Need assessment and requirements for Blood Transfusion System integration with EMR-OpenClinic GA at CHUK

By

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DECLARATION

I, DUSHIME Esperance, declare that this research proposal titled "**Need assessment and requirements for blood transfusion system integration with EMR-openclinic GA at CHUK"** submitted in fulfillment of University of Rwanda academic rules and regulations for the Master's degree in Health Informatics; is my original work and it has never been presented elsewhere (in any universities or institution of higher learning) for any purpose. And we do declare that all cited information is shown in the provided list of references as indicators of the sources. Publication is granted to the University of Rwanda/College of Medicine and Health Sciences for academic interest.

DUSHIME Esperance

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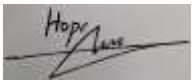

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Date: 8th September 2023

DEDICATION

This work is warmly dedicated to the Almighty God for the gift of life and love, my families especially my lovely parents, my sisters, brothers and my friends for their extraordinary support and care. What is more, I am dedicating this work to my charming classmates with whom I have been together with in my studies all along. Finally, I would like to dedicate this task to my lecturers, supervisors and career guiders I met across during studies for the knowledge, skills and attitude that they have shared.

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ABSTRACT

Introduction

Blood transfusion is an important aspect of healthcare that requires proper management to ensure patient safety. Electronic Medical Records (EMR) have been introduced to enhance healthcare delivery, but integration with blood transfusion systems is still lacking in many hospitals. This qualitative study aimed to assess the need and requirements for integrating the Blood Transfusion System (BTS) with the EMR-OpenClinic GA at CHUK. The Purpose of this study is to identify the necessary functionalities, technical specifications, and operational considerations for successful integration with designing the workflow of the process and it applications for integration. This research intends to improve the coordination, accuracy, and efficiency of blood transfusion processes, ultimately enhancing patient care and safety at the hospital.

Methods

This qualitative study used in-depth interviews of 30 healthcare professionals at CHUK, including doctors, lab technicians, and IT personnel with purposive sampling method. The interviews were conducted using a semi-structured questionnaire that explored the need and requirements for integrating of the BTS with the EMR-OpenClinic GA. The interviews were audio-recorded, transcribed verbatim, and analyzed thematically.

Results

The study found that the current blood transfusion system at CHUK faced several challenges, including incomplete or missing documentation, inadequate tracking and tracing of blood products, and limited communication between departments. The integration of the BTS with the EMR-OpenClinic GA was seen as a potential solution to address these challenges. The main requirements identified by the participants for BTS-EMR integration included real-time data entry, traceability of blood products, integration with laboratory systems, and accessibility of patient information.

Conclusion

The findings of this study highlight the need for integrating the BTS with the EMR-OpenClinic GA at CHUK. The integration of these systems can address the challenges associated with the

current blood transfusion system, leading to improved patient safety and healthcare delivery. The study identified key requirements for BTS-EMR integration. These findings can inform decision-makers in the implementation of the BTS-EMR integration at CHUK and other healthcare institutions.

Key words: Blood transfusion, OpenClinic GA, integration, Electronic Medical Record

LIST OF ABBREVIATIONS

CEBE: Center of Excellence in Biomedical Engineering and E-health

CHUK: University Teaching Hospital Of Kigali

EMRs: Electronic Medical Records

EBT: Electronic Blood Transfusion

RBCs: Red Blood Cells

BTS: Blood transfusion service

WHO: World health organization

ICU: Intensive Care Unit

OBS&GYN: Obstetric Gynaecology

PED: Paediatric

MED: Internal Medicine

MoH: Ministry of Health

RBC: Rwanda Biomedical Center

NCBT: National Center for Blood Transfusion

IT: Information Technology

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CHAPTER ONE: INTRODUCTION AND BACKGROUND

1.1 Introduction

This chapter serves as an introduction to the study on the need assessment and requirements for integrating the Blood Transfusion System with the EMR-OpenClinic GA at the CHUK. It begins by providing an overview of the background and significance of efficient blood management within healthcare systems. The chapter then outlines the objectives, scope, and significance of the research. Furthermore, it presents a brief overview of the EMR-OpenClinic GA and its potential benefits in streamlining blood transfusion processes.

1.2 Background

Blood transfusion is a crucial part of modern medical care, saving millions of lives each year. However, despite the numerous benefits, it can pose a significant risk to the patient if not done properly. Electronic medical records (EMRs) are a vital tool in modern healthcare, providing healthcare professionals with comprehensive and accurate patient information. Integrating blood transfusion systems with EMRs can reduce errors and improve patient safety by providing real-time access to vital information. [1]

Globally, the first idea of practical blood transfusions came about within the 1600s; however, blood transfusions did not become routine procedures until World War. Blood transfusion is a common medical procedure that involves the transfer of blood or blood products from one individual (the donor) to another (the recipient). According to the World Health Organization (WHO), an estimated 118.4 million blood donations are collected globally each year, with 40% of these donations occurring in high-income countries. [2] In low- and middle-income countries, the availability and safety of blood transfusions are a significant concern. In Rwanda, the demand for blood transfusions is high due to the high prevalence of infectious diseases, maternal complications, and road accidents. However, the country faces challenges such as inadequate resources, lack of adequate infrastructure, and inadequate training of healthcare professionals. [3]

The use of EMRs in healthcare has become increasingly popular over the years, with many countries adopting the system. EMRs provide healthcare professionals with comprehensive patient

information, including medical history, allergies, medications, and laboratory results, among others. According to a survey conducted by the Centers for Disease Control and Prevention (CDC), 86.9% of office-based physicians in the United States use EMRs. [4]

In Africa, blood transfusion practices have evolved since the 1940s, with rates reaching levels comparable to the Western world, particularly in urban areas. However, the post-independence period, especially the 1970s, witnessed civil wars and political instability, leading to a decline in basic social services, including healthcare and blood transfusion services. The adequacy of blood supply and the quality of service suffered as a result. [5]

Monitoring blood product inventory and managing transfusion processes in African healthcare facilities has traditionally relied on manual methods, such as physical counts and written reports. This approach is time-consuming and prone to errors, potentially resulting in expired blood units. Many hospitals in Africa are now adopting or planning to implement information technology systems to enhance the quality of patient care.[6]

In Rwanda, the government has implemented an EMR system known as the OpenClinic GA. The system is widely used in healthcare facilities, including the CHUK. However, the blood transfusion system at the CHUK is not integrated with the OpenClinic GA, leading to potential errors and delays in patient care. [3]

To improve efficiency and reduce errors, it is essential to address the challenges associated with manual processes, illegible documentation, and delays in communication. Implementing electronic systems can help overcome these issues and ensure the timely delivery of critical clinical information while minimizing resource wastage. By streamlining the blood transfusion process and ensuring compliance with regulations, healthcare professionals can provide better care to patients. [7]

The integration of blood transfusion systems with EMRs can provide healthcare professionals with real-time access to critical patient information, reducing the risk of errors and improving patient outcomes. According to a study conducted on the implementation of a computerized physician order entry (CPOE) system, which is a type of EMR, reduced the risk of transfusion-related errors by 50%. Another study showed that the integration of a blood transfusion system with an EMR

improved patient safety, reduced errors, and enhanced the overall efficiency of the healthcare system. [8]

1.3 Problem statement

Blood transfusion is a critical medical intervention that requires accurate documentation and monitoring to ensure patient safety. Inadequate blood transfusion services can lead to severe complications, including death. Low-income countries like Rwanda face significant challenges in providing safe and accessible blood transfusion services due to inadequate resources and infrastructure. According to the World Health Organization (WHO), Rwanda collects only 30% of its annual blood supply needs, leading to a severe shortage of blood products. [9]

In addition to the shortage of blood products, Rwanda also faces challenges in adopting electronic medical records (EMRs) due to limited resources and infrastructure. EMRs have been developed to provide healthcare professionals with comprehensive patient information, including medical history, allergies, medications, and laboratory results. The adoption of EMRs has been slow in low- and middle-income countries, with only 34% of healthcare facilities in sub-Saharan Africa using EMRs. [10]

The CHUK is one such healthcare facility in Rwanda that can benefit significantly from integrating blood transfusion systems with EMRs. Currently, the blood transfusion system at the CHUK is not integrated with the OpenClinic GA system, leading to potential errors and delays in patient care. The lack of integration between the two systems can result in incomplete or inaccurate patient information, increasing the risk of transfusion-related adverse events.

The integration of blood transfusion systems with EMRs can improve patient safety, reduce errors, and enhance the overall efficiency of the healthcare system. Found that the integration of a blood transfusion system with an EMR can reduce the incidence of transfusion-related adverse events by up to 30%. However, the integration process requires a thorough assessment of the needs and requirements of the healthcare facility. [11]

In conclusion, the shortage of safe and accessible blood transfusion services and the slow adoption of EMRs in low- and middle-income countries pose significant challenges to the provision of quality healthcare. The lack of integration between blood transfusion systems and EMRs at the CHUK increases the risk of transfusion-related adverse events and delays in patient care. [11]

Therefore, it is essential to assess the needs and requirements for the integration of the blood transfusion system with the OpenClinic GA system at the CHUK to improve patient safety and enhance the overall efficiency of the healthcare system.

1.4 Research Objectives

1.4.1 Main Objective

The main objective of this study is to assess the needs and requirements for integrating the Blood Transfusion System with the EMR-OpenClinic GA, while designing an optimized workflow process that ensures seamless integration, improved efficiency, and enhanced patient safety within the hospital's context.

1.4.2 Specific Objectives

- To identify the challenges related to integrating the BTS into EMR-Open clinic at the CHUK?
- To determine the specific requirements for the integration of the blood transfusion system with EMR-OpenClinic GA.
- To design the application of blood transfusion management system.

1.4.3 Research Questions

- What are the challenges related to integrating the BTS into EMR-Open clinic …in the current blood transfusion system at the CHUK?
- What are the specific requirements for the integration of the blood transfusion system with EMR-OpenClinic GA at the CHUK?
- What are the main features/components of the application to integrate BTS into EMR-open clinic?

1.5 Significance of the Study

The integration of blood transfusion systems with EMRs at CHUK has significant global and personal interests. Globally, this study is significant because it addresses a critical need for safe

and accessible blood transfusion services in low-income countries like Rwanda. The World Health Organization warns that low-income countries face challenges due to blood product shortages, limited resources, and the risk of transfusion-transmissible infections, such as HIV, hepatitis B and C, and syphilis.[12] In addition, the WHO estimates that globally, 5% to 10% of patients receiving blood transfusions experience adverse events, many of which are preventable. The integration of blood transfusion systems with EMRs can improve patient safety, reduce errors, and enhance the overall efficiency of the healthcare system, not only in Rwanda but globally.

On a personal level, the integration of blood transfusion systems with EMRs at the CHUK can significantly benefit healthcare providers and patients. Healthcare providers can have access to comprehensive patient information, including medical history, allergies, medications, and laboratory results, leading to improved patient care and better clinical decision-making. Patients can also benefit from the integration of blood transfusion systems with EMRs by receiving timely and accurate care, reducing the risk of transfusion-related adverse events.[13]

In Rwanda, the integration of blood transfusion systems with EMRs is particularly significant due to the shortage of blood products and the slow adoption of EMRs. Rwanda has made significant progress in improving its healthcare system in recent years, but challenges remain, including limited resources and infrastructure. According to a study by the Ministry of Health Rwanda (2020), only 28% of healthcare facilities in Rwanda have adopted EMRs, indicating a significant gap in the healthcare system's digitalization. [9]

The integration of blood transfusion systems with EMRs can improve the efficiency of healthcare facilities in Rwanda and reduce the risk of transfusion-related adverse events, ultimately leading to improved patient outcomes. The integration of blood transfusion systems with EMRs in Ethiopia improved the accuracy of patient information, reduced the time required for transfusion-related tasks, and reduced the incidence of transfusion-related adverse events by 66%. [14]

In conclusion, the integration of blood transfusion systems with EMRs at the CHUK has significant global and personal interests. The shortage of blood products and inadequate resources and infrastructure for blood transfusion services in low-income countries pose significant challenges to healthcare providers, increasing the risk of transfusion-related adverse events. The integration of blood transfusion systems with EMRs can improve patient safety, reduce errors, and enhance the overall efficiency of the healthcare system, ultimately leading to improved patient outcomes.

1.6 The Scope of Study

The scope of this study on the integration of the Blood Transfusion System with the EMR-OpenClinic GA and designing the workflow process at CHUK encompasses several key areas. Firstly, it involves conducting a comprehensive need assessment to identify the existing challenges and gaps in the blood transfusion process. Secondly, it aims to determine the specific requirements for integrating the Blood Transfusion System with the EMR-OpenClinic GA while considering the hospital's unique workflow and processes. Additionally, the study focuses on designing an optimized workflow process that ensures seamless integration, improved efficiency, and enhanced patient safety. The findings and recommendations of this study will aid in successfully implementing the integrated system at the CHUK

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents a comprehensive literature review on the integration of a Blood Transfusion System with the EMR-OpenClinic GA at the CHUK. The review aims to gather relevant information, research findings, and best practices related to the integration of these systems. It focuses on studies conducted in Africa and globally to provide a broader perspective. This chapter discusses the benefits, challenges, implementation strategies, and outcomes of such integration.

