بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Developing Electronic Medical Records EMRs Framework for Sudanese Hospitals

تطوير إطار عمل للسجلات الطبية الإلكترونية للمستشفيات السودانية

A thesis submitted in partial fulfillment of the requirement for the degree of MSc. In information technology

Prepared By:

HAFIZ BAHR SHARAFELDIN ABDELSHAFI

Supervised By:

Dr. WAFAA FAISAL MUKHTAR

March 2021

الآيـــــــة

﴿ يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ وَاللَّهُ بِمَا تَعْمَلُونَ خَبِيرٌ ﴾

المجادلة: (11)

Acknowledgements

I would like to thank the following people and institutions who have helped me undertake this research: My supervisor **Dr. wafaa faisal .M**, for her enthusiasm for the study for her, support, encouragement and patience; consistent support and guidance during the works of this study.

The bahri educational hospital, federal ministry of health, ahmed gasim hospital, their collaborative effort during data collection.

Sudan university of science and technology / graduate studies for They gave me a chance to study with them in this solid educational edifice.

Dear friends and family and to my parents, and university who set me off on the road to this MSc a long time ago.

And finally, special thanks for **Dr. Mustafa Mohammed Ali** for the contribution to data collection and Provide me with important information without tiring or boredom.

ABSTRACT

An electronic Medical record (EMR) is a collection of electronic health information about individual patients or populations. It is a record in digital format that is being shared across different health care settings. The problem at present, all Sudanese hospitals in Sudan still rely on the paper-based way of keeping health records of patients. In this research, Electronic Medical Records framework was developed to automate the activities of the following sections for a Sudanese hospital; the doctor's unit, the laboratory unit, the statistics and information unit, reception (patients' registration) unit. The framework was developed using .NET framework as the front end, and SQL Server R2 as the database backend.

A framework was evaluated by using google online survey the result concluded that this framework is effective and clearly serves the health sector in Sudan through satisfactory performance, ease of use, understandability and can be relied upon in performing the main tasks. This framework – if adopted - would go a long way to solve the problems attached with the conventional paper-based records and data collection.

المستخلص

السجل الطبي الإلكتروني (EMR) عبارة عن مجموعة من المعلومات الصحية الإلكترونية حول المرضى الأفراد أو السكان. إنه سجل بتنسيق رقمي تتم مشاركته عبر إعدادات الرعاية الصحية المختلفة. المشكلة في الوقت الحاضر ، لا تزال جميع المستشفيات السودانية في السودان تعتمد على الطريقة الورقية لحفظ السجلات الصحية للمرضى. في هذا البحث تم تطوير إطار السجلات الطبية الإلكترونية لأتمتة أنشطة الأقسام التالية للمستشفيات السودانية ؛ وحدة الطبيب ، وحدة المختبر ، وحدة الإحصاء والمعلومات ، وحدة الاستقبال (تسجيل المرضى). تم تطوير الإطار باستخدام NET framework. كواجهة أمامية ، و SQL Server R2 كواجهة خلفية لقاعدة البيانات.

تم تقييم إطار العمل باستخدام استبيان google على الإنترنت ، وخلصت النتيجة إلى أن هذا الإطار فعال ويخدم بوضوح القطاع الصحي في السودان من خلال الأداء المرضي وسهولة الاستخدام والفهم ويمكن الاعتماد عليه في أداء المهام الرئيسية. هذا الإطار – إذا تم اعتماده – سيقطع شوطًا طويلاً لحل المشكلات المرتبطة بالسجلات الورقية التقليدية وجمع البيانات.

Table of Contents

List of tables

LIST OF FIGURES

Abbreviations Table

Symbol	Meaning
EMRs	**E**lectronic **M**edical **R**ecords
HITECH	**H**ealth **I**nformation **T**echnology for **E**conomic and **C**linical **H**ealth
EBM	**E**vidence **B**ased-**M**edicine
RAD	**R**apid **A**pplication **D**evelopment
CER	**C**linical **E**lectronic **R**ecord
CIS	**C**linical **I**nformation **S**ystems
PR	**P**aper-based **R**ecord
EHR	**E**lectronic **H**ealth **R**ecord
EPR	**E**lectronic **P**atient **R**ecord
WHO	**W**orld **H**ealth **O**rganization
MOH	**M**inistry **of H**ealth
SQL	**S**tructured **Q**uery **L**anguage
BMI	**B**ody **M**ass **I**ndex

List of Appendices

CHAPTER I: INTRODUCTION

1.1 INTRODUCTION

Technology has played a large and important role in healthcare in the past few decades. Therefore, it is clearly reflected in healthcare information technology systems. Electronic Medical Records (EMRs) are a form of information technology that can affect a patient's health outcomes. (Delpierre C, Cuzin L, Fillaux J, Alvarez M, Massip P, Lang T., 2014), (Chaudhry B, Wang J, Wu S, 2016).

Electronic medical records are computerized patient records that appeared in the 1970s. (L, 2008) However, it has not been widely taken up by the healthcare sector until information technology becomes available at affordable prices to these institutions. At the turn of the century, electronic medical records gained attention due to the benefits they can provide to healthcare, such as: organizing patient healthcare information, improving medical record arrangements, as well as easy and fast electronic access to medical information and report extraction. (Tripathi, M. , 2012), (Chang F, Gupta N, 2015). This has made organizations and governments create programs to promote the adoption of electronic medical records in healthcare (Tripathi, M. , 2012). The Health Information Technology for Economic and Clinical Health (HITECH) Act, which was implemented in 2009 in the United States, is a vivid example of these attempts to promote the adoption of electronic medical records (Anon., 2009).

Information technology becomes a major driver for effective business and clinical institutions. The advancement of Electronic Medical Records (EMR) technology has made it possible for a broad change in the health care provider and to replace the traditional paper-based way that was used at the time, and the use of electronic medical records promises to make great progress in patient care (Richards, R.J., Prybutok V.R. & RyanS, 2012).

The Electronic Medical Record (EMR) is located in an electronic copy of the paper record. It is a computer-based way for storing, retrieving and organizing patient data, and holds high expectations for improving the quality, performance and safety of healthcare. The EMR can contain a set of information such as patients' personal information, details of treatments, chronic diseases, ancient medical history, allergies,

laboratory and test results; And the surgeries that were performed. As well as complete documentation of the patient. Which can be accessed from various locations within the hospital under the protection of security, patient privacy and confidentiality (biohealthmatics, 2006)

Before using this new technology EMR, the situation in health care institutions was completely different from the situation it appeared after Implement it. Situation prior to implementation of electronic patient records, patient records were stored manually in paper records format. Since there is a lot of information in the paper records was written in handwriting and it is usually difficult to read, copy and understand it as it is written by health care professionals, it makes medical errors more likely, but through the existence of the electronic medical records system as a tool to facilitate access to central patient information and to provide documented records of care that support current and future care by healthcare workers and also as a means of communication between healthcare professionals who contribute to the patient's care. (H, 2011)

In the past recent years, healthcare organizations have tended to provide more customer-oriented services to achieve the goal of improving health care quality, which requires timely access to quality, complete and clear information however, due to the many limitations in the use of paper - records based on the required data. The required data may be unavailable or incomplete and clear to health care providers when needed, and to face this dilemma, health information systems have been trying to solve over the past thirty years, to make electronic medical records EMRs certified.

Electronic medical records help collect health information for individuals from birth to death so that it can be recorded, approved, and shared in various places by health care providers. The main objective of implementing electronic medical records is to improve performance and quality by reducing medical errors, providing a permanent, good and effective of communication, for exchanging information between health care providers, and gathering health information for educational and research purposes. Electronic medical records (EMRs) facilitate the use of e-health, which is the most important and complex type of health in terms of data availability, accessibility, and accuracy.

The clinician and researchers now days facing real obstacles in data collection and full information about certain health problems in community if new outbreaks of diseases and phenomena when occur. They spend a lot of time to collect the data of the field to conduct their research to solve their problems.

In Sudan, there is no implementing an electronic Medical Records EMRs to take advantage of the benefits and services provided by the electronic medical records EMRs especially for Government's clinic or medicine and hospitals. And totally depends on paper-based records which make the problem more aggravated and expensive, the private clinics and hospitals sectors interested on the financial and internal management resources aspects more than collect medical data. No one can deny the rule of research and Evidence Based-Medicine (EBM) which has guiding rule in making polices of improving patient's and community health through understand the behavior of disease and the its distribution, impact it on the human life and environment.

1.2. PROBLEM STATEMENT

At present, the hospitals in the Sudan there is no electronic Medical Records EMRs, rely on traditional paper-based medical records.

1.3 RESEARCH OBJECTIVES

The main idea of this research to design Electronic Medical Records [EMRs] framework which highlight the following:

- To create a unified database for registration of all medical information related to patients (patient History).
- To provides access to patient's record and ability to make different type of queries for required information to make reports.
- To providing permanent medical data source for studies and scientific researches or other related studies.

1.4 RESEARCH METHODOLOGY

To development the electronic medical records framework for Sudanese educational hospitals after interviews a several stages will be used, which are requirements, data collection, identification of data items, in addition to the stages of database design and interfaces, and finally the evaluation of EMR framework, which will be mentioned in detail in the chapter three.

1.5 RSEARCH SCOPE

This Electronic medical records framework for Educational hospital in Sudan.

1.6 RESEARCH STRUCTURE

Chapter one mainly discussed the research problem, objectives and methodology. Chapter two explains the Literature Review. Chapter three talk about methodology stages that use to implement the EMR framework. Chapter four will cover the development of EMR framework and what tools and techniques will be used. Chapter five the results and discussions and the evaluation of EMR framework Finally, chapter six the conclusion and recommendations.

CHAPTER II: LITERLATURE REVIEW

2.1 Introduction

This chapter will cover how information technology is involved in healthcare, which defines the electronic clinical record (ECR), clinical information systems (CIS), electronic health records. The differences between electronic medical records and electronic health records will be shown, their benefits, impact and barriers. Finally, Primary Health care and a summary of some electronic medical records that exist around the world.

2.2 Information Technology in Healthcare

Medical records or the so-called patient focal points that are keen to deliver health care within hospitals and different types of medical institutions, and the importance of records that play their role in preserving all the details and information pertaining to the patient, which represent all the examinations, diagnoses and treatment that have been performed (Junji Lin,Tianze Jiao,Joseph E Biskupiak &Carrie McAdam-Marx, 2014).

The old (manual) method of medical records was modified in the form of a file or group of papers that were handwritten, and from here the concept of electronic medical records emerged. Electronic health records do not differ much from traditional paper records in their function and purpose, but they differ completely in their nature, advantages, methods of use and benefits, in addition to being characterized by content and accessibility to it accurately through integration with different sources of information through networked systems, which led to the use of the idea centralization of information and communication between more than one hospital and medical institution (Dave Garets, Mike Davis, 2005).

The adoption of information technology in hospitals provides protection, safety, effectiveness and efficiency in healthcare delivery systems that may be used effectively in the healthcare industry to improve procedures, practices, regulations, standards, and general protocols to achieve outstanding patient outcomes and enhance patient safety and their data (Thielst, 2007). Information Technology (IT) has sufficient potential to develop and increase the value, security and performance of healthcare. Healthcare is a

huge and hugely growing industry that is undergoing a major change in its Information Technology base (Hamade, Noura, 2017).

Clinical institutions and companies work on the industry and development of healthcare and gain enormous benefits by adopting their information technology applications, ranging from medical systems to administrative systems. If the accreditation is accurate and correct in information technology, this can greatly affect the value and performance of medical services provided by clinics and medical institutions. These factors will greatly influence the progress and development of information processing in healthcare in the future, such as: population development, medical advances, and advances in informatics (Hamade, Noura, 2017) , (I.C. Chang, H. G. Hwang, & J.W. Lian, 2015).

The rapid advancement of Information Technology and the explosive growth of health information, the medical institutions create Electronic Health Record (EHR). An Electronic Health Record refers to comprehensive record of a patient health care history in digital format. terms are usually involved in Information technology IT in healthcare:

2.2.1 Clinical Information Systems CIS

Clinical Information System (CIS) is a computer-based system that is implemented for collecting, storing, viewing and make the clinical information available. The data of the clinicals it's very important to the healthcare delivery process. Clinical Information Systems may be limited in extent to a single part (e.g. laboratory systems) or they may be very diffuse and include all details of clinical information like (e.g. electronic medical records). Clinical Information Systems provide a clinical information container that stores clinical data such as the patient's medication history and illness and more. The container encodes information capable of helping physicians decide about the patient's condition, treatment options, and activities, as well as the status of decisions, actions taken, information related to them, and related information that can assist in implementing these actions (Ibrahim Zakaria, dr. diaa Mustafa, 2016).

2.2.2 Electronic Health Records EHR

The Electronic Health Record (EHR) is an extended and more detailed electronic record for patient health information created by one or more encounter in any care delivery conditions (Saima Nisar, Abas B Said, 2012), This information includes patient

vital signs, problems, past medical history, demographics, progress notes, medications, lab data, immunizations, and radiology reports. Electronic Health Records (EHR) have the ability to create a complete record of patient interviews, and also support other care-related activities directly or indirectly across the interface including evidence-based. Decision support, quality management and reporting on results (Euclid, Seeram, 2012). The disadvantages of the electronic health record are the complexity and focus on large hospitals that is considered highly commercial and profitable. Many electronic health records have different healthcare facilities, such as affiliated clinics and many diagnostic and treatment centers, as well as laboratories working on research and training, and the complex business processes to manage all these complex components (H, 2011).

The electronic health records EHRs contains all the patient's health information, and access to that data, which represents the data of the electronic health record, electronically, by the body that provides health care Electronic health record Improve the accuracy, efficiency and quality of data recorded in a health record. Promote health care practitioners' access to information to enable everyone to share it. EHR Improving the quality of care as a result of providing health information immediately. Caregivers need this at any point in time to continue the patient care process. EHR come with the introduction of an electronic health record and eliminate many of the problems in maintaining paper health records (Euclid, Seeram, 2012; N. Anju Latha ،B. Rama Murthy ،U. Sunitha, 2012). EHR maintain privacy and confidentiality, reduce medical errors and costs There are quite benefits with EHR, especially in the areas of medical error reduction, compliance, completeness of records, decision support, accurate billing, and even returns on investment. The patient's health record contains information such as the type of treatment, the patient's medical history, daily lifestyle, medications that have been prescribed, test results, and so on (Boulus, 2014).

The healthcare provider, health insurance companies, government health agencies and other health care providers such as doctors and specialists in the medical information office can access patient records, and problems facing the doctor and patient are eliminated through the electronic health records system, however electronic health data is used to suggest adequate treatment The patient is from various specialist doctors and medical advisors who have an electronic medical record. Doctors with an

electronic record speed up treatment by providing fast and secure access to this digitally stored data. The health information in electronic health record will be used as right information in the right hands at the right time will support patient health care to make correct health decision. Computer-based records take up hospital space by the device accessing it, search is nearly instantaneous, and can be accessed by multiple departments at the same time. Computerized systems help reduce medical errors. Systems can check prescriptions against patient drug allergies, dangerous drug combinations and misunderstandings caused by illegible handwritten prescription (Euclid, Seeram, 2012).

The aggregate electronic record of health-related information of an individual that is created and gathered cumulatively across more than one health care organization and is managed and consulted by licensed clinicians and staff involved in the individual's health and car (Shruti, 2011) e. Figure 2.1 show the applications of the EHR.

