection of disease progression. Legally, incomplete radiology reports may have implications in medical malpractice claims. Missing data also may prevent research and quality improvement efforts, compromising the integrity of research findings

and impeding analysis for enhancing radiology practices and patient outcomes. Additionally, missing data limits the usefulness of radiology reports for research and quality improvement initiatives. To address this, comprehensive data capture, structured reporting templates, quality control measures, communication among healthcare providers, and regular audits are important for mitigatingthe impact of missing data in clinical radiology documents (Troude et al. 2014).

5.3 Benefit of the study and future implication

This study presents several notable advantages. To our knowledge, it stands as the pioneering endeavor to assess the completeness of the EMR-OpenClinic database in Rwanda. The research employs a substantial

sample size to gauge the accuracy of health-related information and its applicability for study through the Electronic Medical Records system (OpenClinic). Nevertheless, there exist certain limitations to consider. Notably, the study's scope is confined to a single hospital (CHUK), thereby precluding the extrapolation of results to EMR databases in other healthcare facilities due to population disparities. Various hospitals may employ distinct health information systems for electronic health records, potentially leading to variations in data entry methods, including the utilization of structured and free-text fields.

The study's discourse substantially enhances comprehension of missing data, thereby serving to augment the necessary documentation to support both clinical care and research, ultimately bolstering patient care service delivery. Given the paramount importance of information quality in patient care, stakeholders in the research and policy sectors emphasize its significance. The implementation of EMRs (OpenClinic) at CHUK offers a foundation for refining clinical practices and, by extension, the quality of care.

The findings of this study suggest that assessing data completeness within the broader context of data quality has implications for patient care service delivery, thus warranting the utilization of electronic medical record data. Policymakers have the opportunity to enhance the healthcare system's efficacy and safety by leveraging information from EMRs, thereby potentially yielding numerous advantages.

Within our study, our primary focus centered on the completeness of patient care-related data as recorded in the EMR-OpenClinic system. Consequently, researchers who intend to employ EMR data for clinical research should be cognizant of its data completeness and task-dependent data quality. Future investigations are needed to explore other facets of data quality within the EMR-OpenClinic, such as validity, currency, and accuracy.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

6.1 Conclusion

In the analysis of 2,413 data variables within clinical documents from 104 outpatients, it was observed that 57.02% of these variables had complete patient medical information filled in the fields, while the remaining 42.98% were marked as incomplete with no data entered. The study's outcomes reveal that data completeness exhibits variability based on the specific information requirements and the nature of the interaction. Notably, the EMR-OpenClinic system database is a valuable resource for assessing data completeness pertaining to patient care service delivery through clinical research. This assertion is supported by the substantial acquisition of data related to patient demographics, clinical laboratory records, clinical radiology documents, and clinical consultation documents from the EMRs database. EMRs-open clinic databases present an opportunity for conducting high-quality clinical research. These databases offer access to extensive population data collected at multiple time points and contained the information that can be used by policy makers to improve patient care service delivery. Nonetheless, there remains a need for additional research endeavors to delve into the content and completeness of EMRs concerning distinct patient populations. These studies would aim to assess various aspects of data quality within Electronic Health Records (EHRs), thereby ensuring their credibility, accuracy, and applicability in research endeavors.

6.2 Recommendation

A comprehensive approach to enhancing the completeness of Electronic Medical Records (EMRs) involves implementing several strategic measures including but not limited to the following:

Firstly, instituting policies that encourage healthcare providers to meticulously record all relevant data in the EMRs system is paramount. For example, a policy could mandate that healthcare providers record patient demographics, medical history, current medications, vital signs, diagnoses, treatments, and outcomes consistently and comprehensively in the electronic medical records (EMRs) system.

To further reinforce this effort, considering the integration of completeness of EMRs as Key Performance Indicators (KPIs) could prove instrumental. KPIs, being quantifiable metrics, offer a concrete means to assess performance and success, facilitating progress tracking and identification of areas necessitating enhancement among healthcare providers.

Additionally, an important part of the process is to ensure that certain fields must be filled out, especially in-patient assessment forms, like clinical diagnoses and treatments. When these required fields are enforced, it enhances the completeness of data, which ultimately leads to better patient care. Furthermore, establishing a routine electronic documentation audit program for EMRs can play a pivotal role in evaluating the accountability of each system user in fulfilling patient information records requirements.

As we look ahead, future research endeavors should center on scrutinizing the accuracy of specific EMR components' data. This examination should extend to vital data attributes for quality assessment, including

aspects like granularity, timeliness, and comparability. To attain a comprehensive understanding of EMR data quality, it is imperative to conduct subsequent investigations that focus on distinct patient groups. These research initiatives will delve into additional dimensions of data quality within Electronic Health Records, further enhancing the overall utility and reliability of EMRs for healthcare provision and research. (EHRs).