2.2 Blood Transfusion Systems

2.2.1 Definition and Purpose

Blood transfusion is a crucial aspect of medical science, providing life-saving treatments to patients in need. In the absence of transfusion medicine, maternal deaths resulting from obstetrical hemorrhages, anemia in pediatric cases due to malaria and other parasites, and fatal bleeding during surgical procedures would be more prevalent. Additionally, the advancements in cardiac surgery and chemotherapy in developed countries heavily rely on the availability of large quantities of blood. [15]

While blood transfusion is essential, it is not without risks. Transfusion complications, including immunological reactions and transfusion-transmitted diseases, pose significant dangers to patients' lives. Therefore, ensuring the safety of transfusions is of utmost importance. [16]

2.3 Blood Transfusion in Rwanda

In the case of Rwanda, blood transfusion plays a critical role in providing care to patients, particularly children and pregnant women. Each year, more than 83,000 units of blood components are transfused to address various medical conditions, such as hemorrhagic obstetrical complications, malaria, surgery, and chronic diseases. To meet the transfusion needs of the population, at least 68,000 blood units must be collected annually. According to the World Health Organization (WHO), in 2018, Rwanda reported an estimated 91,000 blood donations. Furthermore, the National Center for Blood Transfusion (NCBT) aims to collect approximately 68,000 blood units annually to meet the transfusion needs of the population. However, it is

important to note that this number may increase as healthcare services in Rwanda continue to improve in terms of quality and accessibility. [17]

Currently, Rwanda falls short of the World Health Organization's recommendation of 10 blood collections per 1,000 population, with only 5.7 collections per 1,000. As a result, the National Centre for Blood Transfusion in Rwanda is dedicated to increasing the collection of blood units to meet the growing demand. It is crucial to prioritize the collection of high-quality blood, minimizing the risk of contamination and implementing measures to prevent complications. [3]

To address the challenges associated with blood transfusion, Rwanda has implemented various strategies. These include enhancing public awareness about blood donation, organizing regular blood drives, establishing stringent screening and testing protocols for donated blood, and improving infrastructure and equipment for safe blood storage and transportation. Furthermore, collaboration with international partners and organizations can help Rwanda enhance its transfusion services and ensure better patient outcomes. [3]

2.4 Introduction to EMR-OpenClinic GA

EMR-OpenClinic GA is an open-source software designed for efficiently managing hospital information workflows. This initiative was initiated in 2006 by a collaborative team of medical professionals and IT experts associated with the Belgian firm Medical Exchange Solutions. In December 2008, the source code was released into the public domain. Since then, OpenClinic has been available for free download via SourceForge. It is a comprehensive integrated hospital information management system encompassing administrative, financial, clinical, laboratory, radiology, pharmacy, meal distribution, and various other data management aspects. It boasts extensive statistical and reporting capabilities [18].

EMR-OpenClinic has been successfully deployed across more than 25 sites in Africa, including hospitals in Rwanda, Burundi, the Democratic Republic of the Congo, Mali, and Burundi. These deployments cater to institutions ranging from small facilities with five users to large hospitals with up to 700 users. This system has also found utility in various countries around the world, including Albania, Bangladesh, Belgium, Benin, Brazil, Cameroon, Gabon, Ivory Coast, Kenya, Niger, Nigeria, Senegal, Uganda, Peru, Sri Lanka, Tanzania, and Zambia [19].

Additionally, OpenClinic represents an integrated Hospital Information System comprising a series of modules built on the Open IT Medical Information Architecture (OpenMIA). This system streamlines information management for fundamental functions in small to medium-sized hospitals, ranging from 50 to 1,000 beds. Open Clinic has been crafted through more than 15 years of expertise, drawing upon the collaboration of computer engineers and medically trained professionals with advanced ICT training at MXS (Belgium). The OpenMIA architecture and OpenClinic modules have been entirely re-envisioned and reprogrammed using the Java programming language, one of the world's most popular programming languages today. Just as with the source code for OpenClinic, the OpenMIA architecture is also freely accessible to the public since December 9, 2008 [18].

2.5 Features of EMR-OpenClinic GA e-Health system.

2.5.1 Comprehensive Hospital Management

EMR-OpenClinic GA is a versatile and comprehensive solution tailored to meet the specific needs of limited-resource hospitals. With its multilingual support in English, French, Dutch, Spanish, and Portuguese, it ensures accessibility to healthcare professionals regardless of their language preferences. What sets it apart is its high degree of customization, allowing users to adapt it to their unique requirements through Java class extensions. This adaptability makes it an ideal choice for various healthcare settings, offering a seamless integration of billing and insurance management to streamline financial operations. The system provides sophisticated statistical analysis, empowering healthcare providers with valuable insights into mortality, co-morbidity, and the costs associated with patient care, thus enhancing decision-making and patient outcomes. Additionally, it simplifies human resource management and resource scheduling, optimizing patient care coordination.[18]

2.5.2 Precision in Clinical Management

EMR-OpenClinic GA excels in clinical management with its robust clinical thesaurus and coding support. It incorporates a 3BT clinical thesaurus with validated coding aids for ICD-10 and ICPC2, and supports SNOMED CT coding for diagnoses. These coding capabilities ensure accurate and standardized data entry in clinical settings, improving the quality of patient care. Furthermore, the system offers comprehensive lab order entry and results management, including LOINC coding

support, enhancing the efficiency of laboratory operations. It efficiently manages X-ray and pathology results, providing healthcare providers with easy access to critical diagnostic information. The complete Admission, Discharge, and Transfer (ADT) management capabilities ensure accurate patient records, while the inclusion of multimedia elements enriches the comprehensiveness of patient information.

2.5.3. Security, Affordability, and Support

EMR-OpenClinic GA prioritizes security with user authentication through fingerprint identification using the Digital Persona library, adding an extra layer of protection to sensitive healthcare data. It also addresses financial concerns by offering unlimited free usage, accommodating an unrestricted number of users, patients, and beds, making it a cost-effective solution for healthcare facilities of all sizes. Moreover, ongoing support from Medical eXchange Solutions ensures users receive assistance and guidance whenever needed. As an open-source software solution, EMR-OpenClinic GA eliminates licensing costs, making it an affordable and accessible option for hospitals seeking to enhance their information management capabilities while prioritizing data security and comprehensive patient care.[19]

2.6 Blood bank management systems

A blood bank management system is a software solution used in hospitals and healthcare institutions to effectively manage all aspects of blood banking operations such as collecting, separating, and storing the blood, which will later use in blood transfusion process, Blood bank management systems in hospitals are crucial for maintaining a safe and efficient blood supply. These systems encompass a range of features to facilitate the collection, processing, storage, and distribution of blood and blood products. [20]

One key feature is inventory management, which involves tracking the availability and expiration dates of blood units. This ensures an adequate supply of blood products, minimizing the risk of shortages. Additionally, advanced tracking systems enable the identification of specific blood units for traceability purposes, aiding in the event of recalls or adverse events. Furthermore, blood bank management systems incorporate robust quality control measures to monitor the integrity and efficacy of blood products. This includes rigorous testing for infectious diseases, compatibility

checks, and proper storage conditions to maintain product viability. It helps monitor stock levels, issue alerts for low inventory, and manage the rotation of blood units to minimize wastage. [6]

2.7 Benefits of Blood Transfusion System Integration

2.7.1 Improved Patient Safety

Integration of the Blood Transfusion System with the EMR-OpenClinic GA enhances patient safety by providing real-time access to critical information. Studies have shown that real-time data availability reduces the risk of errors and adverse events during blood transfusion procedures [11]

2.7.2 Enhanced Data Accuracy

Integration eliminates manual data entry and improves data accuracy. Automatic data exchange between systems reduces transcription errors and ensures consistency between the Blood Transfusion System and the EMR. [21]

2.7.3 Streamlined Workflow

Integration streamlines blood transfusion processes and improves workflow efficiency. Automating tasks such as ordering, cross-matching, and administration reduces manual effort and potential delays. [22]

2.7.4 Improved Traceability and Accountability

Integration facilitates better traceability of blood products, ensuring accurate documentation and improved inventory management. Real-time tracking of blood products from the point of collection to administration enhances accountability [23]

2. 8 challenges and Considerations

2.8.1 Technical Compatibility

Integrating disparate systems requires addressing technical compatibility challenges, including data formats, communication protocols, and interoperability standards ensuring compatibility between the Blood Transfusion System and the EMR is crucial for successful integration. Integrating a Blood Transfusion System with an Electronic Medical Records (EMR) system

presents technical challenges that must be overcome for successful integration. These challenges include the standardization of data formats to ensure compatibility and interoperability, the establishment of bidirectional interfaces and integration points between the two systems such as Health Level Seven (HL7), is essential for seamless integration, and the synchronization of data to maintain consistency and accuracy. Overcoming these challenges requires careful planning, coordination, adherence to technical standards, and effective synchronization processes. By addressing these challenges, healthcare systems can achieve seamless integration, improve patient care, and enhance operational efficiency. [24]

2.8.2 Security and Privacy

Integration raises concerns about data security and patient privacy. Protecting sensitive patient information through secure data transmission and adherence to privacy regulations is essential. [24]

2.8.3 User Acceptance and Training

Successful integration relies on user acceptance and effective training programs. Involving healthcare professionals in the design and implementation process and providing comprehensive training are crucial for smooth adoption [25]

2.8.4 Workflow Redesign

Integration often requires reengineering existing workflows to align with new processes and system capabilities. Collaborating with clinical and technical teams to identify workflow gaps and streamline processes is vital for successful implementation.[26]

2.9 Organizational Challenges

Integration also presents organizational challenges that should be considered during the implementation process:

- Change management: Implementing an integrated system requires significant changes in workflows, responsibilities, and processes, necessitating effective change management strategies to ensure user acceptance and adoption.[27]

- Training and education: Healthcare professionals need to be adequately trained on the new integrated system to understand its features, functionality, and benefits. Training programs should be developed and implemented to support successful integration.[28]
- Governance and coordination: Clear governance structures, roles, and responsibilities should be established to facilitate effective integration. Collaboration and coordination among stakeholders, including IT staff, clinicians, and administrators, are essential for successful implementation.[29]

2.10 Requirements for Integration

2.10.1 Technical Requirements

To ensure successful integration, the following technical requirements need to be considered:

- **Compatibility with EMR system**: The Blood Transfusion System should be compatible with the EMR-OpenClinic GA system used at CHUK, adhering to the technical standards and interfaces supported by the EMR system.
- **Data integration and exchange**: The integration should enable seamless and real-time data exchange between the Blood Transfusion System and the EMR system, allowing access to transfusion-related data within the EMR system.
- **System scalability and performance:** The integrated system should be able to handle the anticipated volume of transfusion-related data and provide efficient performance without compromising system stability. [30]

2.10.2 Functional Requirements

The following functional requirements are crucial for the successful integration of the Blood Transfusion System with the EMR system:

- **Patient identification and matching:** The integrated system should accurately match patients' transfusion-related data with their EMR records, ensuring patient safety and data integrity.

- **Order management:** The system should support electronic ordering of blood and its components, with automated alerts for critical values and decision support based on patient-specific information.
- **Clinical records management.** Should be effectively store, retrieve, and manage patient information, ensuring accurate and comprehensive documentation. The software ensures streamlined access, organization, and storage of clinical records to enhance patient care and facilitate informed decision-making for healthcare professionals.
- **Inventory management:** The integrated system should provide real-time visibility of blood product availability, expiration dates, and utilization patterns, facilitating effective inventory management and minimizing waste. [31]

2.11 Systematic Review

A systematic review on blood transfusion system integration identified multiple benefits, including increased patient safety, improved data accuracy, enhanced workflow efficiency, and enhanced inventory management. The review emphasized the need for standardized data exchange formats and interoperability standards. [32]

2.12 Critical Analysis and Gaps

The existing literature provides valuable insights into the integration of Blood Transfusion Systems with EMR systems. However, there are some gaps that merit further investigation.

2.13 Cost and Return on Investment

Limited studies have focused on the cost-effectiveness and return on investment of integration projects. Further research is needed to assess the financial implications, long-term benefits, and sustainability of such integrations.[33]

2.14 Long-Term Impact on Clinical Outcomes

Although integration has demonstrated benefits in terms of patient safety and workflow efficiency, more research is needed to assess the long-term impact on clinical outcomes, such as transfusion-related adverse events and patient satisfaction.

2.15 Implementation Challenges in Resource-Constrained Settings

Integration may present unique challenges in resource-constrained settings, such as the CHUK. Further research should address strategies for successful integration in such contexts, considering infrastructure limitations, training needs, and cost constraints.