Figure 2.1 Applications of Electronic Health Records

2.2.3 Electronic Patient Records EPR

An Electronic Patient Record EPR is an electronic set of information about a single patient. An Electronic patient record system is a system specifically designed to provide patient records electronically. This is not necessarily limited to a single clinical information system. EPR implementation has become a major concern in the healthcare industry, as it is a major issue for healthcare quality developers. Today, despite the

immense investment in EPR systems in hospitals, these systems are not used by the clinical staff in most hospitals. The main drawbacks of EPR are limited for hospitals (Boulus, 2014).

2.3 Electronic Medical Records EMR

Electronic Medical Record EMR – All the data in a doctor's office is usually collected in the form of charts and forms on papers. The use of a paper record creates piles of papers and it is difficult to manage and use these records, and the electronic medical record is the term given to the patient medical record that is collected in electronic form, and electronic records can be easily transferred and accessed at any time and from anywhere. It is easy to transfer electronic records to several different entities at a time (Anon., n.d.). With the tremendous growth in technology, it is now possible to preserve data in an electronic format and this electronic data can be used to analyze business, patient care and draw potential conclusions, additionally physician performance and for various other researches (Junji Lin,Tianze Jiao,Joseph E Biskupiak &Carrie McAdam-Marx, 2014). According to the International Organization of Standardization (IOS) "An EMR is a repository of patient data in digital form, stored and exchanged securely, and accessible by multiple authorized users. It contains retrospective, concurrent, and prospective information and its primary purpose is to support continuing, efficient and quality integrated health care." EMRs hold a portion of a patient's health record information and are maintained by the health care provider. EMRs contain all data related to a patient's medical visits such as diagnostic, treatment, allergies and medication prescription information (I.C. Chang, H. G. Hwang, & J.W. Lian, 2015).

Electronic health records HER are similarly maintained by the healthcare provider but differ from EMRs in that they hold a complete record of the patient's lifetime health history. This includes information that reaches beyond just medical information to document a full patient history (Ministry of Medical Services, Ministry of Public Health and Sanitation, 2014). For the purposes of this review, any electronic record created with the purpose of storing patient information, which fulfils the definition by the International organization for Standardization IOS, will be referred to as an electronic medical record or EMR. EMRs were created to be a secure and efficient way to organize patient information and assist in daily primary health care functions. To

enable EMRs to perform these functions, they have been equipped with various features. The storing of organized and secure patient information is made possible through the health templates feature (Junji Lin,Tianze Jiao,Joseph E Biskupiak &Carrie McAdam-Marx, 2014).

Health templates are used to manage patient-related information such as lists of medications and treatments, a list of patient surgeries, patient history, diagnostic information, and laboratory results. The stored patient information can be used in combination with clinical decision support features to assist health care professionals with treatment and prescription options. Another way to benefit from health templates is the use of these EMR features for the exchange of patient health care information. This allows for managing the flow of laboratory, diagnostic imaging and prescription patient information by allowing for electronic communication between health care providers. feedback. The primary intended users of the EMR are health care providers; however, there are some EMR features that allow for patient involvement (I.C. Chang, H. G. Hwang, & J.W. Lian, 2015) (Hamish SF Fraser,Paul Biondich, Deshen Moodley, Sharon Choi, Burke W Mamlin, 2015). figure 2.2 show the applications of the EMR.

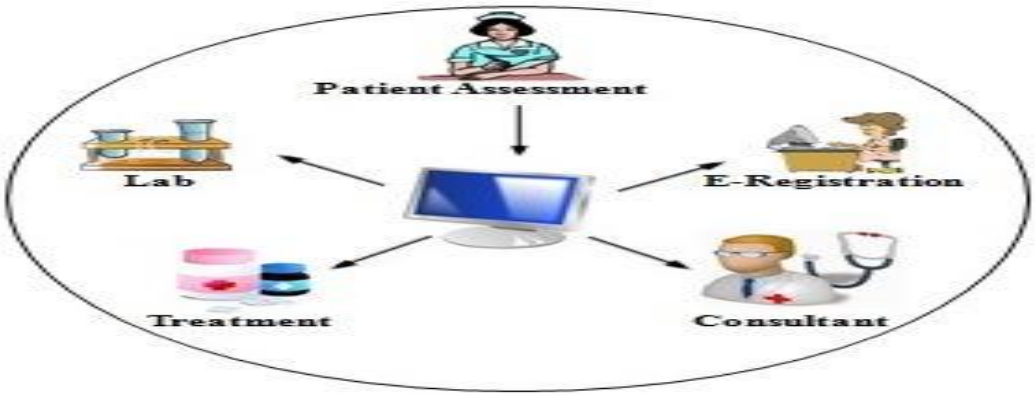


Figure 2.2 Applications of Electronic Medical Records

2.3.1 Benefits of an Electronic Medical Record EMR

Supporting patient care and improving its quality, immediate, rapid and comprehensive access to the electronic patient record, and ensuring the confidentiality and privacy of patient data at all times. Drug interactions, patient allergies, enhance productivity of health care professionals and reduce the administrative costs associated with health care delivery and financing. clinical data is easy to read and analyze and

reduction of paperwork, documentation errors, filling activities. Ability to electronically transmit information to other providers and availability of clinical data for use in quality, risk utilization (Euclid, Seeram, 2012). Electronic Medical Records (EMRs) provide health care teams with a more complete picture of their patients' health and can improve communication among members of the care team, as well as between them and their patients. According to a pan-Canadian (canada, 2010) and (KHALIFA, 2017) study, electronic medical records can:

1. Enhance efficiencies in community-based practices and allow staff to focus on patient care.
2. Reduce the number of duplicate tests that are ordered, resulting in health care system efficiencies.
3. Improve patient safety by reducing adverse drug events.
4. Support improved interactions and communications among care team members and between providers and patients.
5. Improve health outcomes when used for preventive care and chronic disease management.

2.3.2 Differences Between EMR and EHR

It is easy to differentiate between an electronic medical record and electronic health records if you think of the term "medical" as opposed to the term "health." The Electronic Medical Record (EMR) is a narrow and limited view of a patient's medical history, while the Electronic Health Record (EHR) is a more detailed and comprehensive report of a patient's general health (infoway, n.d.). Here are some of the ways that electronic medical records and electronic records differ:

- EMR is mainly used by service providers for diagnosis and treatment. EMRs are not designed to be shared outside of standardized healthcare delivery organizations. EHRs are designed to share a patient’s information with authorized providers and staff from more than one organization. EHRs allow patient medical information to be transported with them to specialists, laboratories, imaging facilities, emergency rooms and pharmacies, as well as across state lines (medicine, 2020).

Both EHRs and EMRs offer benefits to patients and healthcare providers:

With prompt, accurate and up-to-date medical records information, medical errors and healthcare errors are greatly avoided or minimized. Patient charts are more

complete and clearer – no more deciphering illegible scribbles. Sharing information can reduce redundancy of information in records, saving time, money and hassle for patients and medical providers. This makes improved access to prescribing information safer and more reliable. Promoting patient participation can encourage healthier lifestyles and more frequent use of preventative care (infoway, n.d.). More complete information means more accurate diagnoses. Electronic records are expected to make healthcare more efficient and less costly, making the switch a good investment for our nation's healthcare (medicine, 2020).

To keep it simple, EHR is a bigger umbrella and EMR is a part of it. If we look at the bigger picture of electronic health records, we are talking about electronic health records where the record and history of each patient is from all possible systems consolidated in a pool. This information includes patient's demographics, progress notes, immunization, lab results, reports etc. Hence, it is a comprehensive view of patient information from all available subsystems and patient-related records. EMR also constitutes the collaboration of data from different entities like patient's information, labs data for the patients and other clinical data information related to the patient. But in case of EMR this data has boundaries that are limited to a single practitioner or single hospital facility. It will be a drastic improvement in diagnosis of any disease and retrieval of patient's record across the globe. EHR will help in many departments of healthcare (Shruti, 2011).

2.4 Impact of EMRs

EMRs creation and introduction into primary health care, EMRs were expected to have a positive impact on the quality of health care. This was expected to be achieved through the use of electronic medical records to improve data quality and immediate, secure and seamless access to it by recording patient information and performing primary health care functions. However, even after the rise in adoption rates, studies continued to show mixed results of the impact of EMRs on patient health outcomes (Rodriguez M, Spohr M, Lippeveld T, Edwards M, 2015).

While EMRs have been successfully used as an electronic way to store patient information, the impact of the use of more advanced functionalities is still to be determined. The electronic storing of patient information provides rapid and timely

access to patient information which could assist in speeding up the provision of care. (Inc., 2020), (Q, 2012).

Use of the EMR feature resulted in improved patient outcomes through decreasing errors related to patient care. And the exchange patient information allowed for fast and timely patient referrals. The improved use of EMRs is expected to have an impact on data quality and quality of care, which could lead to improvements inpatient health outcomes (Darius Jazayeri, Patrice Nevil, Yusuf Karacaoglu, Paul E Farmer, Evan Lyon, 2012)

2.5 Barriers to EMR Use

There are some limitations that reduce the improved use of EMR records in primary health care and related fields, which may include technical, technological and financial barriers. Some of the most common challenges include: cost, required computer skills, technical EMR system challenges, knowledge of EMR functions and time. The usability of information technology systems, including EMRs, can be a barrier to their adoption (Milliard, 2012).

The technical barriers to EMR use include: lack of computer skills, time to acquire those skills and, added time to incorporate EMR into daily functions of primary health care. Adoption of EMR technology requires administrative technological capabilities. The availability and presence of technical support and technology support is the key to the continuous use of electronic medical records in primary health care. The use of EMR is essential to assist with ongoing maintenance and upgrade costs associated with the continued use of electronic medical records. Financial resources are necessary to assist in maintenance and upgrade costs associated with the ongoing use of EMRs. These three areas group the main barriers to the use and continued use of EMRs which need to be addressed using tailored interventions (Yarbrough AK, Smith TB., 2007)

2.6 EMR Data Items

When dealing with individual patient data it is important to identify specific information so that the patient can be referenced uniquely and reliably. This can be anything from a small data set of demographic and basic clinical information to a complete longitudinal electronic medical record with full professional, laboratory,

radiology and ancillary service input. Most commonly, countries have defined some set of individual patient data that is useful for continuity of care, monitoring and evaluation, or aggregate data for planning or research (Shruti, 2011).

According to the Recommendations of EMR Standards Committee (Committee, R. o. E. S., 2013), constituted by an order of Ministry of Health &Family Welfare, Government of India EMR data items can include all or part of the following:

- The diseases that the patient suffers from.
- The physician's observation of the patient's illness.
- The diagnostic tests that need to be carried out to ascertain the patient's illness and to give the patient better treatment.
- The results of the diagnostic tests
- The kind of treatment to be given to the patient.
- The way the treatment should be given to the patient.

The table 2.1 show the minimum data set MDS is recommended for an EMR to be used in India (Committee, R. o. E. S., 2013) vendors are free and indeed encouraged to opt for additional data to satisfy additional and the unmet needs of the various stakeholders, principally the patients and the clinical care providers. The letters 'O' and 'M' in the status field symbolize 'O' for optional and 'M' for mandatory.

Table 2.1 minimum EMR Data Set

Data Item	Data Type	Value / format	status
UHID	Numeric	As per Aadhar Specifications	M or O
Alternative UHID	any	As per institution/ vendor's specifications	M or O
Patient Name	Alphanumeric	To be split into First Name, Middle Name and Last (Family) Name	M
Patient birth of date	date	dd.mm.yyyy	M
Patient age	numeric	999,99,999 no preceding zero [years, months, days]	O
Patient gender	Alphanumeric	To be shortened to one byte as M, F, U or T for Male, Female, Unknown and Transgender. Systems should translate and show the full	M

		form on user screens	
Patient Occupation	Alphanumeric	Current/Permanent/Previous	M
Patient Address	Alphanumeric		M
Patient address 1	Alphanumeric		M
Patient address 2	Alphanumeric		O
Patient City/Town	Alphanumeric		M
Patient District	Alphanumeric		O
Patient State	Alphanumeric		O
Patient Pin Code	Alphanumeric		O
Patient CountryCode	Alphanumeric	As per ISO Country Codes	O
Patient Phone Type	Alphanumeric		O
Patient Phone No	Alphanumeric	(099)9999999999	O
Patient Email	Alphanumeric	Must contain '@' and "." at appropriate positions	O
Emergency Contact Person Name	Alphanumeric		O
Emergency Contact Person Relationship	Alphanumeric	Spouse/Parent/Child/Partner/Cousin/Friend Neighbor/Other	M or O
Emergency Contact Person Address Type	Alphanumeric	Current/Permanent/Previous	M or O
Emergency Contact Person Address 1	Alphanumeric		M or O
Emergency Contact Person Address 2	Alphanumeric		O
Emergency Contact Person City/Town	Alphanumeric		M or O
Emergency Contact Person District	Alphanumeric		Optional, if used
Emergency Contact Person State	Alphanumeric		Optional, if used
Emergency Contact Person Pin Code	Alphanumeric	As per ISO Country Codes	Optional, if used
Emergency Contact Person Country Code	Alphanumeric		O
Emergency Contact Person Phone number	Alphanumeric	(099)9999999999	O
Emergency Person	Alphanumeric	Must contain '@' and "." at appropriate	O

Email		positions	
Care Provider Name	Alphanumeric		
Care Provider Address Type	Alphanumeric	Current/Permanent/Previous	M or O
Care Provider Address 1	Alphanumeric		M or O
Care Provider Address 2	Alphanumeric		M or O
Care Provider City/Town	Alphanumeric		Optional, if used
Care Provider District	Alphanumeric		Optional, if used
Care Provider State	Alphanumeric		Optional, if used
Care Provider Pin Code	Alphanumeric		Optional, if used
Care Provider Country Code	Alphanumeric	As per ISO Country Codes	O
Care Provider Phone Type	Alphanumeric		O
Care Provider Phone Number	Alphanumeric	(099)9999999999	O
Care Provider Email	Alphanumeric	Must contain '@' and "." at appropriate positions	O
Insurance Status	Alphanumeric	Insured/Uninsured	O
Insurance ID	Alphanumeric	As appropriate	M or O
Organ Donor Status	Alphanumeric	Y - Yes or N - No	O
Episode Type	Alphanumeric	New/Ongoing, alternatively New/Active/Inactive	O
Episode Number	Alphanumeric	9999 format – no prefixed 0	M or O
Encounter Type	Alphanumeric	Outpatient/Inpatient/Emergency/Investigations	M
Encounter Number	numeric	9999 format – no prefixed 0	M
Encounter Date & Time	Date Time	Complete date plus hours, minutes and seconds/Complete date plus hours, minutes, seconds and a decimal fraction of a second should be auto-inserted by the system from system time	M
Reason for Visit	Alphanumeric		M
Present History	Alphanumeric		O
Past History	Alphanumeric		O
Personal History	Alphanumeric		O
Socio-economic Status	Alphanumeric		O
Immunization History	Alphanumeric		O
Allergy Status	Alphanumeric	Active/Inactive	O
Allergy History	Alphanumeric		O

Clinical Exam Vitals Systolic BP	numeric	9999 format – no prefixed 0	O
Clinical Exam Vitals Diastolic BP	numeric	9999 format – no prefixed 0	O
Clinical Exam Pulse Rate	numeric	9999 format – no prefixed 0	O
Clinical Exam Temperature (°C)	floating	99.99	O
Clinical Exam Temperature Source	Alphanumeric	Oral/Armpit/Groin/Rectal	M
Clinical Exam Respiration Rate	numeric	9999 format – no prefixed 0	O
Clinical Exam Height (cms)	floating	999.99	O
Clinical Exam Weight (kgs)	floating	999.99	O
Blood Group	Alphanumeric	A+/A-/B+/B-/AB+/AB-/O+/O	O
Clinical Exam Observation	Alphanumeric		O
Investigation Results	Alphanumeric		O
Diagnosis type	Alphanumeric	Provisional/Final/ Admission/Interim/Working/ Discharge	M
Diagnosis Code Name	Alphanumeric		M
Diagnosis Code	Alphanumeric	Coding system dependent	
Diagnosis (Description)	Alphanumeric		M
Treatment Plan Investigations	Alphanumeric		O
Treatment Plan Medication	Alphanumeric		O
Treatment Plan Procedure	Alphanumeric		O
Treatment Plan Referral	Alphanumeric		O
Other Treatment Plan Type	Alphanumeric	Diet/Life-style/ Others	M or O
Current Clinical Status	Alphanumeric	[Free text]	M

Also, the Standards and Guidelines for Electronic Medical Record in Kenya created by Ministry of Medical Services, Ministry of Public Health and Sanitation (Ministry of Medical Services, Ministry of Public Health and Sanitation, 2014) includes

patient identification information and clinic attendance or encounter information as follows:

- Collect and display essential demographic patient information such as: name, birth date, gender, etc.
- Manage patient's problem / diagnosis list: coded diagnosis, onset date, history, chronicity.
- Collect and display patient medication.
- Collect and display patient allergies.
- Collect and display test results.
- Accept encounter clinical data: vital signs, weight, height, Body mass Index BMI
- Accept clinical notes in structured format and in free text format.