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7. ANNEXES

7.1 Ethical clearance from CHUK

CENTRE HOSPITALIER UNIVERSITAIRE
UNIVERSITY TEACHING HOSPITAL

Ethics Committee / Comité d'éthique

16th Mar,2023 Ref:EC/CHUK/047/2023

Review Approval Notice

Dear Samson RUKUNDO,

Your research project: ***"Assessment of Completeness of the outpatient's electronic clinical documents in EMRs (Openclinic) to enhance patient care service delivery. "***

During the meeting of the Ethics Committee of University Teaching Hospital of Kigali (CHUK) that was held on 16th Mar,2023 to evaluate your request for ethical approval of the above mentioned research project, we are pleased to inform you that the Ethics Committee/CHUK has approved your research project.

You are required to present the results of your study to CHUK Ethics Committee before publication by using this link:www.chuk.rw/research/fullreport/?appid=700&&chuk.

PS: Please note that the present approval is valid for 12 months.

Yours sincerely,

Dr Emmanuel Rusingiza Kamanzi
The Chairperson, Ethics Committee,
University Teaching Hospital of Kigali

ETHICS COMMITTEE
CHUK

Scan code to verify.

" University teaching hospital of Kigali Ethics committee operates according to standard operating procedures (Sops) which are updated on an annual basis and in compliance with GCP and Ethics guidelines and regulations "

Web Site : www.chuk.rw ; B.P. 655 Kigali- RWANDA Tel.: 00 (250) 252575462 E-Mail: chuk.hospital@chuk.rw

7. 2 Ethical clearance from UR/CMHS

UNIVERSITY of RWANDA

COLLEGE OF MEDICINE AND HEALTH SCIENCES

DIRECTORATE OF RESEARCH & INNOVATION

CMHS INSTITUTIONAL REVIEW BOARD (IRB)

Kigali, 14/11/2022
Ref: CMHS/IRB/526/2022

RUKUNDO Samson
Health Informatics Program,
Center of Excellence in Biomedical Engineering and E-Health (CEBE)
CMHS, UR

Dear RUKUNDO Samson,

RE: ETHICAL CLEARANCE

Reference is made to your application for ethical clearance for the study entitled *"Assessment of completeness of the outpatient's electronic clinical documents in EMR to enhance patient care service delivery/ case study: CHUK"*.

Having reviewed your application and been satisfied with your protocol, your study is hereby granted ethical clearance. The ethical clearance is valid for one year starting from the date it is issued and shall be renewed on request. You will be required to submit the progress report and any major changes made in the proposal during the implementation stage. In addition, at the end, the IRB shall need to be given the final report of your study.

We wish you success in your important study.

Assoc. Prof. Stefan Jansen, PhD
Acting Chairperson Institutional Review Board,
College of Medicine and Health Sciences, UR

Cc:

- Principal College of Medicine and Health Sciences, UR
- University Director of Research and Postgraduate studies, UR

Email: researchcenter@ur.ac.rw P.O Box 3286 Kigali, Rwanda www.ur.ac.rw

7.3 Data Collection Form

CLINICAL RECORDS DATA COLLECTION TOOL					
		Date of data collection			
		Department			
		Patient ID			
		Admission date			
			Status	Comments	Total
		OUTPATIENT'S DETAILS			
A	1	Patient ID			0
	2	Age/DoB			
	3	Department/Unit/Ward			
	4	Responsible/ Doctor			
		CONSULTATION CLINICAL DOCUMENTS			
B	a	Vital Sign			0
	1	Temperature			
	2	Height			
	3	Weight			
	4	SP02			
	5	Blood Pressure			
	6	BCF			
	7	Respiratory rate			
	8	Heart rate			
	b	Patient assessment documentation			
	1	Type of patient on arrival			
	2	Doctor's call			
	3	Doctor arrival			
	4	History and anamnesis			
	5	Physical exam			
	6	Differential diagnosis			
	7	Clinical summary			
	8	Technical Exams and result			
	9	Treatments			
	10	Final diagnosis			
	11	Patient cfollow-up or Education			
	12	Comment			
	13	Evolution			

		LABORATORY DOCUMENT			
C	1	Date			0
	2	Patient ID			
	3	Sample			
	4	Sample time			
	5	Document ID			
	6	Phone Number			
	7	Sample storage			
		Freezer			
		Box			
		Position			
	8	Clinical Information			
	9	Conclusion			
	10	Comment			
	11	Emmergence request			
	12	Send SMS or Email notification to			

		RADIOLOGY DOCUMENT			
D	1	Date			0
	2	Patient ID			
	3	Identification number			
	4	Specimen reception date			
	5	Reported date			
	6	Physician			
	7	Adress			
	8	Position			
	9	Anatomical location			
		System			
		Organ			
		Details			
	10	Procedure type			
	11	Clinical data			
	12	Gloss description			
	13	Microscopic examination			
	14	Conclusion			

Save

+ Form Dump Sheet5