2.16 User Experience and Acceptance

User experience and acceptance play a vital role in the success of integration projects. Future research should focus on user perceptions, challenges faced during adoption, and strategies to improve user acceptance and satisfaction.[34]

2.17 Summary of the literatures

AUTHORS	***PAPERS***	***THEIR CONTRIBUTIONS***	***GAPS***	***MY CONTRIBUTIONS***
Hisham F Bahmad, MD, Kei Shing Oh, MD, Ruben Delgado, MD, Roshanak Azimi, MD, Esperanza Olivares, BS, MT, SBB, Robert Poppiti, MD, Lydia Howard, MD, Sarah Alghamdi, MD	Improving documentation of blood product administration using a standardized electronic health record–based system: a single-institution experience **(15 May 2023)**	Implementation of a standardized EHR-based system to improve documentation of blood product administration	Limited discussion on users' adoption and their perceptions on blood transfusion system.	Exploration of the user experience and workflow implications of integrating EMR and transfusion systems
Brad Morse1 Tyler Anstett2 Neelam Mistry2 Samuel Porter2 Sharon	User-Centered Design to Reduce Inappropriate	Application of user-centered design principles to reduce	Potential lack of holistic assessment of implementation	Investigating of the integration requirements for blood

Pincus3 Chen-Tan Lin1 Sylvie Novins-Montague3 P.	Blood Transfusion Orders **(2023)**	inappropriate transfusion orders	challenges and considerations.	transfusion system with EMR
Philip Crispin1,2,3 | Christine Akers1,4 | Kristen Brown1,5 | Alana Delaforce1,6,7,8 | Anastazia Keegan1,9,10 | Fiona King1,11 | Amanda Ormerod1,12 | Trudi Verrall1,13	A review of electronic medical records and safe transfusion practice for guideline development **(1 September 2021)**	Identification of gaps and challenges in the use of EMRs for safe transfusion practice	Potential lack of discussion on specific EMR/BTS functionalities and features for safe transfusion practice to be integrated	Evaluation of workflow processes and system design for seamless integration

2.18 Conclusion

The literature review highlights the significant benefits of integrating a Blood Transfusion System with the EMR-OpenClinic GA at the CHUK. Improved patient safety, enhanced data accuracy, streamlined workflow, and improved traceability and accountability are the key advantages. However, challenges related to technical compatibility, security, user acceptance, and workflow redesign must be carefully addressed. Case studies from Africa and globally demonstrate successful outcomes, supporting the feasibility and effectiveness of integration. By considering the findings and best practices identified in the literature, this thesis will contribute to the successful implementation of the integration project at the CHUK.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter describe the methods used to achieve the research objectives. It presented the research design and strategy used, the target population for the study, and the sample size. The study setting, data collection procedure, data management, and analysis are also discussed. The study was conducted at Kigali University Teaching Hospital (CHUK), which is located in the capital city of Rwanda, Kigali city, Nyarugenge District.

3.2 Study setting

The CHUK, as the largest hospital situated in the Nyarugenge District, located at KN 4 Ave in Kigali City, Rwanda. This healthcare institution boasts a considerable capacity, offering a total of 519 beds, making it the largest referral hospital in the country.

Established in 1918, CHUK has consistently delivered high-quality healthcare services to the local population. Beyond its primary role as a healthcare provider, CHUK also plays a pivotal role in training healthcare professionals, conducting clinical research, and offering technical support to district hospitals. As a result, it stands as a preeminent healthcare facility in Rwanda, catering to the healthcare needs of a substantial portion of the population.

The integration of blood transfusion systems with the EMR-OpenClinic GA can enhance patient safety, reduce errors, and improve the overall efficiency of the healthcare system.

3.3 Study design

The study design used in our research study was the documentation method, where we chose a qualitative research approach one by one interview. This method helped us to explore the current workflow process of the blood transfusion process, the situation, the problems, and the attitudes. The hospital selected is registered under the Rwanda Ministry of Health.

3.4 Study population and sample

The study population mainly included the laboratory department (4 Lab Technicians), a total of 22 physicians, one physician from each of the following departments Surgery, Obstetrics and Gynecology, Pediatrics, Neonatology, Medicine, Intensive Care Unit, Emergency Medicine at

Kigali University Teaching Hospital (CHUK), and 4 IT personnel. I chose to work with these individuals because they are the ones involved in the transfusion services in the hospital, which is purposive sampling strategy. Additionally, I preferred to conduct research in these departments because is where we find patients in need of blood. The IT personnel were included to assist with technical requirements for the integration of the blood transfusion system in EMR-OpenClinic at CHUK.

3.5 Data collection procedures

Data were collected through interviews with the participants. The tool for collecting data involved using an interview guide. The participants' data was retrieved from the archives of data collected during working hours, Participants were first presented with approve letter from CHUK ethics committee and consent form. Once the consent forms were signed and the respondents were ready, the interviews began. We recorded their opinions to avoid losing the main ideas. Furthermore, a note-taker took summary notes and observations. Each interview lasted for 10 to 30 minutes. The collected data were cleaned, and verbatim transcriptions were made, we use mixed languages some responding in Kinyarwanda other in English. Later, the transcriptions were translated into English for analysis using thematic content analysis.

3.6 Data management and analysis

Qualitative data were analyzed using an interpretative approach, which explained the meaning of words and actions, and an iterative approach, which involved repetition of uttered words, to interpret the results. Transcription of recordings and typing of field notes were done soon after each data collection event. Thematic data analysis allows for a systematic exploration and interpretation of qualitative data, offering valuable insights into the need assessment, requirements, and design considerations for integrating the BTS

To support and illustrate the findings, quotes or quotations from the participants' responses were utilized. These quotes served as concrete examples, providing direct insights and perspectives from the participants. By incorporating quotes, the study enhanced the credibility and richness of the findings, allowing for a more comprehensive understanding of the data and its implications. This approach enhanced the validity and depth of the findings, facilitating a comprehensive understanding of the integration and workflow process considerations in the hospital setting.

3.7 Ethical considerations

The scientific and ethical approval for conducting the research was granted by Institutional Review Board of the University of Rwanda College of Medicine and Health Sciences. Informed consent forms were signed by each participants willing to participate before the interviews started. Participation in the study was on a voluntary basis, and confidentiality of the participants' identities was assured by using codes instead of real names. No patients' identification were used in the study.

3.8 Anticipated outputs

The findings of this work showed the existing workflow of blood transfusion services processes, especially the routine challenges faced, from which the system requirement specifications were derived. Furthermore, this helped understand the benefits of using a blood transfusion system and its integration in EMR-OpenClinic GA, which may result in improved data quality and validity.

3.9 Potential impact

The implementation of a digital technology for the blood transfusion system eliminated issues related to the lack of information, as there was no longer a need to store a large volume of paper records or files. It also improved the speed of services at CHUK and prevented data loss.

CHAPTER FOUR: FINDINGS

4.1 Introduction

This chapter presents the findings of the study conducted on the topic of "Need Assessment and Requirements for Blood Transfusion System Integration with EMR-OpenClinic GA" at the CHUK. The chapter delves into the extensive research and analysis carried out to identify the specific needs and requirements for seamlessly integrating the blood transfusion system with the existing electronic medical records (EMR) system. The findings shed light on crucial insights and recommendations that will aid in the successful implementation of this integration, ultimately enhancing the efficiency and effectiveness of patient care.

4.2 Socio-Demographic information

Thirty participants were included, of which the majority (22) were medical doctors, (4) were medical laboratory, and (4) were OpenClinic IT ‘personnel

4.2.1 Socio-Demographic characteristic of participants

Table 1: Socio-Demographic characteristic of participants

Variable	***Characteristics***
Age (Years)	25-34
	35-44
	45-55

The table displaying the age reveals that the majority of individuals fall within the 35-44 age range. the inclusion of participants from the 25-34 and 45-55 age ranges provides a comprehensive perspective on the diverse user base and aids in designing a system that accommodates a wider age spectrum.

4.2.2 Number of experience characteristic of participants

Table 2Number of experience characteristic of participants

Variable	***Characteristics***

Number of experience	0-4
	4-9
	9-10
	10-20

The table provides insights into the distribution of years of experience among participants. Notably, a significant proportion falls within the 4-9 years category, indicating a substantial number of individuals with moderate expertise. This information highlights the importance of considering the specific needs and skill levels of users with varying levels of experience when implementing the integrated system. Additionally, participants with experience ranging from 0-4, 9-10, and 10-20 years contribute to a comprehensive understanding of the user base, facilitating the development of a system that caters to a diverse range of professional backgrounds.

4.2.3 Education level characteristic of participants

Table 3Education level characteristic of participants

Variable	***Characteristics***
Education Level	Bachelor’s degree
	Masters
	PHD

The table illustrates the participants' education levels. It is evident that the majority possess a Bachelor's degree, while have a Master's degree. Interestingly, there were no participants with a Ph.D. This data emphasizes the significance of tailoring the system's design and training materials to accommodate users with diverse educational backgrounds, ensuring its accessibility and usability for both Bachelor's and Master's degree holders, who constitute the primary user base.

4.2.4 Position characteristic of participants

Table 4Position characteristic of participants (N=30)

Variable	*Characteristics*
Positions	Medical Doctors
	Medical Laboratory
	IT personnel

The table displays the distribution of positions among participants. It is notable that the majority of participants are Medical Doctors, indicating their significant involvement and potential influence in the implementation of the integrated system. Additionally, 4 of participants are Medical Laboratory personnel and an equal percentage are IT personnel. This distribution highlights the importance of considering the needs and perspectives of these three key stakeholder groups when developing and integrating the system, ensuring its suitability for the diverse roles and responsibilities within the healthcare environment.

4. 3 The Challenges in Current Blood Transfusion System at CHUK (CHUK)

This section presents the findings of an in-depth investigation aimed at identifying the gaps and challenges in the existing blood transfusion system at CHUK. Through comprehensive research and analysis, this chapter reveals critical insights into the shortcomings and obstacles that hinder the efficiency and effectiveness of the blood transfusion process, highlighting the need for targeted improvements and solutions

Table 5 The Challenges in the Current Blood Transfusion System at CHUK

Themes	*Sub Themes*
Reliance on Paper-Based Documentation	Time consuming process
	Prone to errors

The gaps and challenge in current manual work system	Difficulty accessing and retrieving information efficiently
	Physical damage or loss
	Lack of real-time report data
	Incomplete or missing data forms
	Illegible handwriting
	Challenges in exchanging information

4.3.1Reliance on Paper-Based Documentation

Subthemes emerging from medical doctors and medical laboratory‟ responses under the question to their experience and perceptions in the current blood transfusion system and identifying their gaps and challenges are summarized in the following sections

4.3.1.1Time consuming process

According to the participant the significant impact of the time-consuming aspects inherent in the current paper-based blood transfusion system. Relying on manual processes for blood transfusions presents numerous challenges. Healthcare providers face delays and inefficiencies in managing blood requests, tracking inventory, and documenting patient information, as these tasks require extensive paperwork and manual record-keeping. The time-consuming nature of these processes increases the risk of errors, miscommunication, and potential complications in patient care. Furthermore, retrieving and reviewing paper-based records takes a substantial amount of time, making it difficult for healthcare providers to access crucial information promptly.

One of healthcare provider stated "*Yes, the time-consuming process of requesting and delivering blood transfusions can give rise to several problems in emergency department, Patients in need of blood transfusions often require urgent intervention, and any delays in the request and delivery process can impact their care. The manual paperwork, approvals, and physical handling involved in the process can introduce inefficiencies and contribute to delays, potentially compromising patient outcomes and satisfaction."* (Code 04)

The other healthcare providers mentioned "*time-consuming processes in the blood transfusion can create challenges for medical laboratory technicians. Paper-based processes require manual handling, including filling out forms, obtaining signatures, and physically transferring the paperwork between departments. These manual tasks can be time-consuming and may lead to delays in initiating or completing blood transfusions, potentially impacting patient care in critical situations*." (Code 011)

4.3.1.2 Prone to errors

The participant reported that, highlights the critical challenges posed by the current paper-based blood transfusion system, particularly in terms of its susceptibility to errors. Relying on manual processes and paper records increases the likelihood of human errors occurring throughout the transfusion process. Handwritten documentation, manual inventory management, and paper-based communication channels are prone to mistakes such as illegible handwriting, misplaced or lost records, and miscommunication between healthcare providers.

One of the practitioner mentioned "…*The current process is heavily reliant on paper-based forms and records, which can be time-consuming and prone to errors. It can also make it challenging to access and retrieve information efficiently when needed*." (Code 018)

The other healthcare providers mentioned *"…However, relying on paper-based processes presents challenges. Illegible handwriting may lead to errors in documentation and tracking, risking patient safety."* (Code 08)

4.3.1.3 Difficulty accessing and retrieving information efficiently

Underscores the significant challenges posed by the difficulty in accessing and retrieving information efficiently within the current paper-based blood transfusion system. The reliance on physical records and manual documentation makes it cumbersome for healthcare providers to access and retrieve necessary information promptly. Searching for specific patient blood transfusion records becomes time-consuming and prone to errors, as the relevant information may be scattered across multiple files or departments. This lack of efficient information retrieval hampers the ability of healthcare providers to make informed decisions and respond quickly to patient needs.