2.7 EMR Data model

According to Hamish SF Fraser and others in implementing electronic medical record in developing countries paper (Hamish SF Fraser,Paul Biondich, Deshen Moodley, Sharon Choi, Burke W Mamlin, 2015). The design of the database tables and their relationships, the data model, is the core of any EMR, but unfortunately its design and implementation do not always receive enough attention.

Pressures to develop an EMRs quickly and according to a set of initial project requirements often contribute to this. The strength of the data model will dictate the scalability and flexibility of a system. The design of the database schema is usually driven by the functional requirements of the EMR; if the EMR is primarily for reporting and health statistics; there is a tendency to represent all data items as columns, similar to a spreadsheet. This approach is suitable for simple single functional function systems, such as for clinical trials, but tends to be inflexible, especially for chronic care. For more multi-functional EMR, a data model is required that:

1. Can support a variety of functions within clinical care, reporting, supplies and logistics, and research.
2. Need to be able to handle different types of data.
3. Can accommodate new data such as drugs, clinical conditions and outcomes without modifying the data model.

4. lows for temporal data; data for clinical diagnoses, laboratory tests, treatments and outcomes are often temporal in nature, particularly for chronic disease management.
5. Allows for data to be exported in standard formats for analytic and statistical packages, third party software, etc.
6. Allows for, or can gracefully expand to, support different spoken languages and variations in medical terminology.

Most EMRs use commercial relational databases such as MS Access and SQL Server and Oracle, or open source alternatives such as MySQL and Postures. Maintaining and using relational databases is simplified by the widespread availability of expertise, tools and software for these systems (Hamish SF Fraser,Paul Biondich, Deshen Moodley, Sharon Choi, Burke W Mamlin, 2015). One approach in designing a data model for more complex EMR systems is the use of a concept dictionary. For example, hard-coding types of clinical conditions and outcomes into the database schema often results in making frequent changes to the data model as the system is expanded to allow for more types of clinical conditions (Shruti, 2011). This expansion is not always possible or easily made and the data model can end up restricting certain extensions to the system. When the system expands to allow for new clinical conditions, all that is required is to insert new concept codes without changes to the database schema (Committee, R. o. E. S., 2013).

2.8 EMRs requirement

EMRs supports a function where the contents of the paper record as defined by standardized Ministry of Health MOH forms can be entered for inclusion in the EMR the basic functions of EMRs is (Inc., 2020):

1. EMR captures data that can be used for individual patient care as well as for Program monitoring and evaluation.
2. EMR shall associate key identifier information (e.g., system ID, medical record number) with each patient record.
3. EMR allows for query information in different parts of the system to be sorted and filtered by date or date ranges and chronology.

In addition to a set of requirements that are needed to develop electronic medical records framework, which will be presented in detail in the methodology chapter, namely:

1. Functional requirement.
2. Doctor's requirements.
3. Administrators requirements.

2.9 Related Works

(Hamish SF Fraser,Paul Biondich, Deshen Moodley2005 ،) dealt with the Partners in Health (PIH) that has started a programmed treatment for drug-resistant Tuberculosis TB called PIH-EMR in the favelas of Lima, Peru. PIH-EMR is a web-based EMR that was built and developed to record and track data for these patients. During the first year, the number of registered patients ranged between 4,300 and 2,900 received treatment. The PIH-EMR system was designed as Open source web powered by Oracle database. Bilingual English and Spanish. Electronic forms are to be filled out by doctors specializing in chest diseases, And also the required examination forms. Medication data were entered by the nurses and their assistants who manage patients at each site on the advice of doctors. in additionally PIH-EMR includes a clinical record, with initial history, physical examination, laboratory results, and patient prescription medications on all who receive treatment for MDR-TB. PIH-EMR provides nurses with personalized drug insertion, complications, problems and drug reactions. PIH-EMR is also used to generate periodic reports for the Global Fund, the Ministry of Health, and other related institution.

(Darius Jazayeri MEng, Carole D Mitnick ScD, Joia S, 2010) is a web-based medical record system deployed in Peru to support the management of MDR-TB (PIH-EMR). The MDR-TB EMR is a core system is a database-backed Web site which provides reliable, secure, real-time access to individual patient records from anywhere with Internet access. This was built using free software: Linux, Apache Web server and Tomcat Java servlet engine. An Oracle database was used, Web pages are written using Java server pages. Clinicians and clinical researchers are able to access the site and review patients' chart or perform real-time analyses from any Web browser. Digital images of chest x-rays are acquired with a digital camera, processed with custom software and uploaded to the system. Drug regimens are recorded in detail including the

starting date of the drug, the expected treatment duration and the daily and weekly dosages (TB drugs are usually given 6 days per week in this program).

(Darius Jazayeri, Patrice Nevil, Yusuf Karacaoglu, Paul E Farmer, 2012). developed the HIV electronic medical record (HIV-EMR) in Haiti. It is based on the technology that used to develop management of MDR-TB. Clinical data forms include Patient demographics, history of presenting complaint, Previous treatment and any adverse events, Symptoms, Physical examination, Laboratory investigations, Social circumstances, housing, occupation, drugs, narrative text is also allowed in some categories such as clinical history and assessment all that based on the paper forms. It is built with standard, open source software—Linux operating system, Apache web server, the Tomcat Java Servlet engine, and using an Oracle database.

(JOSEPH K. ROTICH, TERRY J. HANNAN,Others, 2010) The authors implemented Mosoriot Medical Record System MMRS is an electronic medical record system in a rural Kenyan health center. patient's data are recorded on a paper encounter form, eliminating duplicate documentation in multiple clinic logbooks. Data are entered into an MS-Access database through interfaces designed by visual basic framework and supported by redundant power system. a modular system comprised of a Registration Module, a paper encounter form, a data entry module, a reporting module, and a Data Dictionary. When a new patient presents to the check-in window, he or she is registered into the MMRS and given a plastic card on which his or her name and MMRS number are recorded located in an online data supplement at (www.jamia.org). when patient visit, the patient is present his or her identification (ID) card, and the MMRS number is handwritten on a blank encounter form MMRS has generate unique identifier base on the data items :First name, Middle name, Last name, Mother's first name, Father's first (name required socially to maintain the status of Kenyan men), Village, Location, Sublocation. And to assure data security and confidentiality the MMRS All accesses to the MMRS are protected by passwords, Access to data for multiple users is limited only to the users of the MMRS and persons they are responsible to provides health care, the MMRS automatically backs up its entire database to external disk. when the MMRS computer is shutdown at end of day, the entire database is back up again in a Zip disk. the MMRS' system administrator receives a copy of the entire database on a Zip disk and places it on his own computer.

(Kamadjeu, R., Tapang, E.M., & Moluh, R.N., 2005)was develops EMR system called MEDCAB in Cameron, MEDCAB is a locally designed electronic Medical record (EMR) system for primary health care sectors in Cameroon. MEDCAB was designed after observations and interviews, and modeling of the provider-patient encounters Using the International Classification for Primary Care ICPC for disease classification, and using Visual Basic 6 for programming, development platform was Microsoft Windows, MS-Access and MySQL as the system databases. The system consisted of many user interfaces with multiple functionalities including; users' administration, medical encounter, patient registration, report generation, patient card generator, diagnosis, etc.

(Kumudini Sarathchandra, Shriyananda Rathnayake, 2019) The Open-source version of HHIMS version 1 was implemented for the Regional Director of Health Services, Kegalle through the partnership with Information Communication Technology Agency and Ministry of Health, Nutrition & Indigenous Medicine planned to implement this system in 47 hospitals in 2016, 100 hospitals in 2017, and 150 hospitals in 2018.

EMR is a real time electronic record of patient's health information which can reduce healthcare costs to families, improve equitable access to quality services, and efficiently link health systems with social protection programmers, and increase accountability and sustainability of health service delivery. In past three decades, a number of different forms of EMRs have been realized in developed and developing countries although other countries are currently in the process of planning and implementing EMR systems.

Researchers and implementers have recognized several barriers such as coordination, leadership, interoperability, Confidentiality, Security, national policy, lack of empirical research, etc. Therefore, it is important to conduct a systematic empirical research to find-out these barriers and develop a national policy/outline which will be instrumental for policy makers to expedite this national implementation of EMR in Sri Lanka.

The completion of the University Malaya Medical Center UMMC Breast Cancer Module required populating EMR including management of clinical data access, establishing information technology and research focused governance model and

integrating clinical data from multiple internal clinical departments. This multidisciplinary collaboration has enhanced the quality of data capture in clinical service, benefited hospital data monitoring, quality assurance, audit reporting and research data management, as well as a framework for implementing a responsive EMR for a clinical and research organization in a typical middle-income country setting. Future applications include establishing integration with external organization such as the National Registration Department for mortality data, reporting of institutional data for national cancer registry as well as data mining for clinical research. We integration of multiple clinical visit data sources provides a more comprehensive, accurate and real time update of clinical data to be used for epidemiological studies and audits

(Nurul Aqilah Mohd Nor, Nur Aishah Taib, others, 2019) Quality Implementation Framework (QIF) was adopted to develop the breast cancer module as part of the inhouse EMR system used at UMMC, called i-Pesakit©. The achievement of the i-Pesakit© Breast Cancer Module requires management of clinical data electronically, integration of clinical data from multiple internal clinical departments towards setting up of a research focused patient data governance model. The 14 QIF steps were performed in four main phases involved in this study which are: initial considerations regarding host setting, creating construction for implementation, continuing structure once implementation begins, and improving future applications. The architectural framework of the module incorporates both clinical and research needs that comply to the Personal Data Protection Act

2.10 Related works summary

Table 2.2 show summarized some studies which dealing with and implementation electronic medical records EMRs.

Table 2.2 Related works summary

Authors	EMR Name/Country	Design	results
Siika AM, Rotich JK, Simiyu CJ et al	AMRS/ Kenya	Two networked computers running Microsoft (MS) AccessTM, powered by a UPS with solar battery back-up. For the AMPATH project,	Data are collected on all patients seen in the medical clinic, including their laboratory results and medications

		the network has expanded to seven networked computers linked to a single MS Access database.	
Hamish SF Fraser,Paul Biondich, Deshen Moodley	PIH-EMR/Peru	Open source web system backed by an Oracle database.	The PIH-EMR collected a clinical record with initial history, physical examination, laboratory results and medications on all patients receiving individualized treatment for MDR-TB
Milberg J	Careware/ Uganda	Stand-alone database built with MS Access	An internet-accessible version that is under development will allow local data entry offline but provide networked communications and back-up
Darius Jazayeri, Patrice Nevil, Yusuf Karacaoglu, Paul E Farmer	HIV-EMR/Haiti	Open source web system backed by an Oracle database (the same as the PIH-EMR) with an additional offline client for data entry and review.	History, physical examination, social circumstances and treatment recorded. Decision support tools provide allergy.
Kamadjeu et al	MEDCAB / Cameron	using Visual Basic 6 for programming, and development platform was Microsoft Windows, MS-Access and MySQL as the system databases	locally designed electronic Medical record (EMR) system for primary health care sectors
Nurul Aqilah, Mohd Nor, Nur Aishah Taib and others	Malaysia/i-Pesakit©	14 QIF steps performed in 4 main phases (i)initial considerations regarding host setting, (ii) creating structure for implementation, (iii) ongoing structure once implementation begins, (iv) improving future applications.	management of clinical data electronically, integration of clinical data from multiple internal clinical departments

As recommendations extracted from previous studies and the table 2.2 Most researcher's data are collected on all patients seen in the medical clinic and designed after observations and interviews, including their laboratory results and medications and management of clinical data electronically, integration of clinical data from multiple internal clinical departments ,Electronic medical records are designed using tools such as open source web pages,vb6, Microsoft access and Oracle packages as database tools.

Data items in the aggregate were identified using previously used forms manually in clinics or hospitals because most electronic medical records target specific diseases such as HIV treatment and drug-resistant Tuberculosis TB.

CHAPTER III: METHODOLOGY

3.1 Introduction

Electronic Medical Records EMRs are increasingly being deployed within healthcare institutions to reduce the problems and limitations. In this chapter the research will cover research methodology stages, EMR user requirement and data items, Basic Demographic and Clinical Health Information, EMR Data Model, EMR User Interfaces.

3.2 Research methodology Stages

To development the electronic medical record framework for Sudanese educational hospitals a several stages will be used Figure 3.1 shows the stages of the methodology used in this research.

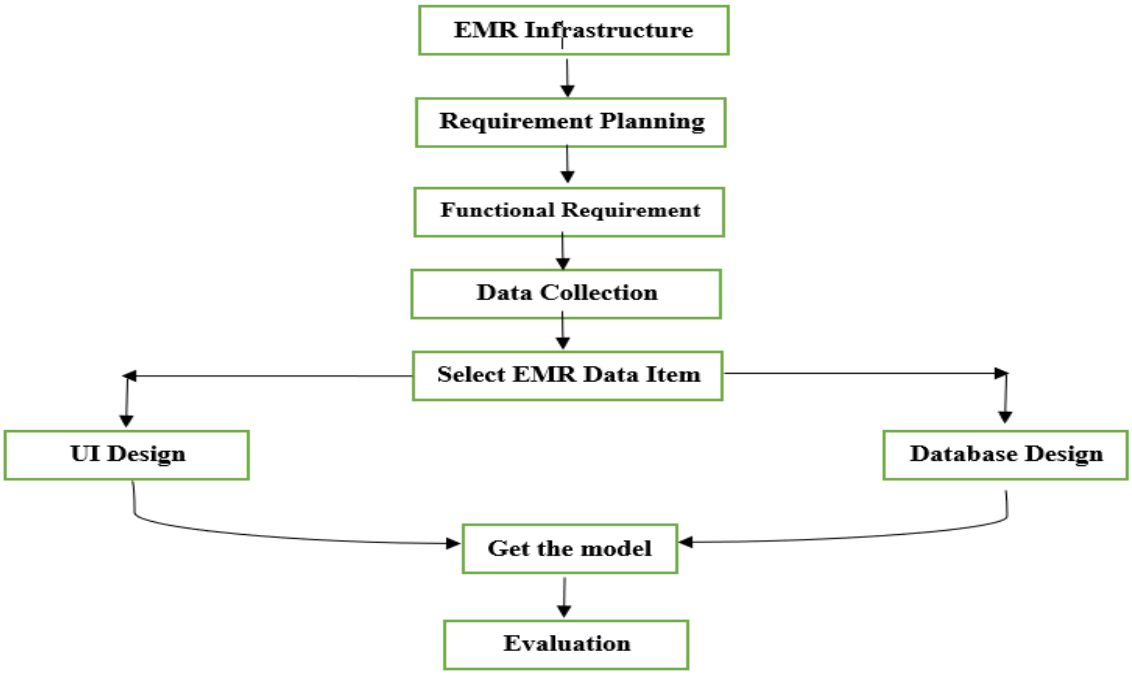


Figure 3.1 research methodology stages

3.3 EMR infrastructure

The proposed Electronic Medical Record framework consists of number of Sub-prototypes that works together to captures and stores and manages the medical information. The first prototype works inside the organization provides the EMR

service, and this sub-prototype performs Registration and management of Medical Information, and patients' records services which already given the permission, in additionally to manage the EMR users. The second sub-prototype works in the center that provides services and performs the registration and manages user's accounts which those doctors. The last subsystem follows to the center around the department of the statistical and information which follows to the ministry of health to make reports. This sub-prototype work on query the health information of the patient and exchanges it with ministry of health and other related parties.