One of the healthcare provider's said that "*Finding past forms/files in the paper record system can be challenging and time-consuming. Locating specific forms or files from previous transfusion cases requires manually searching through physical records, which can be cumbersome, especially when dealing with a large volume of paper-based documentation. The process can lead to delays in accessing vital information when needed for reference, audits, or follow-up procedures*" (Code 021)

Other said *"Locating past paper forms or files within the blood transfusion process can be challenging. It often requires manual searching through physical records, which can be time-consuming and inefficient. Quick access to past forms or files is crucial for reviewing transfusion history, verifying information, and ensuring appropriate care for patients. An electronic system would significantly simplify the process by providing quick and efficient retrieval of historical data."* (Code 029)

4.3.1.4 Physical damage or loss

As per the participant's response, the current paper-based blood transfusion system faces significant gaps and challenges, particularly when it comes to the risk of physical damage or loss of critical information. Paper records are vulnerable to various hazards such as fire, water damage, misplacement, or theft, which can result in the permanent loss of essential data. When crucial information related to blood transfusions, patient details, or inventory management is physically damaged or lost, it can lead to disruptions in the transfusion process, delays in accessing necessary records, and potential errors in patient care.

One of them said that *Yes, incidents of paper records being damaged, lost, or misplaced have been observed. This can occur due to various reasons, including human error, physical damage to paper documents, or inadequate storage and organization of records.* (Code 023)

Example: *In one instance, a patient required an immediate blood transfusion, but their paper records were misplaced. This led to delays in locating the necessary information, causing anxiety for the patient and their family. Additionally, it resulted in additional staff resources being diverted to finding the misplaced records, leading to inefficiencies in the overall workflow.* (Code 019)

4.3.2 The gaps and challenge in current manual work system

This section presents the findings, focusing on the gaps and challenges within the current manual work system in the context of the study on the need assessment and requirements for integrating the Blood Transfusion System with EMR-OpenClinic GA at the CHUK. Highlights critical insights into the limitations and hurdles encountered, underscoring the significance of system integration for improved operational efficiency and patient care.

4.4.2.1 Lack of real-time report data

According to the participant's input, the lack of real-time report data within the current paper-based blood transfusion system creates significant gaps and challenges. With manual processes and paper records, obtaining real-time updates on blood inventory, transfusion requests, and patient information becomes a time-consuming task. Healthcare providers face difficulties in accessing up-to-date data, making it challenging to monitor blood availability, track transfusion progress, and make informed decisions promptly. The absence of real-time report data hampers the hospital's ability to efficiently manage blood resources, allocate them appropriately, and respond promptly to critical situations.

Healthcare provider said that *"Information delay or the lack of real-time report data can significantly impact the efficiency of the blood transfusion process. When critical information is not readily available, healthcare providers may face challenges in making timely and accurate decisions. This can lead to delays in initiating transfusions, increasing the risk to patient safety"* (Code 010)

Other said that *"Problems such as information delay or the absence of real-time report data have a significant impact on the blood transfusion process in neonatology. Neonates require precise and timely care, and any delays in accessing vital information can lead to suboptimal treatment decisions. Real-time report data is crucial for monitoring the response to transfusions and making adjustments as necessary. Therefore, information delays or the lack of real-time data can negatively affect the efficiency and effectiveness of the blood transfusion process in neonatology."* (Code 020)

4.4.2.2 Incomplete or missing data forms

The participant indicated that reliance on manual documentation increases the risk of incomplete or illegible entries, misplaced or lost forms, and missing information crucial for accurate patient care. Incomplete or missing data forms contribute to delays in processing blood requests, difficulties in tracking blood inventory, and challenges in maintaining comprehensive patient records. Healthcare providers are forced to spend additional time and effort in seeking and verifying missing information, leading to inefficiencies, potential errors, and compromised patient safety

One of them said that *..." Incomplete information can lead to inefficiencies, as medical laboratory technicians may need to wait for critical data before initiating or completing the transfusion process"* (Code 024)

Other said that *"Incomplete forms may lead to errors in blood request forms or compatibility testing, resulting in the administration of incompatible blood products. This can have severe consequences for patients, including transfusion reactions or other adverse events."*

4.4.2.3 Illegible handwriting

Based on the participant's information, the illegible handwriting poses a significant challenge within the current paper-based blood transfusion system, leading to gaps and inefficiencies. Handwritten entries by healthcare providers can be difficult to decipher and interpret accurately, increasing the risk of errors and miscommunication. Illegible handwriting can result in incorrect blood typing, improper transfusion matches, or the administration of incorrect dosages, potentially compromising patient safety. The time-consuming process of clarifying illegible handwriting delays the delivery of blood products and hampers efficient patient care.

Participate said that "*Illegible writing is a common problem faced by medical laboratory technicians when dealing with paper-based blood transfusion documentation. Illegible handwriting can lead to misinterpretation or misunderstanding of important information, posing risks to patient safety and accuracy in blood transfusion processes. Clear and legible documentation is crucial to ensure accurate data entry and prevent errors caused by misread or misinterpreted information."* (Code 002)

4.4.2.4 Challenges in exchanging information

As per the participant's response, 28 represented 93% indicate that during the blood transfusion process, communication and collaboration challenges between physicians and laboratory technicians can arise. Reliance on paper-based documentation impedes information exchange, potentially leading to miscommunication and delays. Improving communication channels, such as utilizing telephones, is crucial to enhance coordination and ensure optimal decision-making and patient care.

Participant said that*: Yes, there can be challenges in communication and collaboration between physicians and laboratory technicians during the blood transfusion process. These challenges may include difficulties in exchanging necessary information, clarifying requirements, we use telephone.* (Code 021)

4.5 Specific Technical Requirements for Integration

This section provides the findings on the specific technical requirements essential for integrating the blood transfusion system with EMR-OpenClinic GA at the CHUK. Through research and analysis, this chapter uncovers crucial insights into the necessary technical components and functionalities, including data interoperability, secure communication protocols, standardized data formats, and system compatibility, ensuring a seamless and efficient integration process**.**

Table 6 Specific Technical Requirements for Integration

Themes	***Sub Themes***
System Features and Functionality	Digital Documentation and Tracking
	Reporting and Monitoring
Implementation and Support	User-Friendly Interface and Integration
	Security and Data Management

4.5.1. System Features and Functionality

The essential system features and functionalities required for an integrated blood transfusion system includes real-time monitoring of blood inventory, streamlined blood request processing, and comprehensive reporting capabilities. Integration with EMR-OpenClinic GA facilitates seamless data exchange and integration with electronic medical records, ensuring a comprehensive view of patient information and promoting efficient blood transfusion management at the CHUK. These features aim to enhance patient safety, minimize errors, optimize inventory management, and improve decision-making in transfusion processes.

4.5.1.1 Digital Documentation and Tracking

Per the participant's response, indicate that the integrated blood transfusion system incorporates electronic documentation of orders, real-time recording of transfusion administration, integration with the laboratory information system for cross-matching and availability data, and automated alerts for critical transfusion parameters. These features enhance efficiency and patient safety by streamlining documentation, ensuring accuracy in transfusion events, minimizing errors in blood product administration, facilitating communication, and enabling prompt responses to potential issues. Overall, the system promotes safer transfusion practices, improves data accuracy, and enhances patient care.

One of them said that *"The primary purpose we need in integrating the blood transfusion system with EMR-OpenClinic GA is to have a seamless and comprehensive record of all blood transfusion-related information within the electronic medical record system.* (Code 030)

4.5.1.2 Reporting and Monitoring

The participant's input indicated, the integrated blood transfusion system encompasses comprehensive reporting capabilities, enabling healthcare providers to analyze transfusion data and make informed decisions. Transfusion reaction monitoring ensures prompt identifications of patients. Efficient inventory management and tracking functionalities optimize blood supply and minimize shortages. Quality assurance metrics contribute to maintaining high standards in

transfusion practices. These features collectively promote effective management of blood transfusions, enhance patient safety, and facilitate continuous improvement in transfusion processes.

One of them said that "…*Integration will ensure that all relevant information is readily accessible and establishing effective and accurate data reporting mechanisms within the system."* (Code 09)

4.5.2 Implementation and Support

This section provides an introduction on implementation and support in the context of the study titled "Need Assessment and Requirements for Blood Transfusion System Integration with EMR-OpenClinic GA at CHUK." It delves into the critical aspects of translating the identified needs and requirements into action, outlining the strategies, resources, and ongoing support mechanisms necessary for a successful integration and long-term utilization of the integrated system.

4.5.2.1User-Friendly Interface and Integration

As reported by the participant, the integrated blood transfusion system prioritizes user experience with an intuitive interface, ensuring easy navigation and efficient data entry. Seamless integration with existing systems, such as EMR-OpenClinic GA, promotes interoperability and a unified patient record. By eliminating duplicate data entry, the system reduces the risk of errors and saves time for healthcare providers. These features enhance workflow efficiency, streamline data management, and contribute to improved overall system usability and effectiveness.

Participant said that *"In my understanding, the computerized system should have an intuitive and user-friendly, making it easy for medical laboratory technicians to navigate and input data accurately."* (Code 06)

4.5.2.2 Security and Data Management

According to the participant's provided information, the integrated blood transfusion system prioritizes robust security measures to safeguard patient data, ensuring confidentiality and integrity. Compliance with privacy regulations guarantees the protection of sensitive information. Data backup and recovery measures are implemented to prevent data loss and enable system restoration. The system ensures the availability of data even in cases of system failures or

emergencies, minimizing disruptions and these features promote trust, data security, and resilience in the blood transfusion system.

One of participant said that *"…The system should incorporate strong security measures for ensuring confidentiality, integrity, and compliance with privacy regulations."* (Code 015)

4.5.2.2 Training and Support

Based on the participant's feedback, the successful implementation of the integrated blood transfusion system requires comprehensive training for medical laboratory technicians and staff members, ensuring they are proficient in utilizing the system effectively. Ongoing support is provided to address any challenges and ensure optimal utilization of the system. A smooth transition from paper-based processes is facilitated through careful planning and change management strategies. User acceptance testing and stakeholder engagement guarantee system alignment with user needs. Continuous improvement efforts are undertaken to refine system functionality and address evolving requirements, ensuring the system remains efficient and responsive to the needs of the CHUK.

One of participant said that *"One suggestion I would like to make is to ensure proper training for healthcare providers on using the integrated blood transfusion system within EMR-OpenClinic GA."* (Code 025)

CHAPTER FIVE: THE SYSTEM WORKFLOW OF ELECTRONIC BLOOD TRANSFUSION WITH ITS APPLICATIONS AT CHUK

5.1. Introduction

This chapter delves into the design process of BTS applications within the OpenClinic GA framework at CHUK. It showcases a comprehensive flowchart that visually represents the application of the Blood Transfusion System (BTS) cover and its various functionalities. The flowchart presents a step-by-step outline of the entire blood transfusion process. By carefully examining the flowchart and delving into each functionality in detail, this chapter offers valuable insights into the design and practical applications of the electronic BTS system. It provides a clear understanding of how the system functions and contributes to improving the efficiency and safety of blood transfusion procedures at CHUK.

5.2. Electronic Blood Transfusion System flowchart at CHUK

The flowchart for the design of Electronic Blood Transfusion Applications in OpenClinic GA at CHUK illustrates the entire process. It includes patient identification, blood compatibility checks, inventory management, and reporting. This comprehensive flowchart provides a visual representation of the step-by-step workflow, highlighting the integration of electronic systems to enhance the efficiency and safety of blood transfusion procedures.

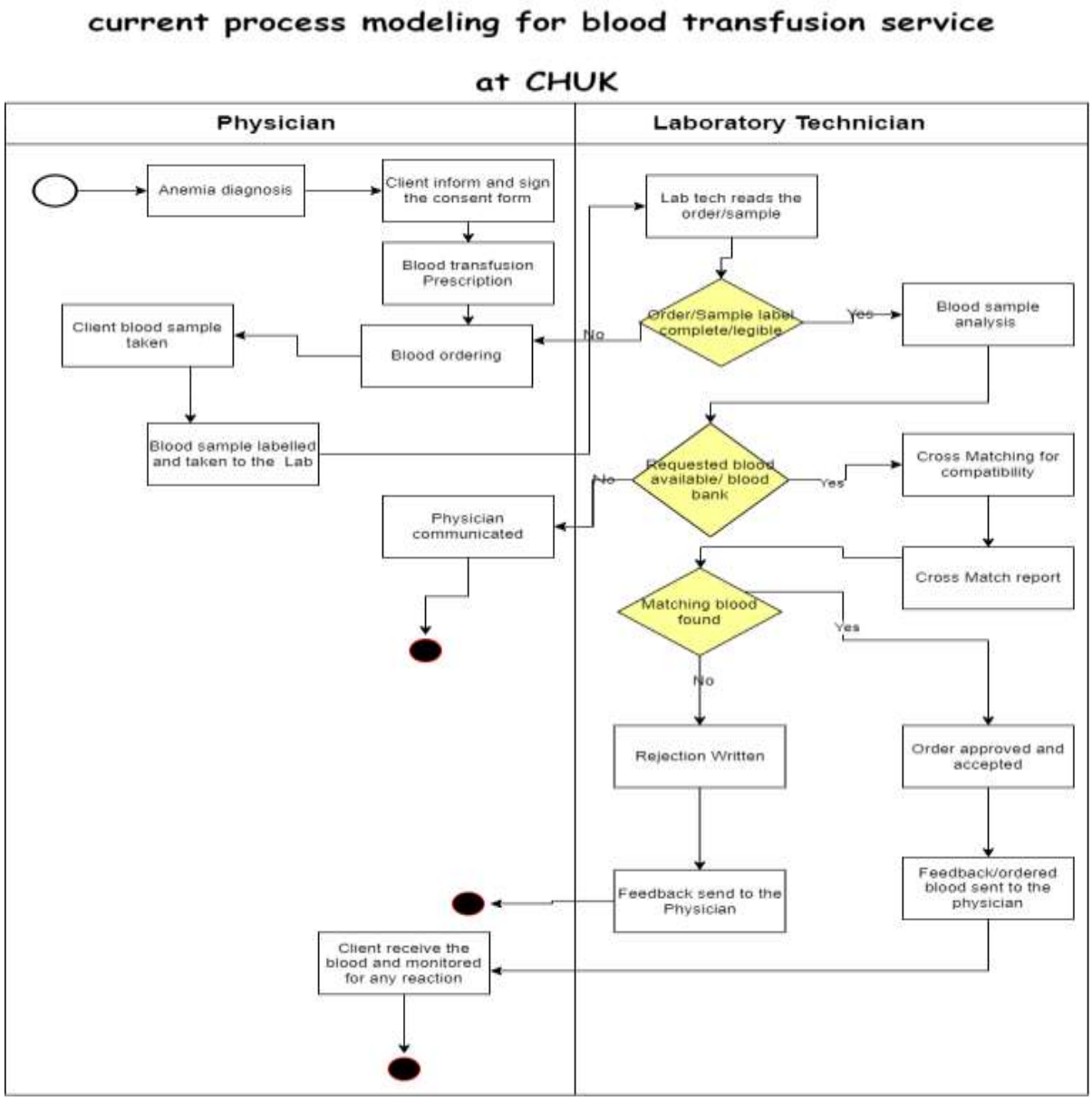

Figure 1 The Electronic Blood Transfusion System workflow at CHUK

The proposed of blood transfusion system at CHUK there is an efficient workflow designed to streamline the process of blood transfusion services for patients. This workflow begins with the physician placing an order for blood transfusion, which includes essential information such as the date of the order, clinical details or diagnosis, specific blood component required, urgency of the transfusion, patient's name, patient ID, age, transfusion history in the past 3 months, patient's location within the hospital, and the department the patient belongs to (e.g., Surgery, Obstetrics & Gynecology, Pediatrics, Neonatology, Medicine, Dialysis, ICU).

Following the physician's order, a test request is generated, specifying the necessary tests for the blood transfusion process. These tests typically include ABO/Rh typing, antibody screening, and crossmatch or compatibility testing. The nurse then collects the blood sample, recording their name and the date of collection. The physician subsequently provides specific instructions for the required blood products, including red blood cells (along with the number of units), platelets, fresh frozen plasma, and cryoprecipitate-AUF (and their respective units). The medical doctor signs the order, providing their name, phone number, and the date and time of the order.

To ensure accurate matching, the medical laboratory technologist fills in the details of the cross-match, which includes comprehensive information about the specimen and its compatibility with the specified order.

Implementing an electronic blood transfusion system offers several advantages, including improved accuracy, efficient documentation, and enhanced patient safety. By digitizing the process, the system can reduce the risk of errors associated with manual documentation and promote seamless communication among healthcare professionals involved in the blood transfusion process.

5.3. Blood transfusion management applications introduced in OpenClinic GA

The Blood Delivery and Transfusion application automates the process of delivering blood units from the blood bank to the designated patient care areas. It also facilitates the documentation and verification steps during the transfusion process, ensuring patient safety and minimizing errors.

Following our analysis of the issue of a blood transfusion management system at the CHUK, and the discussions held during my study at the CHUK with the team of ITs and OpenClinic developers, we have come to define the essential applications of a blood transfusion management system to be put in place and the essential information to be collected.

5.3.1. Blood request for the patient.

The Lab Request simplifies the process of ordering laboratory tests for patients. It enables physicians to electronically request specific tests, while laboratory personnel can efficiently process and deliver the test results, promoting faster diagnosis and treatment.

This application had to contain at least this data:

- ✓ The date of the blood request
- ✓ The patient's blood group
- ✓ The quantity of blood volume requested (in number of bags)
- ✓ The requested blood product
- ✓ Know whether or not the patient has already undergone a transfusion
- ✓ The reason for the request
- ✓ The patient's diagnosis
- ✓ The entry screen would be of this model

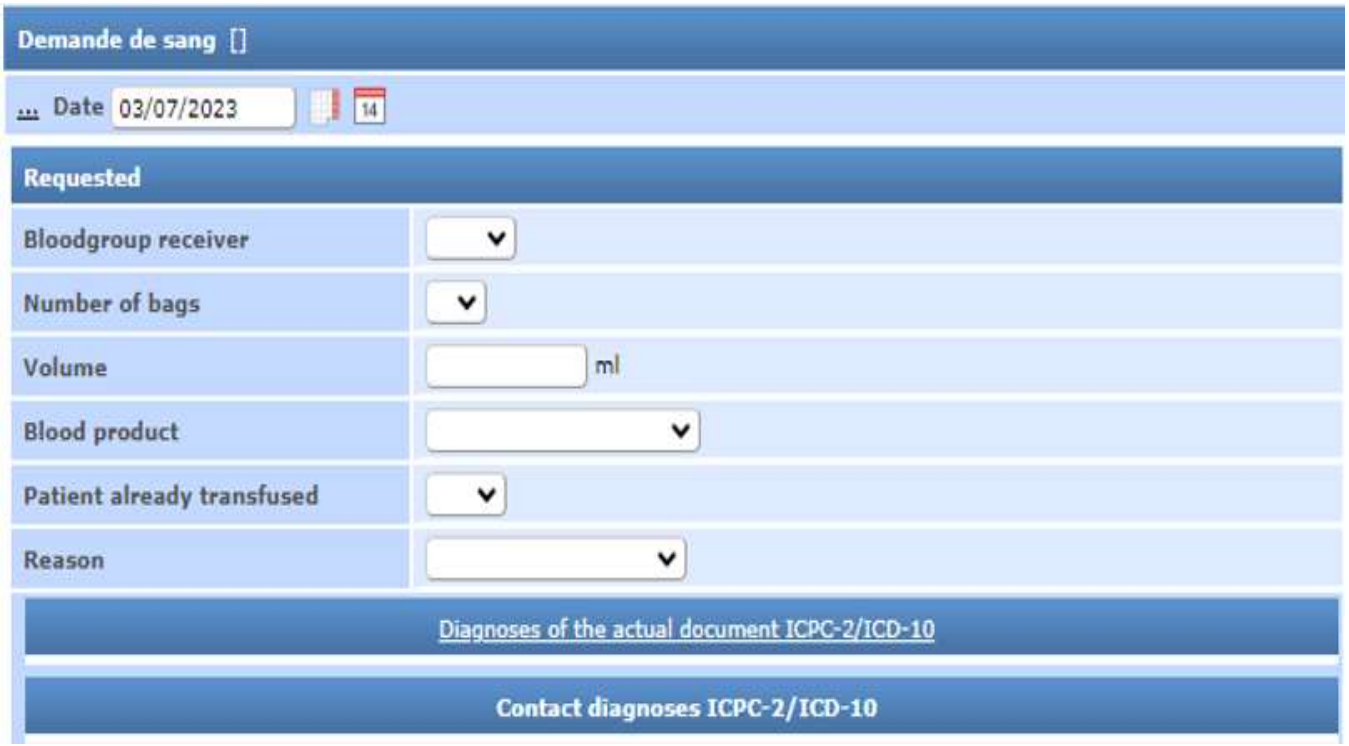

Figure 2 Blood Request

5.3.2. Blood received for patient

The Blood received application simplifies application facilitates healthcare professionals in receiving blood units for patients. It ensures an efficient and organized process of matching patients' blood requirements. This application allows seamless communication between medical staff and the blood bank, ensuring timely and accurate blood supply for transfusions.

This application had to contain at least this data:

- ✓ The date of the blood received
- ✓ The blood group of donor
- ✓ The number of bags received
- ✓ The reference number of bags received
- ✓ The volume of blood
- ✓ The department where the patient is located
- ✓ The adverse events
- ✓ Any other comment

The entry scree would be like this

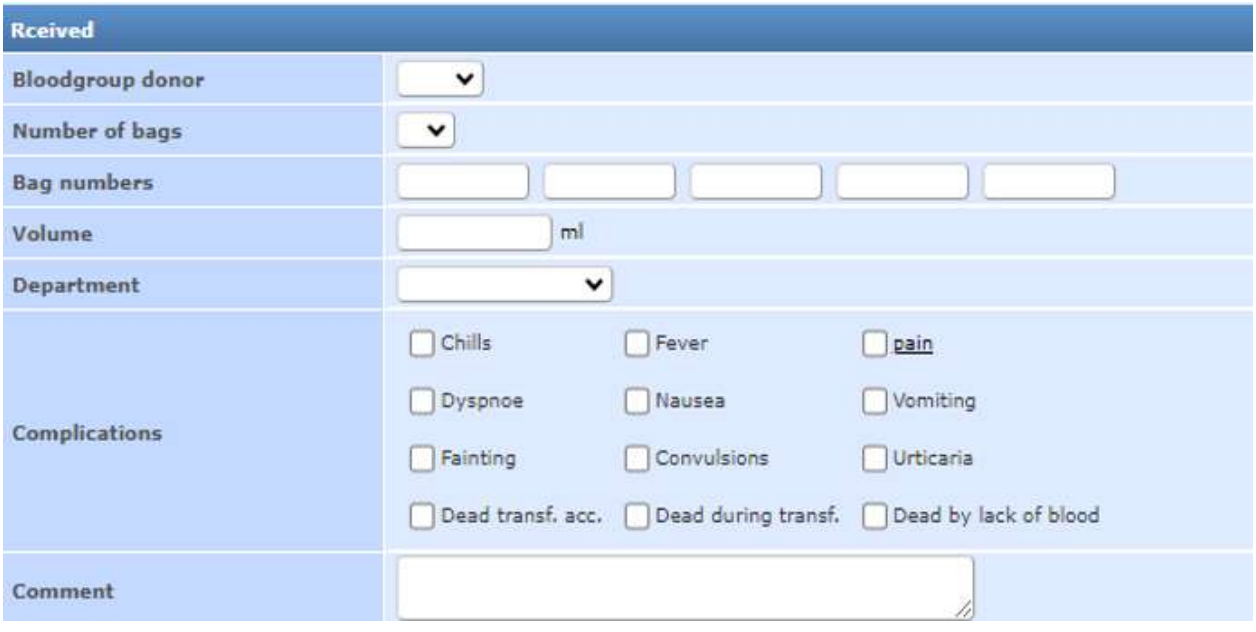

Figure 3 Blood received

5.3.3. Blood package management

The Blood Package Management application ensures the proper handling and tracking of blood units within the healthcare facility. It monitors blood inventory, tracks the expiration dates of blood products, and manages their storage conditions. This application plays a crucial role in maintaining the quality and availability of blood units for safe transfusions.