3.4 Requirements Plan

Requirements plan can be considered the second stages of the methodology shown in figure 3.1. the plan is intended to define the requirements that must be met and will be mentioned in some detail. In the following sections.

3.4.1 Functional requirement

captures data that can be used for individual patient care as well. The prototype shall associate key identifier information (National ID) with each patient record. and allows for get queries about information in different parts of the system to be sorted and filtered to reporting.

3.4.2 Doctor's requirements

For the doctors, they would like a prototype that allows them to access the records from other hospital when they were authorized by EMR admin. So, they don't have to view a handwritten record. That can significantly reduce the medical accident caused by misunderstanding. Doctors hope they can not only read the patient's medical record, but also can create new medical records and make query (report) from medical records.

3.4.3 Administrators requirements

The International Standards Association (ISA) specified that EMR should be a container for healthcare-related information in a computer-readable format. It can be accessed by multiple users in a secure manner, as all users have their own privileges, and medical records can only be accessed when the administrator of the users allows them to do so. its primary purpose is to support continuing, efficient and qualitative integrated health care (Q, 2012).

In the proposed framework the EMRs needs to be managed by administrator. In this part, there is a name list of users (doctor, admin, Register, MoH Report) with their permissions. Administrator need to be able to modify users, add or delete users. If users want to join to the EMR need to apply to the administrator and then added by the administrator. All user accounts should be managed by the administrator. When doctors need to deal with the patient's medical records, must login first by user name and password.

To avoid abusive registration, all the users in this framework can register only one account for each person. They had to use their ID number (security code) to register their account. In the registration, users can set up their password. Also, when users forget the password, there is the ability to retrieve the account via ID number.

3.5 data collection

In the data collection stage, data were collected through the interview and the data available by the Federal Ministry of Health, which is the form that is filled out in teaching hospitals and using India's recommendations That is, in this thesis, we were mainly used to collect data on the template used in educational hospitals that shows in Appendix A1,and the interview that was conducted, and (Committee, R. o. E. S., 2013) recommendations .

3.6 Selection EMR framework Data Items

This research based on data collection will use mixed data items, between the Sudanese ministry of health templet all Sudanese educational hospital use and fill the template shown in Appendix A1 (Dr.mustafa, 2019), which contain the following information: Doctor name, Patient personal information and contact, provisional diagnosis, history of present illness, past medical history, drug history, physical examination, muscle skeletal, investigations and result (Lab examination and result) and medication, analgesics and fluids (Dr.mustafa, 2019).

Taking into consideration the Standards and Guidelines for Electronic Medical Record in Kenya created by Ministry of Medical Services, Ministry of Public Health and Sanitation (Ministry of Medical Services, Ministry of Public Health and Sanitation, 2014) and (Committee, R. o. E. S., 2013) recommendations that was mentioned in the

chapter literature review in the table 2.1 minimum data set. Table 3.1 show the selected data items to develop proposed framework.

Table 3.1 framework selected Data items

Data Item	**Data Type**	**Value / format**
National ID	Numeric	As per Aadhar Specifications
Alternative ID	Any	As per institution/ specifications
Patient Name	Alphanumeric	Full Name
Patient age	Numeric	999 formats
Patient gender	Alphanumeric	Male, Female, other
Patient Occupation	Alphanumeric	
Patient Address	Alphanumeric	
Patient Phone No	Alphanumeric	(099)9999999999
Patient Email	Alphanumeric	Must contain '@' and "." at appropriate positions
Emergency Contact Person Name	Alphanumeric	
Emergency Contact Person Relationship	Alphanumeric	Spouse/Parent/Child/Partner/Cousin/Friend Neighbor/Other
Emergency Contact Person Phone	Alphanumeric	(099)9999999999
Emergency Person Email	Alphanumeric	Must contain '@' and "." at appropriate positions
Hospital	Alphanumeric	
Care Provider Phone Number	Alphanumeric	(099)9999999999
Care Provider Email	Alphanumeric	Must contain '@' and "." at appropriate positions
Insurance Status	Alphanumeric	Insured/Uninsured
Insurance ID	Alphanumeric	As appropriate
Insurance provider	Alphanumeric	
Organ Donor Status	Alphanumeric	Y - Yes or N – No
Location /state	Alphanumeric	
Patient arrive time		hh:mm:ss format
Present History	Alphanumeric	
Past History	Alphanumeric	
Socio-economic Status	Alphanumeric	Middle/poor/Rich class

Immunization status	Alphanumeric	Complete / not complete
Allergy Status	Alphanumeric	Active/Inactive
Blood Pressure	Numeric	999-999 formats
Central nerves system CNS	Alphanumeric	
Total white blood cells TWBC	Numeric	9999 formats
Pulse Rate	Numeric	999/999 formats
Temperature (°C)	Floating	99.99 formats
Temperature Source	Alphanumeric	Oral/Armpit/Groin/Rectal
Respiration Rate	Numeric	9999
Height (cms)	Floating	999.99
Weight (kgs)	Floating	999.99
Blood Group	Alphanumeric	A+/A-/B+/B-/AB+/AB-/O+/O
Observation	Alphanumeric	
Jugular Venous Pressure JVP	Alphanumeric	
Erythrocyte ESR	Alphanumeric	
URINE	Alphanumeric	
BF	Alphanumeric	
Hemoglobin HB	Alphanumeric	
STOOL	Alphanumeric	
Final Diagnosis	Alphanumeric	
prescription	Alphanumeric	
Medications	Alphanumeric	
Medication history	Alphanumeric	
chronic disease	Alphanumeric	
Family disease history	Alphanumeric	

After specify data items and selected in data collection stage the stages database design and tables schema, user interface UI design will implement and mentioned in detail in chapter Five development chapter.

CHAPTER IV: DEVELOPIMENT

In this chapter, design of the database, design of its tables schema, and its description, as well as the graphical user interfaces related to those in the tables. Also, this chapter, will cover the results we reached in this study, the types and forms of reports, how to conduct the information and present the electronic medical record EMR in its final form, in addition to the reports of the Sudanese Federal Ministry of Health, which is represented in the statistics and information unit.

4.1 Database Diagram (Class Diagram)

Is a type of static structure diagram that describe the structure of the database by shown the framework classes, their attribute and operations or methods and the relationship among objects .in this research we have five classes patient record, EMR Admin, Doctor, register and ministry of health Reports which represent a department of statistical and information in the hospital The figure 4.1 Show the classes and class attributes and operations and their types of relationships.

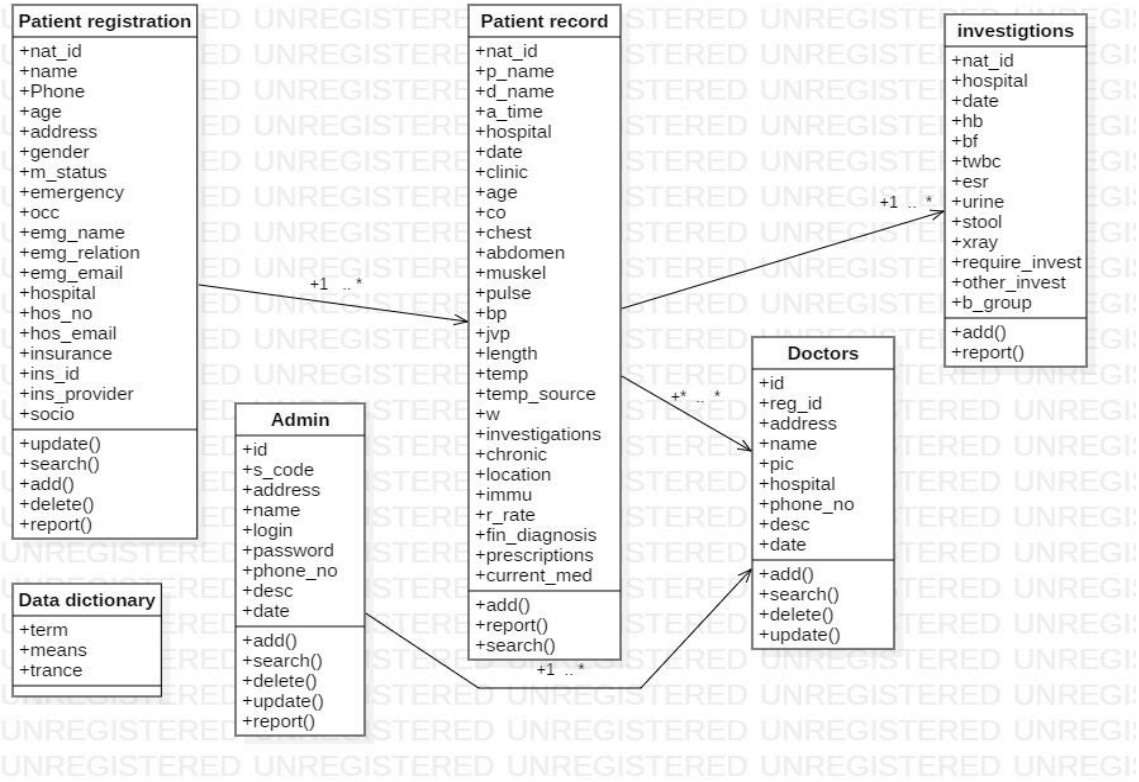


Figure 4.1 framework Class Diagram

4.2 EMR Database design

After examining the requirement planning and a clear understanding of the environment on which data will be build and specified data items, can disintegrate the source database into several parts. The use of this is that it will make a clear partition with regards to different entities present in the healthcare industry and the way data will flow through these entities.

Every part has its own importance and the data that corresponds to that part can be utilized in developing reports. we will describe many parts and the entities which interact with them using user interfaces UI, the database design its designed using SQL server 2008 R2, also UI designed using Microsoft visual studio IDE and visual basic .Net programming language as a tool. Different database tables designs will also be explained.

4.2.1 Registration part

This part contains the basic information about the patients the data items which related to registration part shown in table 4.1 table schema.

Table 4.1 patient registration schema

Field	Data type	Description	constraint
Nat_id	Data type (number)	Patient national id	p. k
Name	Data type (String)	Patient full name	Not null
Phone_no	Data type (number)	Patient phone no	Null
age	Data type (number)	Patient age	Not null
Address	Data type (String)	Patient address	Not null
Gender	Data type (String)	Patient gender	Not null
M_status	Data type (String)	Patient marital status	Not null
Emergency	Data type (number)	Phone no for emergency case	Not null
occ	Data type (String)	Current patient occupation	Not null
Emg_name	Data type (String)	Emergency contact person name	Null
Emg_relation	Data type (String)	Emergency person relationship	Null
Emg_email	Data type (String)	Emergency person Email	Null
Hospital	Data type (String)	Hospital name	Null
Hos_No	Data type (number)	Hospital phone number	Null
Hos_Email	Data type (String)	Hospital email address	Null
insurance	Data type (String)	Insurance status	Null
Ins_id	Data type (number)	Patient insurance id	Null
Ins_provider	Data type (String)	Patient insurance provider name	Null
socio	Data type (String)	The patient Socio-economic status	Null

UI Entry Screen

Through the interface shown in figure 4.2 the register can control user's data and their permissions in addition to the ability of view, adding, modifying, deleting.

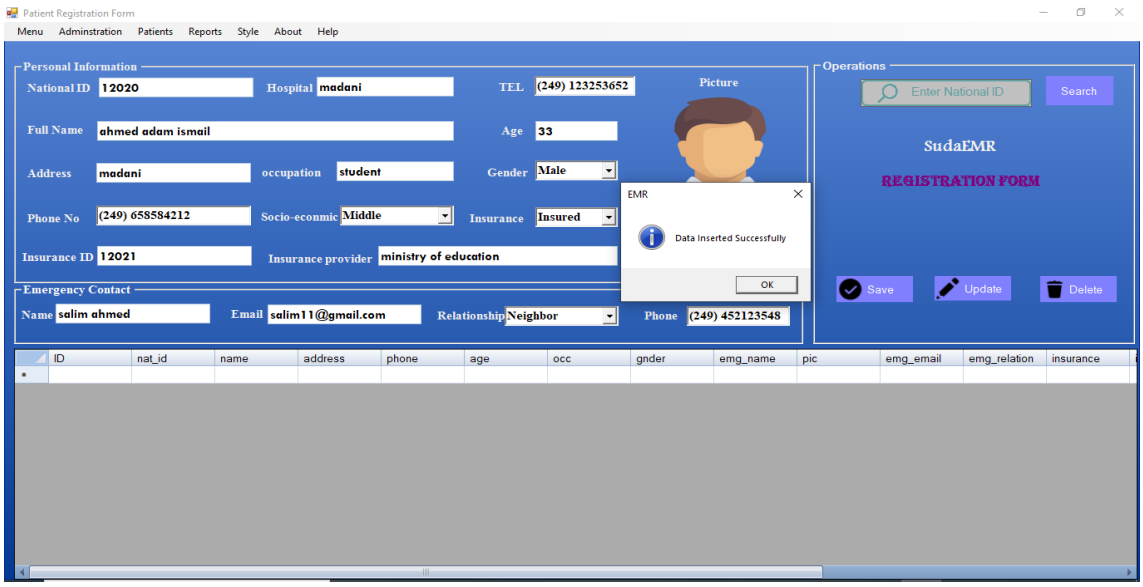


Figure 4.2 patient registration UI

4.2.2 Administration part

This part contains the information about the EMR framework users and manage the passwords. And the table schema shown in table 4.2.