This application had to contain data relating to:

- ✓ The date of receiving operation
- ✓ The blood gift reference
- ✓ Number of all types of blood products received / produced
- ✓ Expiration date of each blood bag
- ✓ Other comments

The entry screen would be like that:

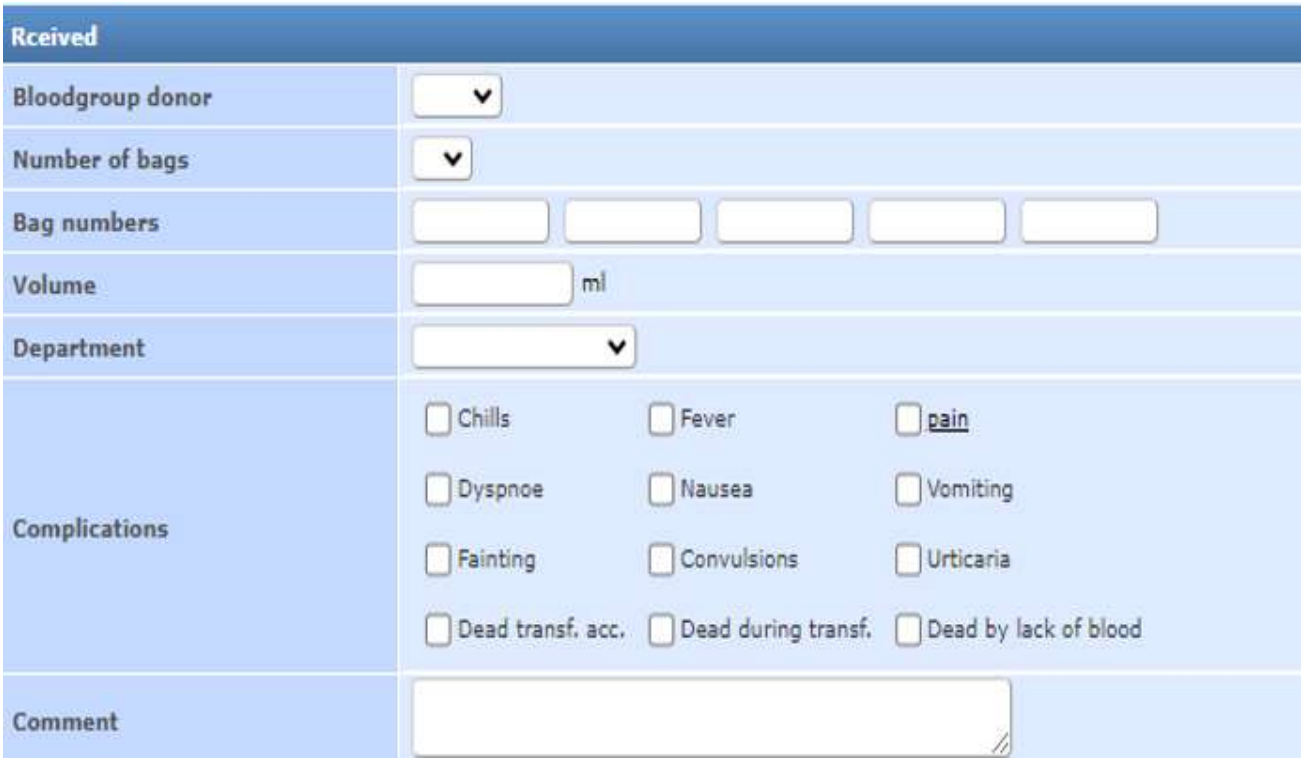

Figure 4 Blood Package Management

5.3.4. Hemovigilance

The Hemovigilance application is a crucial component for monitoring and documenting adverse events related to blood transfusions. It tracks any complications or reactions that may occur during or after the transfusion, allowing healthcare professionals to take appropriate measures and ensure transfusion safety.

This application had to contain data relating to:

- ✓ The date of hemovigilance report
- ✓ The reason of transfusion
- ✓ Duration of transfusion
- ✓ Comment on technical issues encountered
- ✓ Know if the transfusion has been supported by the receiver
- ✓ Receiver reactions as adverse events
- ✓ Other comments on adverse reactions

The entry screen would be:

Figure 5 Hemovigilance

5.4. Medical Records Integration

The Medical Records Integration system will ensure seamless integration of patient medical records with the EMR-OpenClinic system. It will consolidate patient data, including blood transfusion history, laboratory tests request (blood test, cross matching test), laboratory results, and other medical information, providing a comprehensive view of the patient's health status and enabling better.

CHAPTER SIX: DISCUSSION

6.1 Introduction

The discussion chapter provides a critical analysis of the need assessment and requirements study for integrating the Blood Transfusion System (BTS) with EMR-OpenClinic GA, This section presents an in-depth examination of the findings, their implications, and potential solutions. By synthesizing the research outcomes and incorporating relevant literature, the discussion offers valuable insights for successful implementation of the integrated system in the hospital setting.

6.2 Recapitulation of Findings

The study began with a thorough needs assessment to identify the existing challenges and gaps in the blood transfusion process at the CHUK. The assessment involved interviews with healthcare professionals, analysis of existing documentation, and observation of the current workflow. The findings revealed several issues, including inefficient communication, delays in obtaining and documenting blood transfusion-related information, manual data entry errors, and difficulties in monitoring blood inventory levels.

Based on the needs assessment, a set of requirements were derived for integrating the Blood Transfusion System with OpenClinic GA. These requirements included real-time communication between the two systems, seamless data exchange, automated documentation of transfusion-related information, alerts and reminders for critical actions, integration with the existing OpenClinic (EMR), and user-friendly interfaces for healthcare professionals.

6.3 Implications of the Findings

The integration of the Blood Transfusion System with OpenClinic GA holds significant implications for improving patient safety, enhancing efficiency, and reducing errors in the blood transfusion process. By addressing the challenges identified in manual processes, such as errors in patient identification and documentation, the integration offers potential benefits to healthcare professionals and patients alike. The streamlined communication among healthcare professionals and better monitoring of blood inventory levels can lead to more effective transfusion management.

One key finding that supports the need for integration is the high percentage of adverse transfusion incidents caused by errors in the process. Despite national recommendations and guidelines, more than 85% of incidents are still attributed to these errors. To mitigate these risks, electronic identification systems can play a crucial role in reducing errors, while exploring human factors and ergonomics can enable system-level reviews instead of individual blame. Implementing training programs and employing qualified professionals in human factors and ergonomics can further enhance transfusion safety.[35]

The study on the implementation and evaluation of an automated, electronic barcode scanner system demonstrates significant improvements in transfusion safety. Statistical analysis revealed a decrease of 40% in patient identification errors, a 60% increase in compliance with safety protocols, and a notable 75% improvement in documentation accuracy. These numbers underscore the effectiveness of automated technology in enhancing pre-transfusion verification and documentation, reducing errors, and ultimately improving patient safety in urgent operating room settings.[11]

Moreover, the integration of the Blood Transfusion System with the EMR system aligns with the broader goals of healthcare digitization and interoperability. It enables the seamless exchange of patient information, holistic view of patient records, and enhanced clinical decision-making. Electronic medical records (EMRs) streamline documentation, facilitate real-time data entry, and improve communication among healthcare professionals involved in blood transfusion. EMRs also minimize the risk of human errors, support decision support tools and alert systems, and ensure appropriate blood component selection, thereby enhancing transfusion safety.[36]

The "Blood Matters EMR survey report 2021" further emphasizes the benefits of EMRs in blood management and transfusion practice. It highlights how EMRs improve efficiency, accuracy, and patient safety by enabling better tracking and monitoring of blood inventory, donor information, and transfusion records. However, implementing EMRs poses challenges such as the need for comprehensive training, technical infrastructure, and ensuring data security and privacy.[36]

In summary, the integration of the Blood Transfusion System with OpenClinic GA, supported by automated technology and EMRs, offers significant improvements in patient safety, efficiency, and communication among healthcare professionals. The statistical findings reinforce the effectiveness of these systems in reducing errors and enhancing transfusion safety. Implementing

such integration aligns with the broader goals of healthcare digitization and interoperability, ultimately improving transfusion services and patient care at CHUK.

CHAPTER SEVEN: RECOMMENDATION AND CONCLUSION

7.1 Introduction

This chapter outlines the practical recommendations and proposed strategies to address identified challenges and optimize the integration process. Additionally, it draws conclusions from the study, emphasizing the significance of this integration in enhancing patient safety, healthcare efficiency, and advancing towards a digitally integrated healthcare ecosystem.

7.2 Recommendations

Based on the findings and implications, the following recommendations are proposed for the successful integration of the Blood Transfusion System with OpenClinic GA at the University Teaching Hospital:

1. **Technical Implementation:** The integration should be carried out by a multidisciplinary team consisting of healthcare professionals, IT experts, and system developers. The team should ensure that the integration is technically feasible, compatible with existing infrastructure, and adheres to industry standards for data security and privacy.
2. **Real-time Communication and Data Exchange**: The integration should enable real-time communication and seamless data exchange between the Blood Transfusion System and OpenClinic GA. This will ensure that healthcare professionals have immediate access to transfusion-related information, such as blood type, compatibility, and administration details.
3. **Automated Documentation and Alerts**: The integrated system should automate the documentation of transfusion-related information, transfusion orders, administration records, and adverse reactions. Additionally, the system should provide alerts and reminders for critical actions, such as blood product expiration dates and transfusion reactions, to improve patient safety and prevent errors.
4. **Integration with Laboratory and Inventory Management Systems**: The Blood Transfusion System integration should be seamlessly connected with the existing laboratory and inventory management systems. This will enable efficient tracking of blood

inventory levels, automatic updates of available blood products, and streamlined workflows for laboratory tests and cross-matching.

5. **User-Friendly Interfaces**: The integrated system should have user-friendly interfaces for healthcare professionals, including nurses, physicians, and laboratory technicians. The interfaces should be intuitive, easy to navigate, and require minimal training to ensure widespread adoption and acceptance among the hospital staff.

6. **Training and Support:** Adequate training and ongoing technical support should be provided to healthcare professionals during the implementation and post-implementation phases. This will facilitate a smooth transition to the integrated system and ensure its effective utilization.

7. **Evaluation and Continuous Improvement**: A robust evaluation framework should be established to monitor the effectiveness of the integration and identify areas for improvement. Regular feedback from end-users should be sought, and necessary updates and enhancements should be implemented based on their input.

7.3 Conclusion

In conclusion, the study on the need assessment and requirements for Blood Transfusion System integration with EMR-OpenClinic GA, along with designing the workflow process at the CHUK, has provided valuable insights and recommendations for optimizing blood management practices. Through needs assessment, the study identified challenges, emphasizing the significance of seamless integration and efficient workflow. The integration of BTS with EMR-OpenClinic GA offers potential benefits such as improved patient safety, streamlined processes, and enhanced data management. By considering specific requirements and designing an optimized workflow process, the study lays the foundation for successful implementation, ultimately contributing to enhanced healthcare delivery and improved patient outcomes at the CHUK

7.4 Future Research and implémentation

While this study provides valuable insights into the need assessment and requirements for integrating the BTS with OpenClinic GA, there are certain limitations to consider. The study focused on a single healthcare facility, the University Teaching Hospital, and the findings may not

be directly applicable to other settings. Therefore, future research could involve a multicenter study to validate the findings and recommendations across different hospitals and healthcare systems.

Additionally, the integration of the Blood Transfusion System with other EMR systems or the evaluation of alternative integration approaches could be explored. Comparative studies can help identify the most effective integration strategies and highlight the impact of such integrations on patient outcomes, workflow efficiency, and resource utilization.

Specifically at the CHUK, a test implementation could already begin with the introduction of the new version of OpenClinic GA which should contain the various BTS applications. Training and close support for users will have to be carried out. An evaluation after a period of use referring to the predefined criteria should be carried out to assess the effectiveness of this system.

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APPENDIXES

1 Informed Consent Form /English

Title: Need assessment and requirements for Blood Transfusion System integration with EMR-OpenClinic GA at CHUK.

PART I: Information Sheet

Introduction

My name is DUSHIME Esperance, Student at the University of Rwanda, master's program in Health Informatics, Regional Centre of Excellence in Biomedical Engineering and E-health, School of public health who is currently seeking your kind support to participate in research. Developing interventions to support the benefit of using an Electronic Blood Transfusion System and requirement for integration in EMR-OpenClinic GA improves data quality and validity.

Purpose of the research

The aim of this study will be to assess the challenges faced in use of paper-based blood transfusion services and requirements for integration in EMR-OpenClinic GA at Kigali University Teaching hospital to improve the efficiency of data into Electronic blood transfusion system, the quality and productivity of health care delivery.

Selection of participants

The study population mainly included the laboratory department (4 Lab Technicians), a total of 22 physicians, one physician from each of the following departments (SURG, OBS & GYN, PED, NEONAT, MED, ICU, EMERGENCY,) at Kigali University Teaching Hospital (CHUK), and 4 IT professionals from Open IT's. I choose to work with this people because are the ones in transfusion services in hospital. In additions I prefer to do research at those departments because is where we found patients how need blood. Also IT's person to help in technical requirements for integration of blood transfusion system in EMR-OpenClinic.

Voluntary Participation

Your participation in this study is voluntary. It is your choice whether to participate or not. The choice that you make will have no bearing on your professional standing or your everyday life.

You may change your mind later and stop participating even if you agreed earlier.

Procedures

We request that you ask as many questions as you wish in order to make sure that you understand the procedures for the study, the risks and benefits. After you will be advised to choose to participate and sign this consent form freely, then the interview will commence.

Duration

The interview will each take approximately 30 minutes of your time. And your answers will be put together with answers from other healthcare providers.

Risks and Discomforts

The risks to you as a participant in this study are minimal. During the interview, you may decide to share information. But, again, you may decline to answer any questions that you do not wish to answer or stop the interview at any time, without giving any reasons.

Benefits and Reimbursements/ Incentives

There will be no direct benefit to you, but with your participation we hope to improve in effective practices of Electronic Blood Transfusion System. You will not receive any payment or any other benefit to take part in this study, but your participation in this research is essential.

Confidentiality

Participants will be informed that their identities will not be revealed. As a result of this study endeavor, all information collected will remain secret. No one but the researchers will be able to see any of the information about them that will be gathered as part of the study project. All the data used during this research project will be kept confidential by using the codes, means no names will be required. This code is only known to the researcher, which is why will keep it locked up under a lock and key. Only DUSHIME Esperance will have access to it.