Table 4.2 administration schema

Field	Data type	Description	Constraint
ID	(number)	Table identity	Pk
S_code	(number)	Security code this use when user forget the password to restore it	Unique
Address	(String)	User address	Null
Name	(String)	User full name	Null
Login	String	The user name using to login	Unique
Password	String	User password	Unique
Phone no	Number	Phone number	Null
Desc	String	User description this field specify the user type (doctor, register, report, admin)	Not null
Date	Date	The user registration date	Null

UI Entry Screen

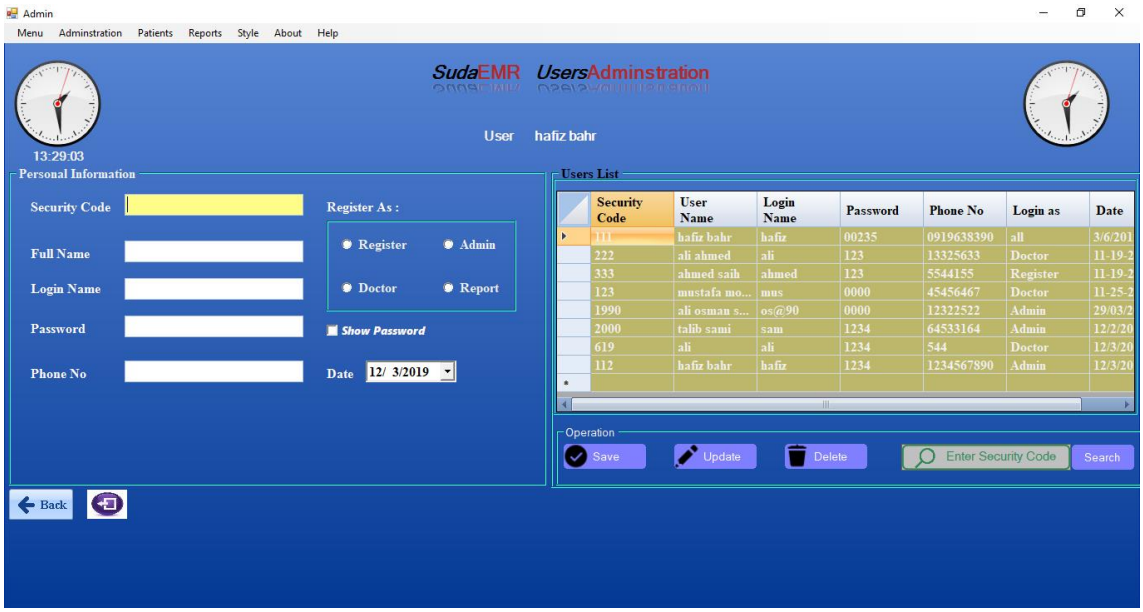


Figure 4.3 Admin UI

4.2.3 Doctors part

This part contains the information about the doctors who deal with EMR framework. Table 4.3 shows the doctor's table schema

Table 4.3 doctor's schema

Field	Data type	Description	Constraint
ID	(number)	Table identity	Pk
Reg_id	(number)	Represent doctor registration identity	Unique
Address	(String)	doctor address	Null
Name	(String)	doctor full name	Not null
Pic	image	Doctor picture	Null
Hospital	String	The hospital where the doctor works	Unique
Phone no	number	Phone number	Null
Desc	string	The doctor description and specialty	Not null
Date	date	The doctor registration date	Null

UI Entry Screen

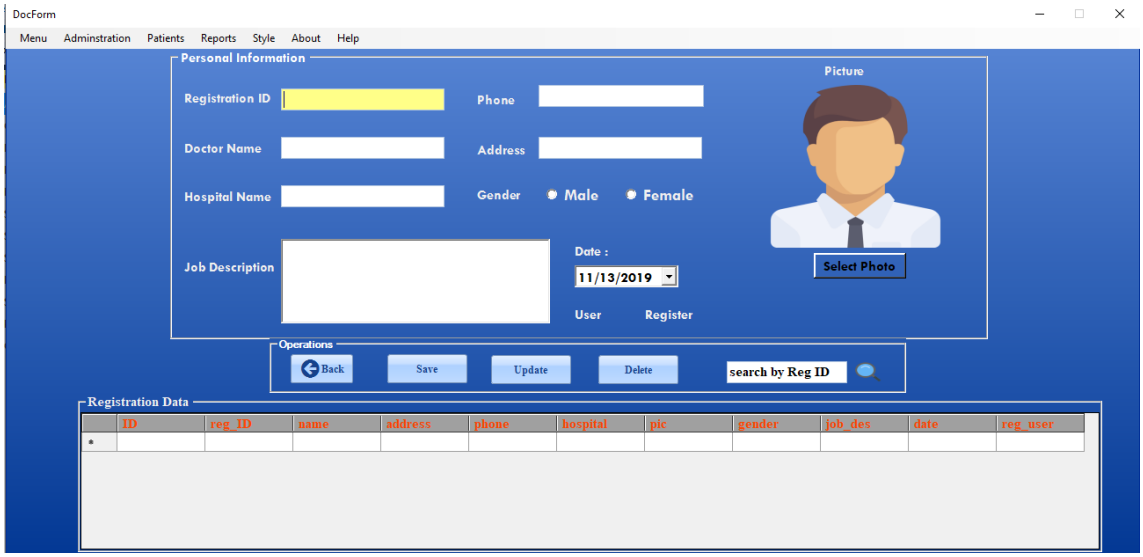


Figure 4.4 Doctors UI

4.2.4 Patient Record Part

This Part is containing table initial patient data and medications such as general patient status, chest, abdomen, pulse, blood pressure, body temp, required investigations and so on the table. Table 4.4 patient record schema.

Table 4.4 patient record schema

Field	Data type	Description	Constraint
Nat_id	Number	Patient national identity	p. k
P_name	Number	Patient full name	Not null
D_name	String	Doctor name	Not Null
A_time	Date time	Patient arrival time	Not null
Hospital	String	Hospital name	Not null
date	Date	Hospital Entry date	Not null
Clinic	String	Medical clinic	Not null
Age	Number	Patient age	Not null
co	String	Patient Complaint and General condition of the patient	Null
Chest	String	Chest state	Null
abdomen	String	Abdomen problems	Null
Muskel	String	Patient Skeletal stat	Null
Pulse	Number	The patient heart pulse	Null
Bp	Number	Patient blood pressure	Not null
Jvp	Number	Patient jugular venous pressure	Null
Length	Number	Patient length	Null
Temp	Number	Patient body temperature	Not null
Temp_source		Temperature source	Null
W	Number	The patient weight	Not null

investigations	String	List of required investigations sent to lab	Null
observations	String	-	Null
chronic	String	Patient chronic disease	Null
location	String	Patient came from	Null
immu	String	Patient Immunization status	Null
R_rate	number	Patient Respiration rate	Null
Fin_diagnosis	String	The patient final diagnosis	Not Null
prescriptions	String	The patient prescription	Null
Current_med	String	The patient current medications	Null

UI Entry Screen

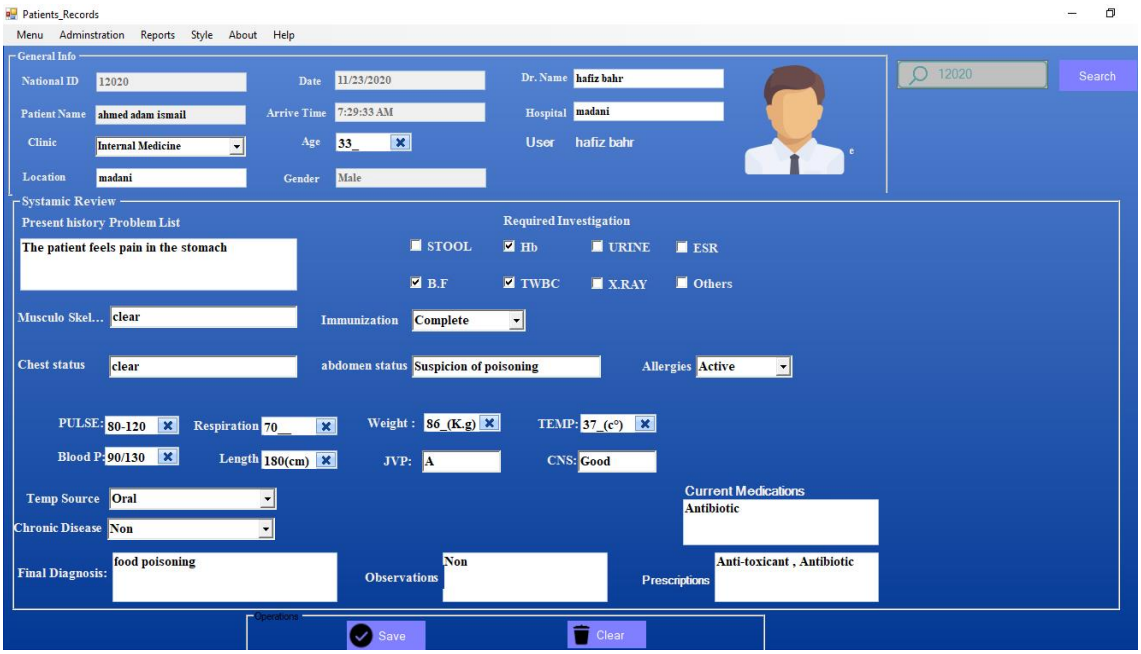


Figure 4.5 patient record UI

4.2.5 Investigations Part

This part uses to deal with and handle most recent investigation and the results of lab examinations that uses in Sudanese educational hospitals. Table 4.6 shows lab investigation table schema and figure 4.5 show the UI.

Table 4.5 lab investigation schema

Field	Data type	Description	Constraint
Nat id	(number)	The patient national id	Pk
Hospital	string	Hospital where patient take service	Not null
Date	Date	Investigation date	Null
Hb	String	Hemoglobin test	Null
Bf	String	Blood film test	Null
Twbc	String	Total white blood cells test	Null
Esr	String	For erythrocyte test	Null
Urine	String	Urethra test	Null
Stool	Sting	Stool test	Null
Xray	String	Xray	Null
Require_invest	String	For required investigations	Null
Other_invest	String	For other invests	Null
B_Group	String	For patient blood group	Null

UI Entry Screen

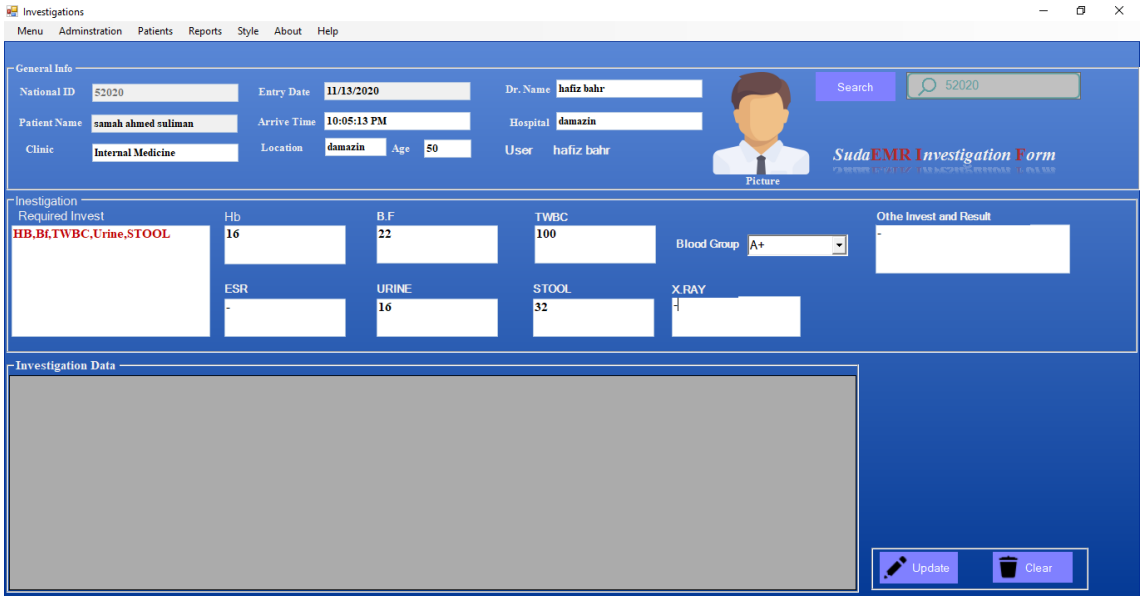


Figure 4.6 Investigations UI

4.3 Data dictionary

EMRs Allows for, or can gracefully expand to, support different languages and variations in medical terminology (Hamish SF Fraser,Paul Biondich, Deshen Moodley, Sharon Choi, Burke W Mamlin, 2015). Also, one of the components of this form is a dictionary of medical terms used in the data elements, provided with terminology, which allows the user to search for a specific term and know its interpretation and its

meaning, also provided by speech in English language. As shown in Figure 4.7 and table 4.6 show the data dictionary data items schema.

Table 4.6 data dictionary schema

Field	Data type	Description	Constraint
Term	String	Medical term used in framework	Pk
means	String	The medical term meaning	Not null
trans	String	The medical term meaning in Arabic	Not null

UI Entry Screen

Figure 4.7 Medical Terminology UI

4.4 BMI Calculation

According to (Ministry of Medical Services, Ministry of Public Health and Sanitation, 2014) EMR includes patient identification information and clinic attendance or encounter information Body Mass Index (BMI)

BMI is a measurement of a person's weight with respect to his or her height. It is more of an indicator than a direct measurement of a person's total body fat. BMI, more often than not, correlates with total body fat. This means that as the BMI score increases, so does a person's total body fat. BMI in an individual is calculated by the use of a mathematical formula (Dr. Ananya Mandal, MD, 2019). The formula is - BMI = (Weight in kilograms) divided by (Height in meters squared)

A normal BMI score is one that falls between 18.5 and 24.9. This indicates that a person is within the normal weight range for his or her height. A BMI chart is used to categorize a person as underweight, normal, overweight, or obese. Figure 4.8 show the framework Body Mass Index BMI calculation.

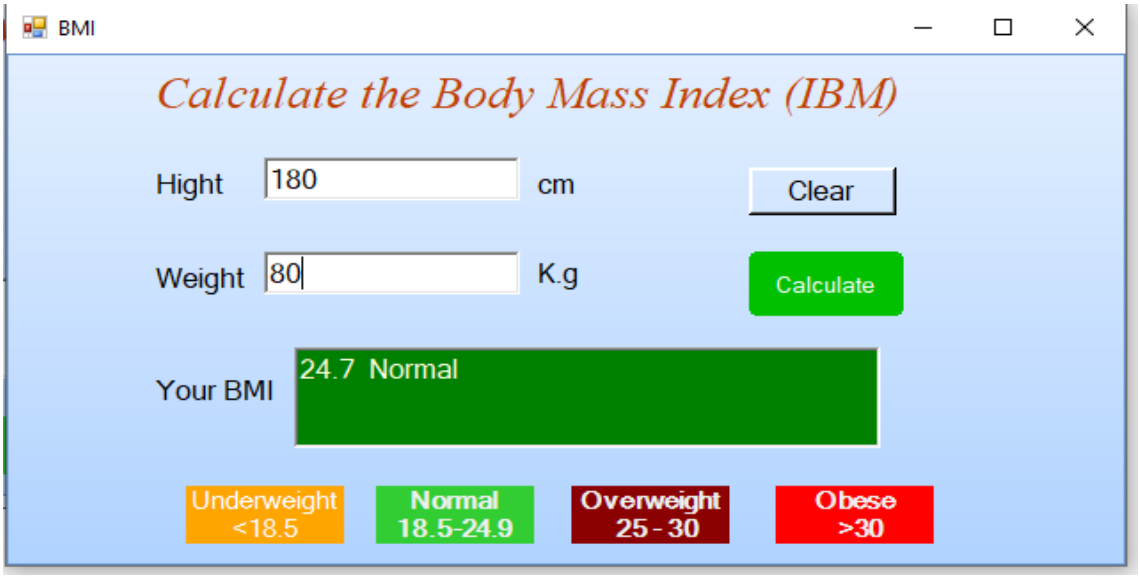


Figure 4.8 BMI calculation UI

5.4 SUMMARY

After complete all stages and designing the class diagram, database schema, user interfaces this electronic medical records framework form was built and will discuss what was reached and present the form of reports and the form of the final medical record of the patient and evaluation of the EMR framework in the chapter Five Results and Discussion chapter.