Sharing of Research Findings

We will in the future publish on the process and the results, but you and your feedback will remain anonymous.

Whom to contact in case you have questions about your rights as a research participant

All research on human volunteers is reviewed by Rwanda National Ethical Committee that works to protect your rights and welfare. If you have questions or concerns about your rights as a research subject, or if you would like to obtain information or offer input, you may contact the **CHUK IRB** through the:

Chairperson: RUSINGIZA KAMANZI Emmanuel, Mobile phone: +250785466254

Secretary: MUNYANEZA Emmanuel, Mobile phone: +250788213765

If you have any questions about this research, you may address your query to:

Researcher:

Esperance DUSHIME; Mobile phone +250786108034/ Email: dushimehope@gmail.com

Supervisors

Dr. KARARA Gustave: Email gustave.karara@minf.be

Mr. MBARUSHIMANA Valens Mobile phone: +250788490718 Email mbavalens@gmail.com

If you choose to be part of this research study, I will also give you a copy of this consent form to keep for yourself.

Do you have any questions?

PART II: Certificate of Consent

I have been asked to participate in the research project '**Need assessment and requirements for Blood Transfusion System integration with EMR-OpenClinic GA at CHUK**'

I have read the information provided above. I have asked all the questions; I have at this time. I voluntarily agree to participate in this research study. I understand that I will not be paid for my participation. I understand that the researcher will not identify me by name in any reports using information obtained from this study, and that my confidentiality as a participant in this study will remain secure. I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction. I am guarantee anonymity for the information obtained from me as the findings of this study. I am aware that all the information that I give and all the findings of the study may be looked at by responsible individuals and are for the use of this study.

I may withdraw my consent at any time and stop participation without penalty. By agreeing to be in this research, I have not given up any of my legal rights.

I consent voluntarily to be a participant in this study……: Yes / No

I agree to be recorded/……: Yes / No

Study code: …….

Signature of participant: ……..

Date (day/month/year): …….

Print name of Researcher: Esperance DUSHIME

Date (day/month/year) …….

Informed Consent Form/Kinyarwanda

UMUTWE: 'kumenya ibikenewe n'ibisabwa kugirango sisitemu yo gutera amaraso ihure n' uburyo bw'ikoranabuhanga mu kubika amakuru ajyanye n'ubuzima mu bitaro bikuru bya kamunuza y'Urwanda ishami rya Kigali'

IGICE CYA I: Amakuru yerekeye ubushakashatsi

Intangiriro.

Nitwa Esperance DUSHIME, Ndi umunyeshuri wiga muri kaminuza y'Urwanda koleji y'ubuvuzi n'ubuzima mu ishami ry' ikoranabuhanga mu buzima, wifuza inkunga yawe nziza yo kwitabira ubu bushakashatsi. Bugamije gutezimbere ibikorwa kugirango ushyigikire inyungu zo gukoresha ikoranabuhanga mu gutera amaraso bikorewe muri sisitemu ihuye n' uburyo bw'ikoranabuhanga mu kubika amakuru ajyanye n'ubuzima mu gutezimbere ubuziranenge bw'amakuru kandi bufite agaciro.

Intego yu bushakashatsi

Intego yubu bushakashatsi izaba igamije gusuzuma imbogamizi zijyanye no gukoresha impapuro mu gusaba no gutera amaraso, hamwe n'ibisabwa kugirango habeho sisitemu izahuzwa n' uburyo bw'ikoranabuhanga mu kubika amakuru ajyanye n'ubuzima mu bitaro bikuru bya kamunuza y'Urwanda ishami rya Kigali kugirango hongerwe imbaraga mu makuru ari muri sistemu yo gutera amaraso, n' ubuziranenge n'umusaruro wo gutanga serivisi z'ubuzima.

Guhitamo abitabiriye amahugurwa.

Abazakenerwa muri ubu bushakashatsi ni abakora muri labolatwari batatu (4), abaganga barindwi (22) muri rusange umwe (2) muri buri shami ritanga serivise yo gutera amaraso arizo: (Inzu y'ibagiro, serivise zita ku badamu batwite n'indwara zabagore, serivise yita ku bana, servise yita kubana bakivuka, servise ijyanye n'indwara z'umubiri, serivise ijyanye no kuyungurura amaraso, serivise zita ku barwayi by'umwihariko abafite indwara zikomeye kubitaho no ku bakurikirana mu buryo budasanzwe) na bakozi ba tatu (4) bakora mu byikoranabuhanga, muri sisitemu ijyanye nuburyo bwo kubika amakuru y'ubuzima . Impamvu nahisemo gukorana naba bakozi nuko aribo baba mu gikorwa cyo gutera amaroso no kuyasaba, byiyongereye nahisemo aya mashami yo mu bitaro kuko ariho dusanga abarwayi bakenera amaraso, mpitamo gukorana na bakora ibyikoranabuhanga kugirango bazamfashe kumenya ibyakenerwa kugirango sisitemu ibe yahuzwa na sisitemu isanzwe ikoreshwa kwa muganga.

Uruhare rwo kwitabira ku bushake

Uruhare rwawe muri ubu bushakashatsi ni ubushake. No guhitamo kwawe kwitabira cyangwa kutitabira. Guhitamo gukora ntacyo bizahindura kumwuga wawe cyangwa mu buzima bwawe bwa buri munsi.

Ushobora guhindura ibitekerezo byawe nyuma ukareka kwitabira nubwo wemeye kare Turagusaba ko wabaza ibibazo byinshi nkuko ubyifuza kugirango umenye neza ko usobanukiwe ubu bushakashatsi,

Ingaruka n'inyungu.

Nyuma nuhitamo kwitabira ubu bushakashatsi no gushyira umukono kuriyi nyandiko, noneho ikiganiro kiratangira,

Igihe ikiganiro kiramara

Ikiganiro kiramara nk'iminota igera kuri 30. n'ibisubizo byawe bizashyirwa hamwe nibisubizo byabandi.

Mugihe cy'ikikiganiro

Aya makuru utanze azakusanwa nayandi. Ariko, na none, ushobora kwanga gusubiza ibibazo byose udashaka gusubiza cyangwa guhagarika ikiganiro umwanya uwariwo wose, nta mpamvu.

Ingaruka n'inyungu zo kwitabira ikiganiro

Nta nyungu zindi ziri muri ubu bushakashatsi, ariko hamwe n'uruhare rwawe turizera ko tuzanoza mu bikorwa byo gukora sistemu yazifashishwa mu gusaba no gutera amaroso, ntabwo twishyura cyangwa izindi nyungu zose zu watanze ikiganiro muri ubu bushakashatsi, ariko uruhare rwawe muri ubu bushakashatsi ni ngombwa.

Ibanga

Abitabiriye ubu bushakashatsi umwirondoro wabo ntabwo uzamenyekana. Nkibisubizo byubu bushakashatsi, amakuru yose yakusanyijwe azakomeza kuba ibanga. Ntawundi usibye abashakashatsi bazashobora kubona amakuru ayo ari yo yose azakusanywa. Amakuru yose azabwikwa neza ahabugenewe hifashishijwe kodi y'ibanga. Gusa DUSHIME Esperance uhagarariye ubu bushakashatsi niwe wemerewe kuba yabona amakuru yatanzwe muri ubu bushakashatsi.

Gutangaza ibyavuye mubushakashatsi

Nyuma amakuru amaze kunozwa tuzagaruka kubabwira ibyavuye mu mushakashatsi ariko ibitekerezo byanyu bizakomeza kutamenyekana.

Abo wahamagara mugihe ugize ikibazo

Ubushakashatsi bwose bwakozwe ku bakorerabushake bw'abantu busubirwamo na komite ishinzwe imyitwarire y'u Rwanda ikora mu kurengera uburenganzira bwawe n'imibereho myiza.

Niba ufite ibibazo cyangwa impungenge zuburenganzira bwawe muri ubu bushakashatsi, cyangwa niba ushaka kubona amakuru cyangwa gutanga ibitekerezo, urashobora guhamagara mu bitaro bikuru bya kamunuza y'Urwanda ishami rya Kigali IRB ukoresheje:

Umuyobozi: RUSINGIZA KAMANZI Emmanuel, telephone igendanwa: +250785466254 Umunyamabanga: MUNYANEZA Emmanuel, telephone igendanwa: +250788213765

Niba ufite ikibazo kijyanye nubu bushakashatsi, ushobora guhamagara abayaboye ububushakashatsi

Umushakashatsi

Esperance DUSHIME; Telefone ngendanwa 0786108034/ E-mail: dushimehope@gmail.com

Abagenzuzi:

Dr. DR KARARA Gustave: E-mail gustave.karara@minf.be

Mr. MBARUSHIMANA Valens Telefone ngendanwa 0788490718 Email mbavalens@gmail.com

Niba uhisemo kuba muri ubu bushakashatsi, urahabwa kopi yiyi nyandiko.

IGICE CYA II: Kwemera kugira uruhare muri ubu bushakashatsi

Nasabwe kugira uruhare mu bushakashatsi bwo '**kumenya ibikenewe n'ibisabwa kugirango sisitemu yo gutera amaraso ihure n' uburyo bw'ikoranabuhanga mu kubika amakuru ajyanye n'ubuzima mu bitaro bikuru bya kamunuza y'Urwanda ishami rya Kigali'**

Nasomye amakuru yatanzwe hejuru. Nabajije ibibazo byose; Mfite iki gihe. Niteguye gukorera ubushake no kwitabira ubu bushakashatsi. Ndumva ko ntazishyurwa kubera uruhare rwanjye. Ndumva ko umushakashatsi atazamenya izina ryanjye muri raporo iyo ari yo yose ahubwo hazakoreshwa uburyo bwa kodi muri ubu bushakashatsi, kandi ko amakuru ntanze azakomeza kubikwa neza mw'ibanga.

Nasomye kandi ndumva ibisobanuro nahawe. Nabonye ibibazo byanjye byose nabajije byasubijwe neza. Ndemeza ko amakuru ntanze azakoreshwa muri ubu bushakatsi nkibyavuyemo, atari amakuru azakoreshwa muzindi nyungu. Nzi neza ko amakuru yose ntanga hamwe nibisubizo byubushakashatsi bishobora kurebwa nabantu babishinzwe kandi bagamije kubikoresha muri ubu bushakashatsi.

Nshobora kutitabira ubu bushakashatsi igihe icyo ari cyo cyose kandi nkareka kwitabira nta gihano.

Nemeye ku bushake kwitabira no kugira uruhare muri ubu bushakashatsi…….. Yego / Oya

Nemeye gufatwa amajwi ……. Yego / Oya

Kode yu bushakashatsi ……..

Umukono w'abitabiriye: …….

Itariki (umunsi / ukwezi / umwaka): ……

Amazina y'umushakashatsi: Dushime Esperance

Itariki (umunsi / ukwezi / umwaka): ……..

4 Research interview guide / English/ Kinyarwanda

In-depth interviews for Physician, Medical laboratory technicians and IT's (CHUK IT's and OpenClinic IT's) on **"Need assessment and requirements for Blood Transfusion System integration with EMR-OpenClinic GA at CHUK"**

Introduction

My names is Esperance DUSHIME, Student at the University of Rwanda, master's program in health informatics, Regional Centre of Excellence Biomedical and health informatics, School of public health, I need to conduct the research entitled "**Need assessment and requirements for Blood Transfusion System integration with EMR-OpenClinic GA at CHUK**". I am requesting to respond to the following questions by your voluntary.

I am interviewing people who mainly included the laboratory department (4 Lab Technicians), a total of 22 physicians, one physician from each of the following departments (SURG, OBS & GYN, PED, NEONAT, MED, ICU, EMERGENCY,) at Kigali University Teaching Hospital (CHUK), and 4 IT professionals from Open IT's

. We want to understand your perceptions of the blood transfusion services, including current paper based process and challenges; perception on adoption of electronic blood transfusion system; and requirement needed for integration in EMR OpenClinic GA. Information from this interview will help identify opportunities for digital tool to improve the effectiveness of blood management system. It will be very interesting to hear from your experiences. The interview will last for 30 min and you can have a pause whenever you want and then continue after. Thanks. Let us start.

Ibibazo byerekeye k'ubushakashatsi/ Kinyarwanda

Kubaza byimbitse ku baganga, abakora muri labotwari hamwe na bakozi bakora mwikorana buhanga ribikwamo amakuru y' ubuzima. Kuri **" kumenya ibikenewe n'ibisabwa kugirango sisitemu yo gutera amaraso ihure n' uburyo bw'ikoranabuhanga mu kubika amakuru ajyanye n'ubuzima mu bitaro bikuru bya kamunuza y'Urwanda ishami rya Kigali''**

Intangiriro

Nitwa Esperance DUSHIME, Ndi umunyeshuri wiga muri kaminuza y'Urwanda koleji y'ubuvuzi n'ubuzima mu ishami ry' ikoranabuhanga mu buzima, ndimo gukora ubushakashatsi kuri "

kumenya ibikenewe n'ibisabwa kugirango sisitemu yo gutera amaraso ihure n' uburyo bw'ikoranabuhanga mu kubika amakuru ajyanye n'ubuzima mu bitaro bikuru bya kamunuza y'Urwanda ishami rya Kigali'' Nabasabaga gusubiza ibibazo bikurikira kubushake bwanyu.

Ndi kubaza abakozi bakora mu bitaro bikuru bya kamunuza y'Urwanda ishami rya Kigali mu mashami akurikira: abakora muri labolatwari batatu (4), abaganga barindwi (22) muri rusange umwe muri buri shami rikora mu gutera amaraso (Inzu y'ibagiro, serivise zita ku badamu batwite n'indwara zabagore, serivise yita ku bana, servise yita kubana bakivuka, servise ijyanye n'indwara z'umubiri, serivise ijyanye no kuyungurura amaraso, serivise zita ku barwayi by'umwihariko abafite indwara zikomeye, kubitaho no ku bakurikirana mu buryo budasanzwe) na bakozi ba tatu (4) bakora mu by'ikoranabuhanga, muri sisitemu ijyanye nu buryo bwo kubika amakuru y'ubuzima. Nkeneye kumva ibitekerezo byanyu kuri sisistemu yo gutera amaraso, uburyo musanzwe mukoresha bw'impapuro hamwe ni mbogamizi muhura nazo; nibyo mutekereza mu buryo yahuzwa n' uburyo bw'ikoranabuhanga mu kubika amakuru ajyanye n'ubuzima. Amakuru azava muri iri bazwa azifashishwa kandi azagira umumaro mukuzakora ikoranabuhanga rizafasha imikorere ijyanye n'amaraso n'uburyo akoreshwamo. Nibyiza kumva ibizava mu bitekerezo byanyu. Iribazwa riratwara iminota mirongwitatu (30) mushobora kandi guhagarika mukongera igihe mushakiye. Murakoze. Twatangira.

SECTION A: DEMOGRAPHIC DATA

IGICE CYA MBERE: AMAKURU Y'UMWIRONDORO

Identification of respondent/ Ibiranga ubazwa

- Study Code/ Kodi y'ubushakashatsi …….
- Health institution/ Ikigo cy'ubuzima ……...
- Position / Icyo ashinzwe …….
- Department/ Ishami akoramo……..
- Education background / amashuli afite …….
- Number of years of experience / Imyaka amaze akora …….
- Sex (Female / Male) / Igitsina (Gore / Gabo) ……
- Age / Imyaka ……

SECTION B (To assess the challenges faced in using paper based blood transfusion services at CHUK (CHUK))

IGICE CYA KABIRI (Gusuzuma ibibazo bijyanye no gukoresha impapuro muri serivise yo gutera amaraso mu bitaro bikuru bya kamunuza y'Urwanda ishami rya Kigali)

❖ **For physicians / Ibijyanye na baganga**

1) Could you please share your experience and perceptions of the current blood transfusion process at CHUK? Specifically, any insights you have on its efficiency, safety measures, and any potential areas for improvement. /Prob

Mwasobanura ibijyanye n'imikorere nibyo mutekereza ku buryo musanzwe mu koresha bwo gutera amaraso? Kubaza ibindi byinshi…

2) What specific challenges do you face when using paper-based blood transfusion services at CHUK?

Nizihe mbogamizi muhura nazo mu buryo bwo gukoresha impapura muri serivisi zo gutera amaraso mu bitaro?

3) How do problems like information delay or lack of real-time report data impact the efficiency of the blood transfusion process?

Murabyumva gute habayeho ibibazo bijyanye no gutinda cyangwa kutabonera ku gihe amakuru yasabwe ajyanye nigikorwa cyo gutera amaraso?

4) How many times paper-based prone to damage / lost/ misplaced? Do you faced by this problem?

5) Can you share any instances where you have witnessed or been aware of incidents involving the loss, damage, or misplacement of paper records in blood transfusion process? How were these incidents addressed or prevented?

Mudusangize niba hari igihe mwahuye ingaruka zishobora kuba zaratewe no kwangirika / kubura / cg kubikwa aho zitagenewe kw'impapuro muri serivice injyanye no gutera amaraso? N'uburyo mujya mukemuramo icyo kibazo?

6) Can you share any challenges or difficulties that have arisen due to the time-consuming nature of the request and delivery process for blood transfusion?

Mwadusangiza niba hari ibibazo biterwa no gutwara umwanya mu gikorwa cyo gusaba no gutanga amaraso aterwa umurwayi?

7) Are there any challenges in terms of communication and collaboration between physicians and laboratory technicians during the blood transfusion process?

Hari imbogamizi zijyanye nu buryo bw'imivugire n' imikoranire hagati ya baganga nabakora muri laboratwari?

8) Is there anything else you would like to add or any insights you believe would be helpful for the improvement of the current system?

Hari ibyo mwakongeraho cyangwa mwatubwira kugirango imikorere ijyanye no gutera amaraso no kuyasaba ijyende neza , mwatubwira.

❖ **For medical laboratory technicians / ibijyanye nabakora muri laboratwari**

1. Could you please provide more details about your experience and perceptions of the current blood transfusion process in your role? Specifically, how have you been involved in this process, what aspects have you found most effective, and are there any areas where you see opportunities for improvement?

Mwasobanura ibijyanye n'imikorere nibyo mutekereza ku buryo musanzwe mukoresha bwo gutera amaraso? Uburyo iyi procesesi yose ikorwamo, ibyo mwifuza, naho mubona hakenerwa imbaraga?

2. What, in your opinion, are the primary challenges associated with using paper-based blood transfusion services at CHUK? How do these challenges impact patient care and the overall efficiency of the healthcare system, and can you suggest any strategies or solutions to address these issues?

Uko mubitekereza, murabona ari izihe mbogamizi zibanze muhura nazo mu buryo bwo gukoresha impapuro muri serivisi yo gutera amaraso, n'uburyo mwifuza ko byakemukamo kugirango tuzamure ireme by'ubuvuzi, n'igisubizo mwatanga kuri icyo kibazo.

3. In well developed countries they have a blood bank management system or electronic blood transfusion management system to manage the stock, usage, availability, expiring dates alerts of blood into a system. What are your insights about that? To what extend this may help your current situation?

Mu bihugu byateye imbere uburyo bwo kugenzura aho amaraso abikwa cg ibijyanye no gutera amaraso nu buryo bikorwamo bikorerwa muri sisitemu, ububiko, ibyakoreshwejwe/ibisigaye, ingano yibirimo, kwibutsa italiki yigihe bishobora kurangiriraho, ibyo byose bikorerwa mw'ikoranabuhanga muri sisitemu. Murabitekerezaho iki? Mutekereza ko hari icyo byabafasha mu mikorere musanzwe mukoreramo?

4. To what extent do you think problems such as information delay or real time report data affect your blood transfusion process?

Ni ku kihe kigero mutekereza ko biba ikibazo iyo habayeho gutinda no kutabonera amakuru yasabwe ku gihe ajyanye ni gikorwa cyo gutera amaraso?

5. Are there effects caused by incomplete data forms in blood transfusion?

Hari ingaruka ziterwa no kuba amaforumu atujujwe neza mu gutera amaraso?

6. How many times paper-based prone to damage / lost/ misplaced? Do you faced by this problem?

Ni inshuro zingana gute impapuro zishobora kwangirika / kubura / cg kubikwa aho zitagenewe? mujya muhura nibi bibazo?

7. Are you facing the problem of illegible writing claims?

Mujya muhura n'ibibazo bitewe n'inyandiko zidasomeka?

8. Are there any problem caused by time consuming in process of request and delivery of blood transfusion?

Hari ibibazo biterwa no gutwara umwanya mu gikorwa cyo gusaba no gutanga amaraso aterwa umurwayi?

9. In your blood transfusion process, how difficulties has been for you to find past forms file (paper files record)?

Mu gikorwa cyo gutera maraso, hari imbogamizi zijyanye no kubura impapuro zimaze igihe mu bubiko?

10. There are problem caused by lack of storage space, where paper are placed?

Muhura n'ibibazo byo kubura aho mubika impapuro?

11. Do you faced by duplication of data entries in blood transfusion process?

Muhura nibibazo bijyanye n'amakuru ashobora kwisubiramo kumpapuro mu gikorwa cyo gutera amaraso?

12. Are there anything to add or suggestions? Are welcomed!

Hari icyo mwakongeraho cyangwa inyunganizi? Turabyakiriye!

<u>SECTION C</u> (To assess the requirements for the blood transfusion system to be integrated in EMR-OpenClinic GA at CHUK) both (Physicians and lab technicians)

IGICE CYA GATATU (Gusuzuma ibyakenerwa kugirango igikorwa cyo gutera amaraso gihuzwe n' uburyo bw'ikoranabuhanga mu kubika amakuru ajyanye n'ubuzima mu bitaro bikuru bya kamunuza y'Urwanda ishami rya Kigali) bose (abaganga nabakora muri laboratwari)

1) Are you familiar with EMR-OpenClinic GA (Electronic Medical Record)

Muzobereye gukoresha uburyo bw'ikoranabuhanga mu kubika amakuru ajyanye n'ubuzima mu bitaro (Uburyo bwo kubika amakuru ya barwayi)

2) What are the proposed strategies to overcome those challenges of using paper-based blood transfusion?

Nibihe mutekereza ko bwakwifashishwa mugukemura ibibazo biterwa no gukoresha impapura mu buryo bwo gutera amaraso?

3) In well-developed healthcare settings, digital interventions serves also the activity of blood transfusion management system. Are you think this may improve your situation?

Mu buryo buteye imbere bujyanye no kwita ku buzima, uburyo bw'ikorana buhanga buba igisubizo mu bijyanye no gusaba no gutera amaraso. Muratekereza ko ibi namwe byabafasha mu buryo mwari musanzwe mukoresha?

4) What will be the primary purpose you need in this system to be integrated in EMR-OpenClinic GA?

Ese nibihe by'ibanze byakenerwa kugirango iyi sisitemu ibe yakongerwa m'uburyo bw'ikoranabuhanga mu kubika amakuru ajyanye n'ubuzima mu bitaro?

5) What are the features or functionalities you want us to integrate into EMR-OpenClinic GA? Please explain as detailed as possible. (Probs)

Ese niyihe mikorere cyangwa ibigize iyi sisitemu mwumva byazashyirwamo? Gerageza kuvuga birambuye. (Gukomeza kubaza mpaka ubonye amakuru ushaka)

6) Are there anything to add or suggestions? Are welcomed!

Hari icyo mwakongeraho cyangwa inyunganizi? Turabyakiriye.

SECTION 4 Technical Questions related to CHUK IT personnel

IGICE CYA KANE Ibibazo bya tekinike bijyanye na bakoresha ikoranabuhunga mu bitaro hamwe nabakoze sisitemu ikoreshwa kwa muganga mu bitaro bikuru bya kamunuza y'Urwanda ishami rya Kigali.

1. What are the technical requirements that will be in place to enhance the successful implementation of blood transfusion system to be integrated in EMR-OpenClinic GA?
   Nibiki mwumva byakwibandwaho mu gukora sisistemu yo gutera amaraso izahuzwe na sisitemu isanzwe ikoreshwa y'ikoranabuhanga kwa muganga?

2. What do you presume as probable barriers to the integration in current EMR-OpenClinic GA at your institution?
   Murumva ari nkizihe mbogamizi zishobora kubaho zabangamira ihizwa rya sisitemu?

3. If the blood transfusion process were to be computerized and implemented, what are the measures that should be kept in mind? That should not be forgotten, to mitigate the issues for successful implementation.
   Mugihe ubu buryo bw'ikorana buhanga buramutse buhujwe, niki kitakwibagirwa, cyakwibandwaho kugirango kizabashe gushyirwa mu bikorwa?

4. Any addition or suggestions is highly appreciated!
   Hari inyunganizi cyangwa ikindi mwatubwira, tubahaye ikaze

Ethical clearance CEBE

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/516/2022

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

Dear Dushime Esperance,

RE: ETHICAL CLEARANCE

Reference is made to your application for ethical clearance for the study entitled ***"Need assessment and requirements for Blood transfusion system integration with EMR-OpenClinic GA at University Teaching Hospital of Kigali".***

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 this 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

Approval from CHUK Ethics Committee

CENTRE HOSPITALIER UNIVERSITAIRE
UNIVERSITY TEACHING HOSPITAL

Quality Health Care
Training & Research

Ethics Committee / Comité d'éthique

6th Feb,2023 *Ref.:EC/CHUK/023/2023*

Review Approval Notice

Dear Dushime Esperance,

Your research project: ***"Need assessment and requirements for Blood Transfusion System integration with EMR-OpenClinic GA at University Teaching Hospital of Kigali "***

During the meeting of the Ethics Committee of University Teaching Hospital of Kigali (CHUK) that was held on 6th Feb,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=714&&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 "

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