CHAPTER V: RESULTS AND DISCUSSION

5.1 introduction

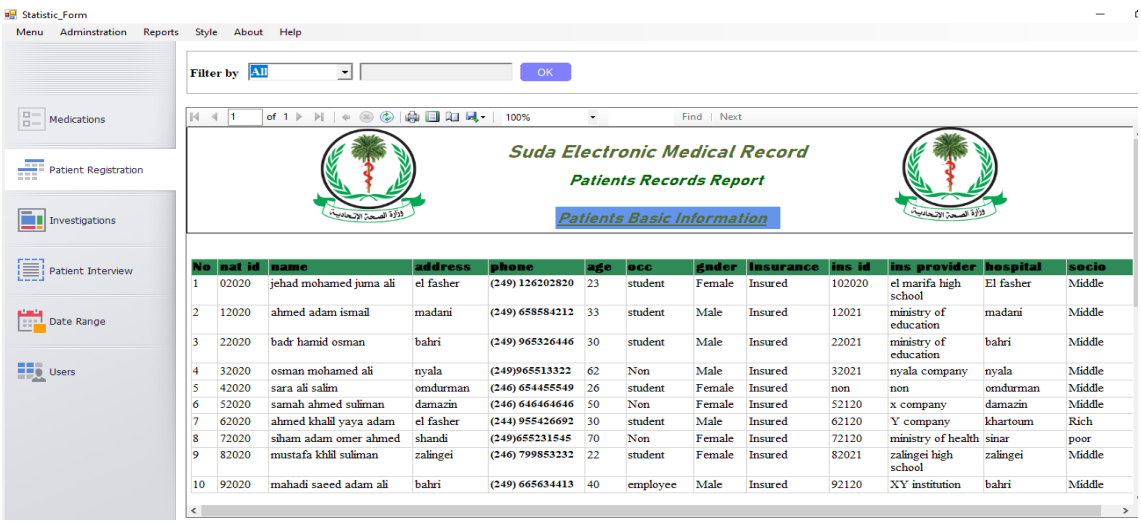
In this chapter show the results obtained and the reports, export report data in other standard format will also display the final medical record of the patient, finally the EMR Framework evaluation.

5.2 Results and discussions

The proposed framework provides reports and we can perform some query through it, will display the reports and one example of the query that can be done in each report and the results of the query.

5.2.1 Registered patients

the information of patients registered in the electronic medical records EMR framework can be inquired by, patient name, phone number, national identity, and can get all data by select “all” option from combo box in this illustration, we take the inquiry through the patient National Id. Figures: 5.1 before query and 5.2 after query.



No	nat id	name	address	phone	age	occ	gnder	Insurance	ins id	ins provider	hospital	socio
1	02020	jehad mohamed juma ali	el fasher	(249) 126202820	23	student	Female	Insured	102020	el marifa high school	El fasher	Middle
2	12020	ahmed adam ismail	madani	(249) 658584212	33	student	Male	Insured	12021	ministry of education	madani	Middle
3	22020	badr hamid osman	bahri	(249) 965326446	30	student	Male	Insured	22021	ministry of education	bahri	Middle
4	32020	osman mohamed ali	nyala	(249)965513322	62	Non	Male	Insured	32021	nyala company	nyala	Middle
5	42020	sara ali salim	omdurman	(246) 654455549	26	student	Female	Insured	non	non	omdurman	Middle
6	52020	samah ahmed suliman	damazin	(246) 646464646	50	Non	Female	Insured	52120	x company	damazin	Middle
7	62020	ahmed khalil yaya adam	el fasher	(244) 955426692	30	student	Male	Insured	62120	Y company	khartoum	Rich
8	72020	siham adam omer ahmed	shandi	(249)655231545	70	Non	Female	Insured	72120	ministry of health	sinar	poor
9	82020	mustafa khlil suliman	zalingei	(246) 799853232	22	student	Female	Insured	82021	zalingei high school	zalingei	Middle
10	92020	mahadi saeed adam ali	bahri	(249) 665634413	40	employee	Male	Insured	92120	XY institution	bahri	Middle

Figure 5.1 patient registered before query

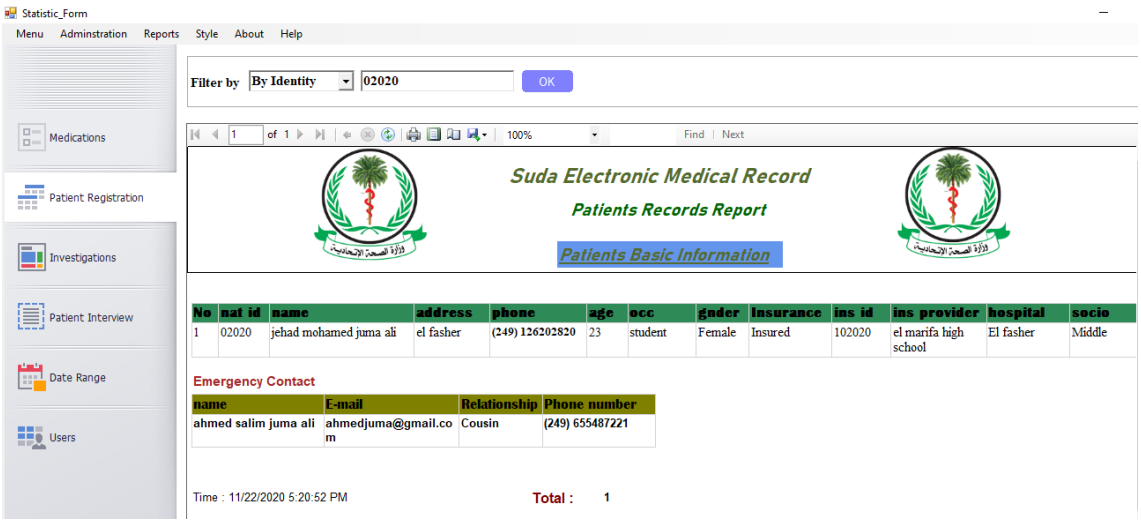


Figure 5.2 patient registered after query

5.2.2 Patient interviews

In the report the information of Interview the patient with the doctor in the electronic medical records EMR framework can be inquired by, Doctor name (Who monitors the patient's condition), Location, Hospital, diagnosis, national identity, and can get all records by select “all” from options. in this illustration, we take the inquiry through the doctor name. Figures: 5.3 before query and 5.4 after query.

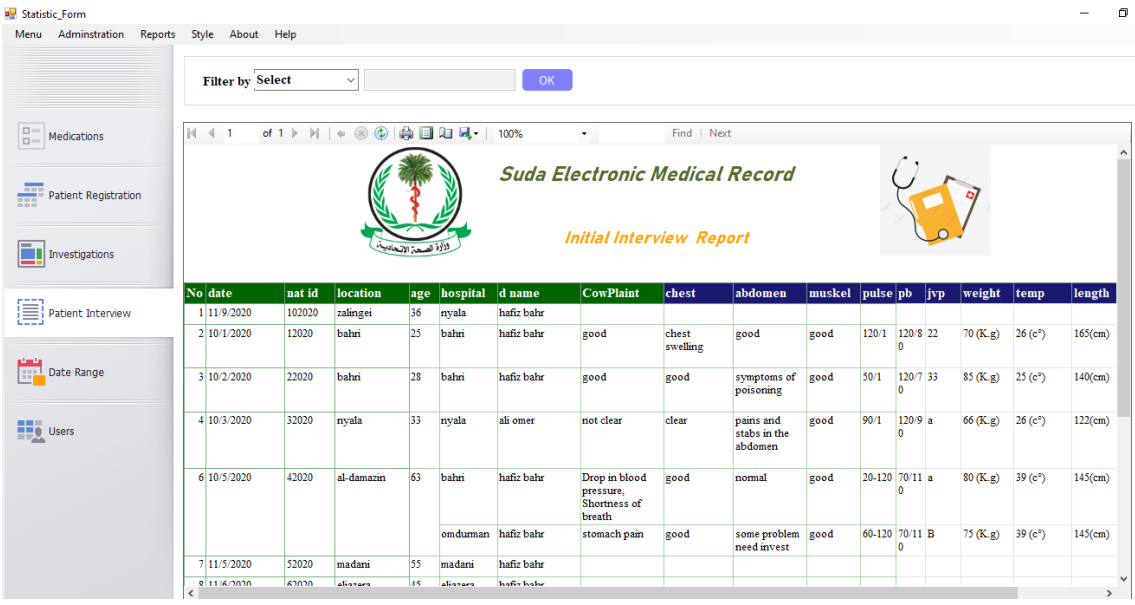


Figure 5.3 patient interviews before query

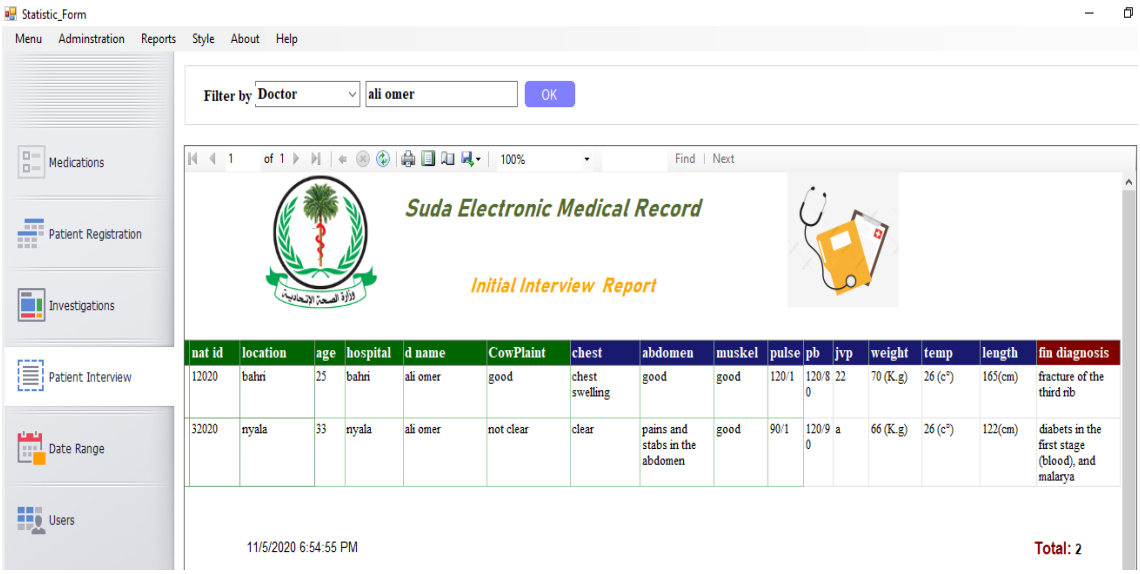


Figure 5.4 patient interviews after query

5.2.3 Lab Investigations

In the report shown in Figure 5.5 and 5.6 the results of patients Lab examinations in the electronic medical records EMR framework can be inquired investigations such as, Hb, BF, RWBC, ESR, URINE, STOOL, X.RAY, and blood group. in this illustration, we take the inquiry through the Blood Group (O+). Figures: 5.5 before query and 5.6 after query.

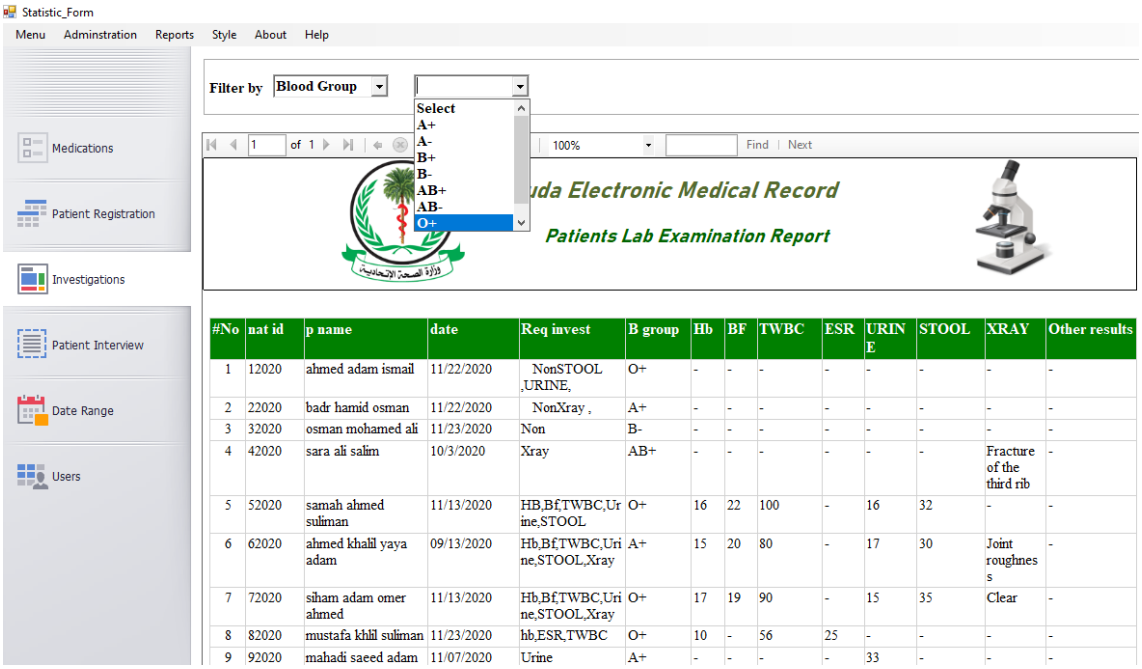
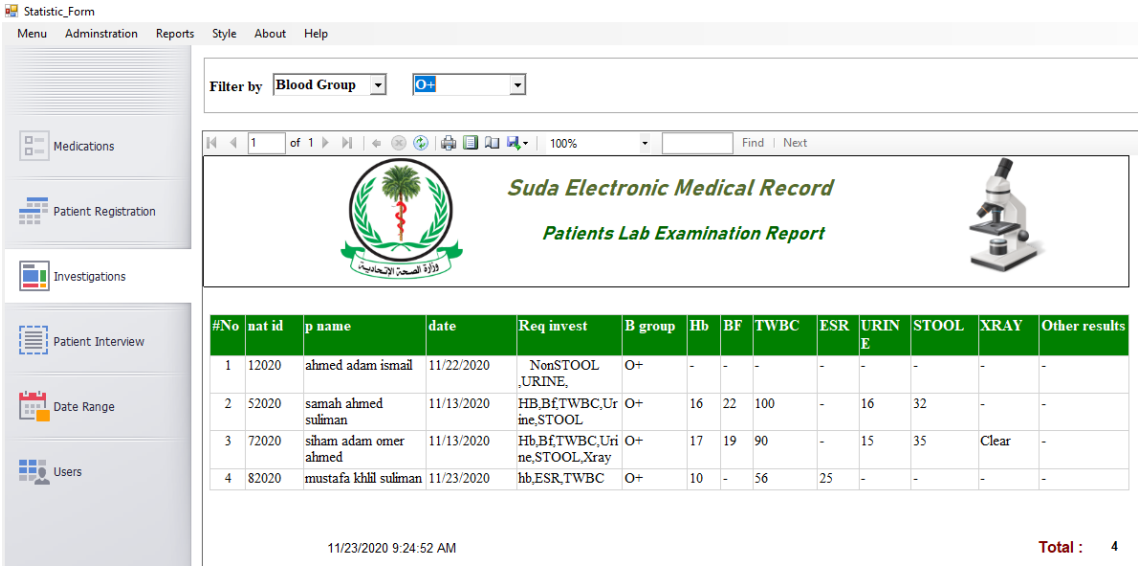


Figure 5.5 lab investigations before query

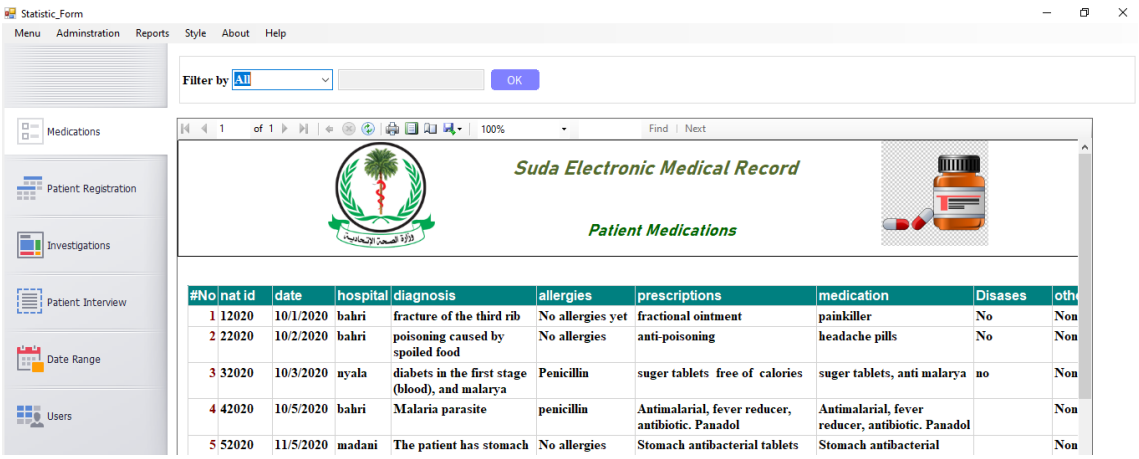


#No	nat id	p name	date	Req invest	B group	Hb	BF	TWBC	ESR	URINE	STOOL	XRAY	Other results
1	12020	ahmed adam ismail	11/22/2020	NonSTOOL ,URINE,	O+	-	-	-	-	-	-	-	-
2	52020	samah ahmed suliman	11/13/2020	HB,Bf,TWBC,Urine,STOOL	O+	16	22	100	-	16	32	-	-
3	72020	siham adam omer ahmed	11/13/2020	Hb,Bf,TWBC,Urine,STOOL,Xray	O+	17	19	90	-	15	35	Clear	-
4	82020	mustafa khlil suliman	11/23/2020	hb,ESR,TWBC	O+	10	-	56	25	-	-	-	-

Figure 5.6 lab investigations after query

5.2.4 patients' medications

In the report shown in Figure 5.7, 5.8 the patients medications data in the electronic medical records EMR framework can be inquired by, patient national id, medications, allergies, and can get all records by select "all" from options, in this illustration, we take the inquiry by the allergies (Allergy that affects the patient to a specific treatment like "penicillin"). Figures: 5.7 before query and 5.8 after query.



#No	nat id	date	hospital	diagnosis	allergies	prescriptions	medication	Disases	oth
1	12020	10/1/2020	bahri	fracture of the third rib	No allergies yet	fractional ointment	painkiller	No	Non
2	22020	10/2/2020	bahri	poisoning caused by spoiled food	No allergies	anti-poisoning	headache pills	No	Non
3	32020	10/3/2020	nyala	diabets in the first stage (blood), and malarya	Penicillin	suger tablets free of calories	suger tablets, anti malarya	no	Non
4	42020	10/5/2020	bahri	Malaria parasite	penicillin	Antimalarial, fever reducer, antibiotic. Panadol	Antimalarial, fever reducer, antibiotic. Panadol		Non
5	52020	11/5/2020	madani	The patient has stomach	No allergies	Stomach antibacterial tablets	Stomach antibacterial		Non

Figure 5.7 medications before query

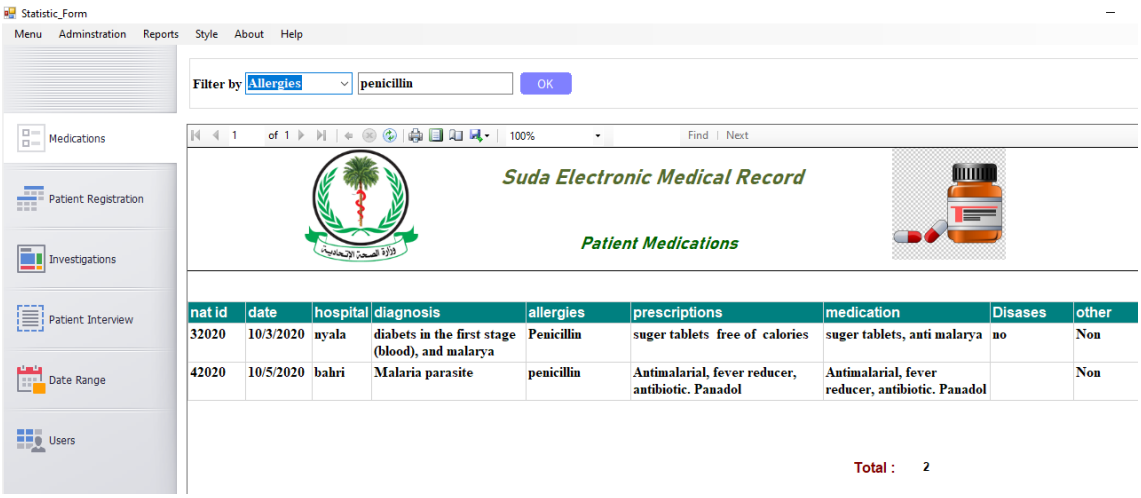


Figure 5.8 medications after query

5.2.5 Date Range Query

In the report shown in Figure 5.9, get the patients data by entering a specific range of dates in the electronic medical records EMR framework. And the data it contains is Patient's national number, patient's name, clinic, name of the treating physician, required laboratory tests, final diagnosis, prescriptions, treatments and date. Figures: 5.9 before query and 5.10 after query.

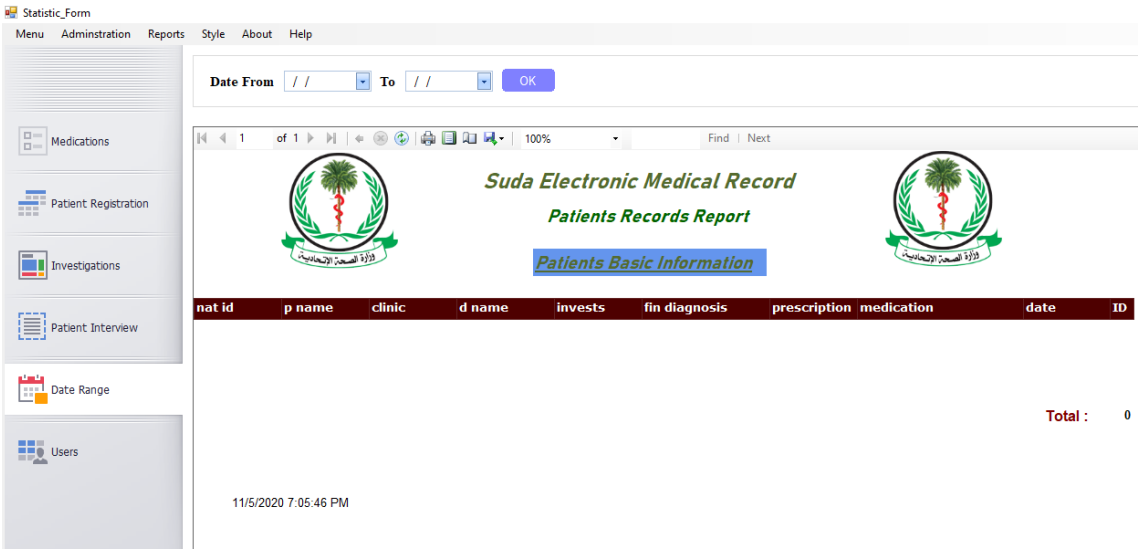


Figure 5.9 date range before query

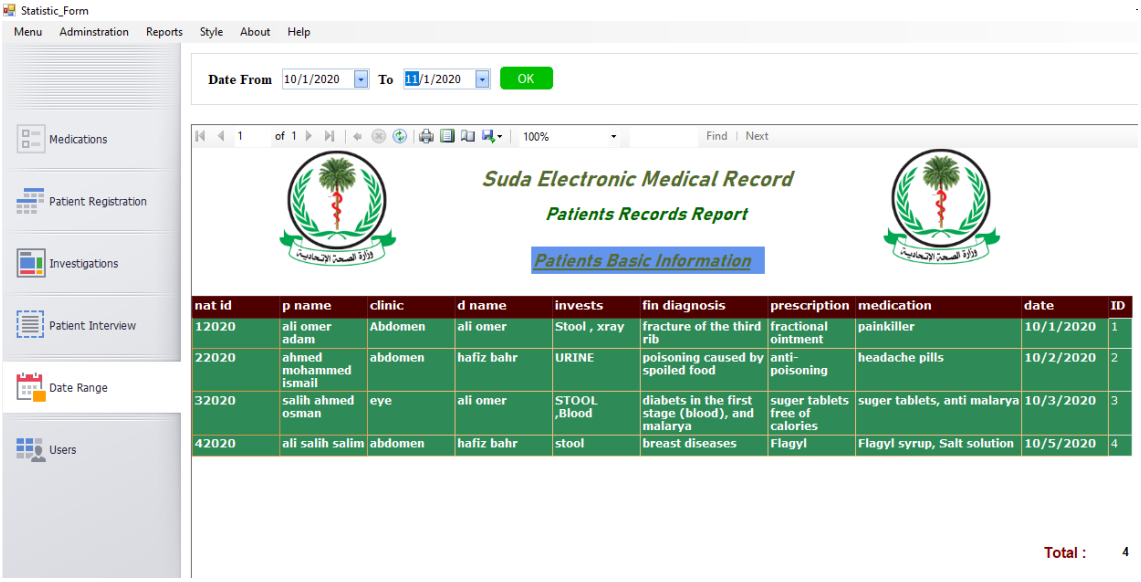


Figure 5.10 date range after query

5.2.6 EMR Framework Users

In the report shown in Figure 5.11, get the Framework users data by entering a specific date, user name, security code. And the data it contains is, user full name, user login name, password, phone number, description, and date. in this illustration, take the inquiry by the user security code. Figures: 5.11 before query and 5.12 after query.

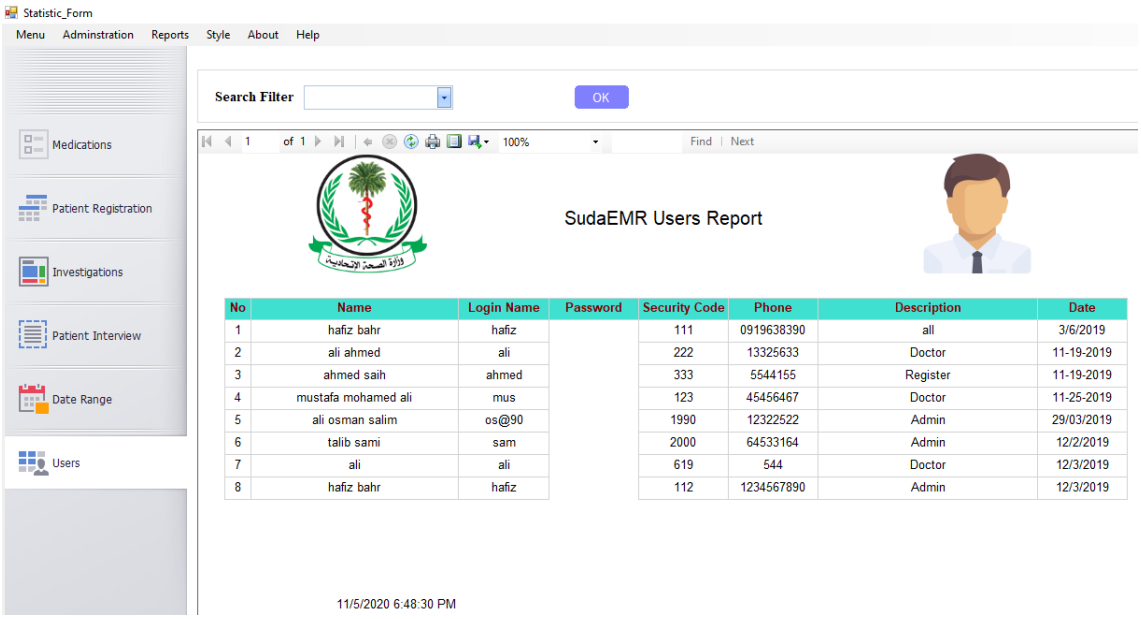


Figure 5.11 EMR framework users before query

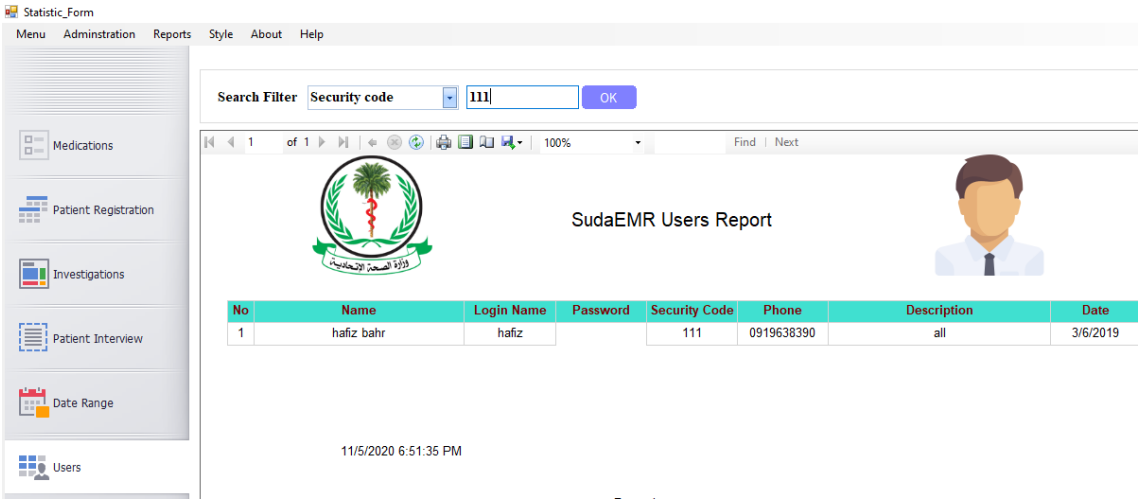
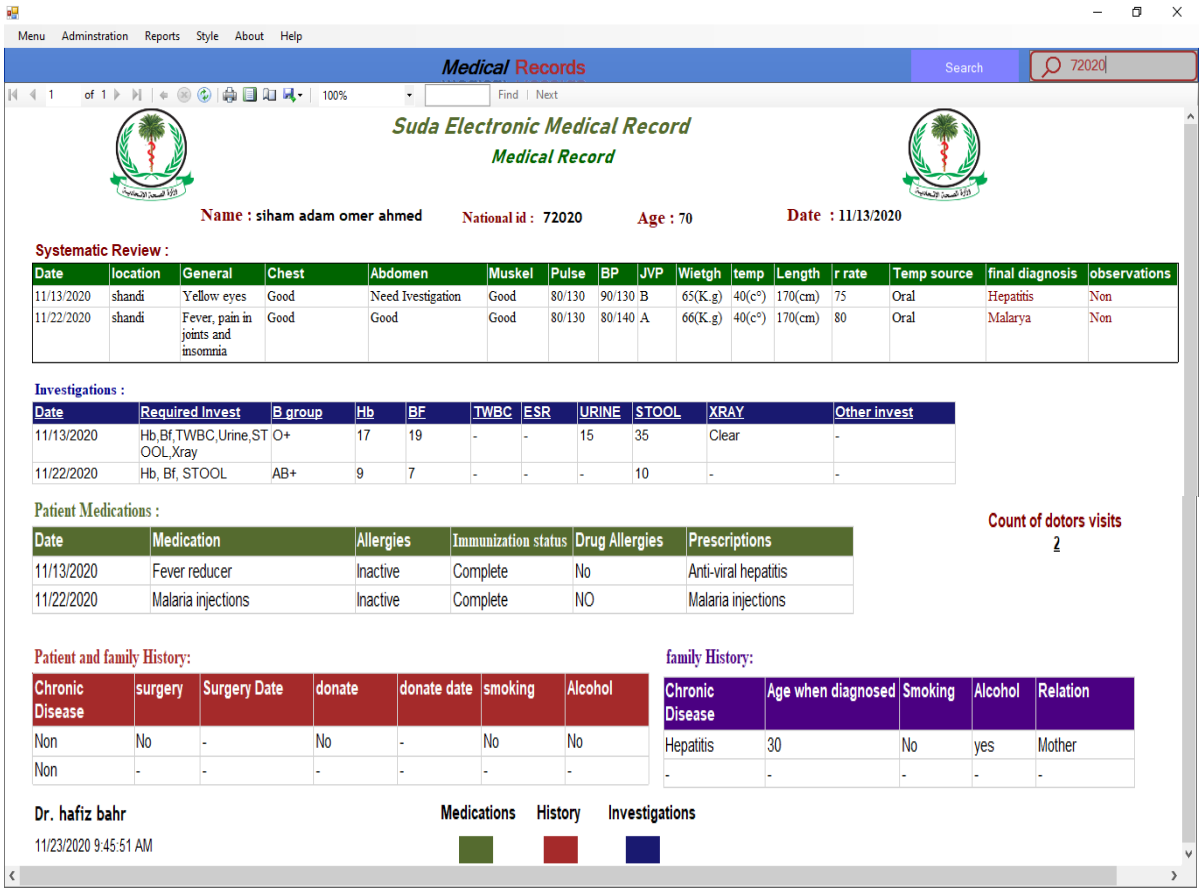


Figure 5.12 EMR framework users after query

5.3 Final Medical record

With this final patient medical record which represents all previews patient's history, we have obtained the final medical record of the patient as shown in the figure 5.13. We can search for a medical record for a specific patient by entering the patient national id and searching for him in order to obtain all the data related to the patient.

This data such as: name, age, gender, address, date of visit the doctor, laboratory investigations, medications, prescriptions, diagnosis, chronic diseases, allergies that the patient suffers from, chronic and hereditary diseases reported by family members and the number of times he went to the doctors. This record can be printed, shared with the competent authorities by exported to other standard documents format like portable document format Pdf, Microsoft word, Microsoft excel sheets.



Date	location	General	Chest	Abdomen	Muskel	Pulse	BP	JVP	Wietgh	temp	Length	r rate	Temp source	final diagnosis	observations
11/13/2020	shandi	Yellow eyes	Good	Need Ivestigation	Good	80/130	90/130	B	65(K.g)	40(c°)	170(cm)	75	Oral	Hepatitis	Non
11/22/2020	shandi	Fever, pain in joints and insomnia	Good	Good	Good	80/130	80/140	A	66(K.g)	40(c°)	170(cm)	80	Oral	Malarya	Non

Date	Required Invest	B group	Hb	BF	TWBC	ESR	URINE	STOOL	XRAY	Other invest
11/13/2020	Hb,Bf,TWBC,Urine,STOOL,Xray	O+	17	19	-	-	15	35	Clear	-
11/22/2020	Hb, Bf, STOOL	AB+	9	7	-	-	-	10	-	-

Date	Medication	Allergies	Immunization status	Drug Allergies	Prescriptions
11/13/2020	Fever reducer	Inactive	Complete	No	Anti-viral hepatitis
11/22/2020	Malaria injections	Inactive	Complete	NO	Malaria injections

Chronic Disease	surgery	Surgery Date	donate	donate date	smoking	Alcohol
Non	No	-	No	-	No	No
Non	-	-	-	-	-	-

Chronic Disease	Age when diagnosed	Smoking	Alcohol	Relation
Hepatitis	30	No	yes	Mother
-	-	-	-	-

Figure 5.13 final Medical record

5.4 Export in Standard Format

For more multi-functional, a data model is required that Allows for data to be exported in standard formats for analytic and statistical packages, third party software, etc. (Hamish SF Fraser,Paul Biondich, Deshen Moodley, Sharon Choi, Burke W Mamlin, 2015) . The proposed framework Allows for data to be exported in standard formats such as PDF, Excel Sheets, Word. for scientific researchers, analytic and statistical packages, third party software, etc. This process is illustrated an example of exporting the report to Excel Sheet.

This report export process can be done on any report provided by this proposed framework, including the final medical record of the patient that we talked about previously. Figure 5.14 and figure 5.15 show the report export into excel sheets.

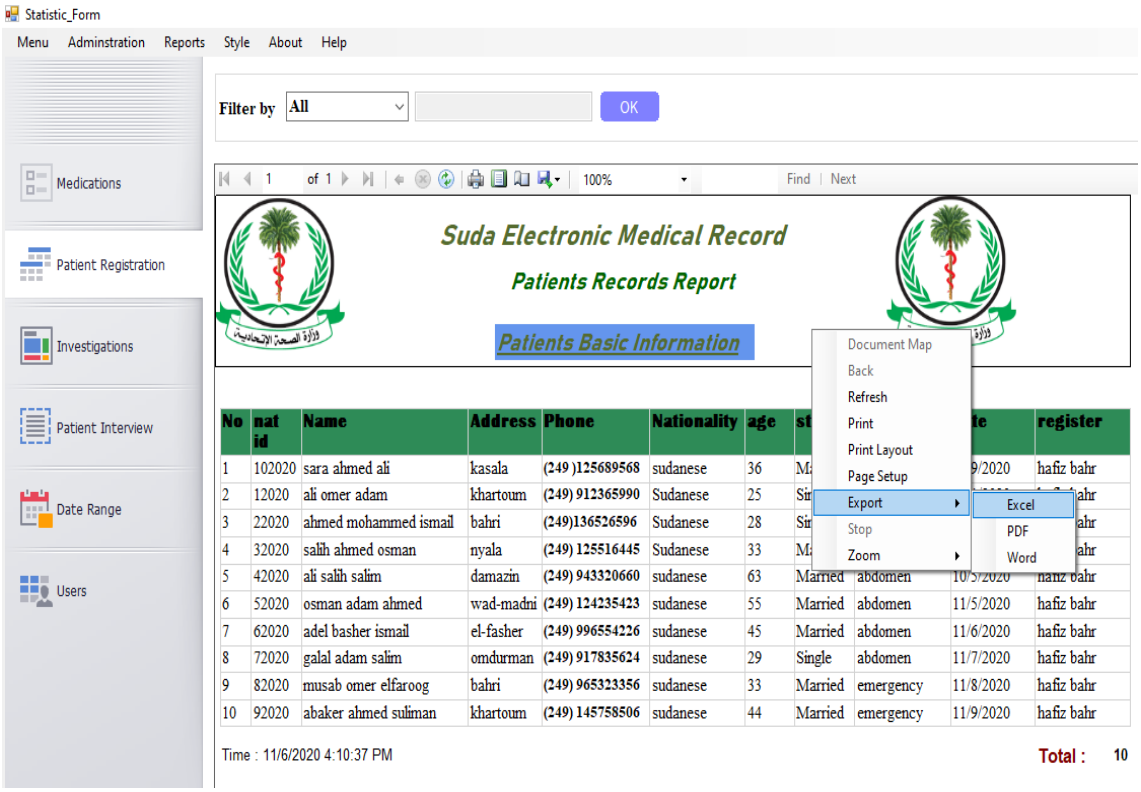


Figure 5.14 report data export process

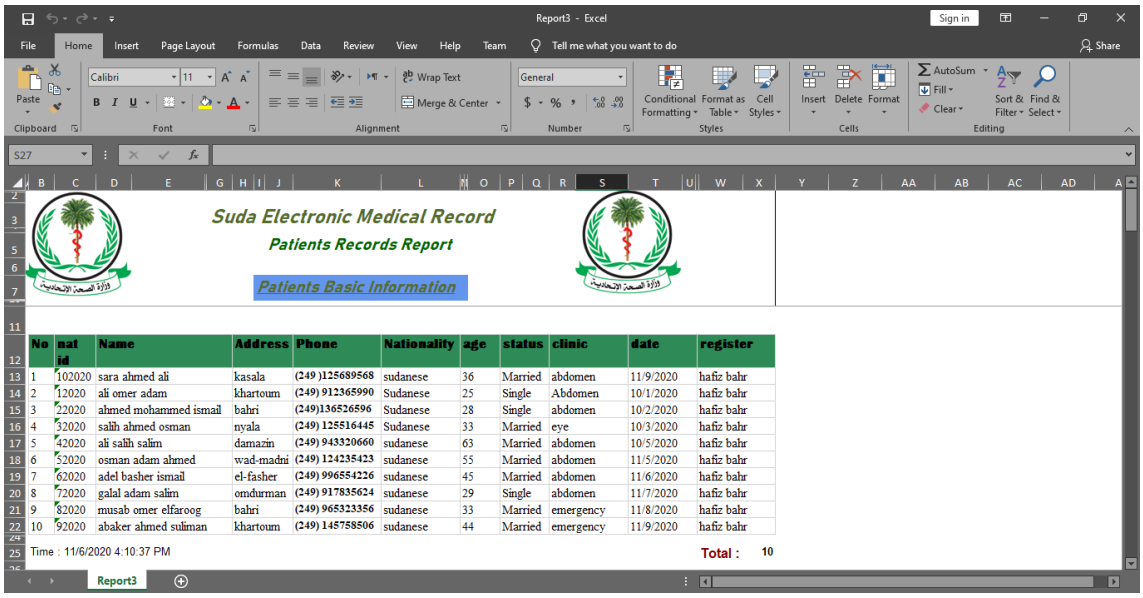


Figure 5.15 report data in Excel Sheet

On this screen, we can search for a specific medical term and we will get a result, explaining the intended meaning of the term, and by pressing the atom we can hear the pronunciation of the term and its meaning in English It also provides the intended meaning of the reformer in Arabic as well.

5.5 EMR Framework Evaluation

To evaluate the Electronic Medical Records (EMR) framework, a google online survey (google forms, 2021) was used. doctors and medical personnel working in a different group of Sudanese hospitals were targeted Who numbered sixty-two 63 people, and this survey consisted of several questions appearing in Appendix B2 about ease of use and satisfaction. efficiency and functionality. The following graphs show the results of the answers about the survey.

Figure 5.16 show the result of opinions about the ease of use of electronic medical records framework developed, Question options were divided into poor, fair, satisfactory, very good, and excellent the result was the result is that this framework is easy to use

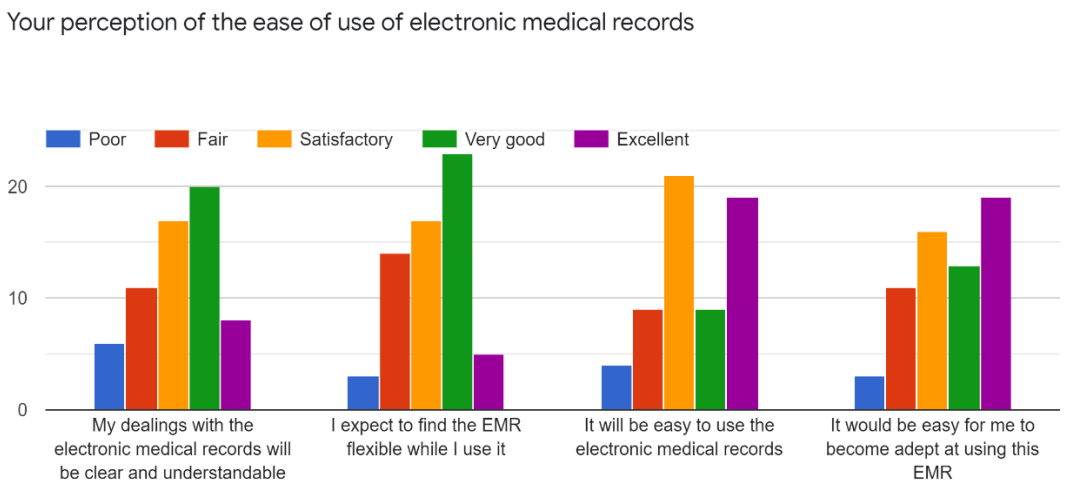


Figure 5.16 Ease of Use response

The result of opinions about the efficiency of electronic medical records framework developed, question options were divided into poor, fair, satisfactory, very good, and excellent the result was the result is that this framework is efficient figure 5.17 show the result.

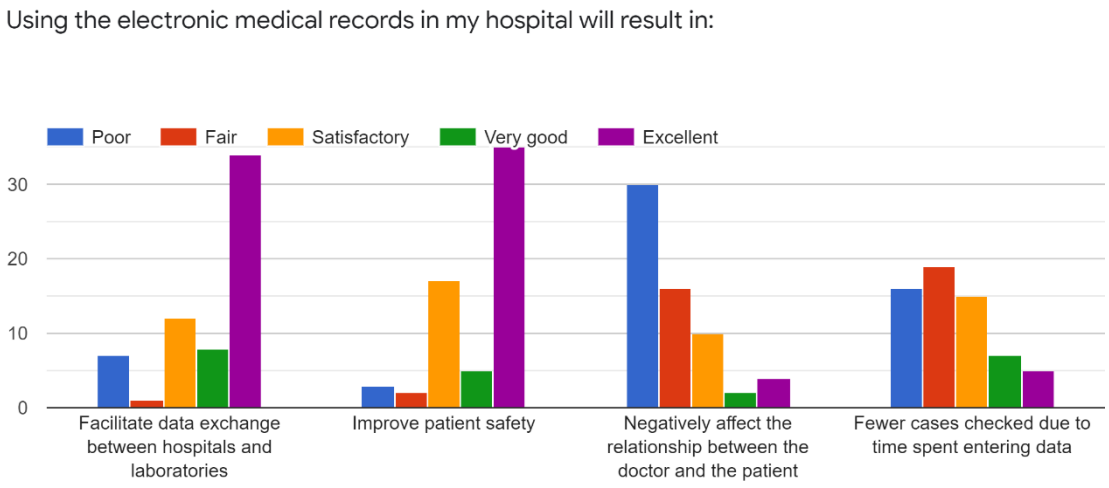


Figure 5.17 efficiency response

the result of workload resulting from using electronic medical records framework, question options were divided into strongly disagree, disagree, neutral, agree, strongly agree the result is that this framework is easy and understandable and workload resulting its more than good figure 5.18 show the result.

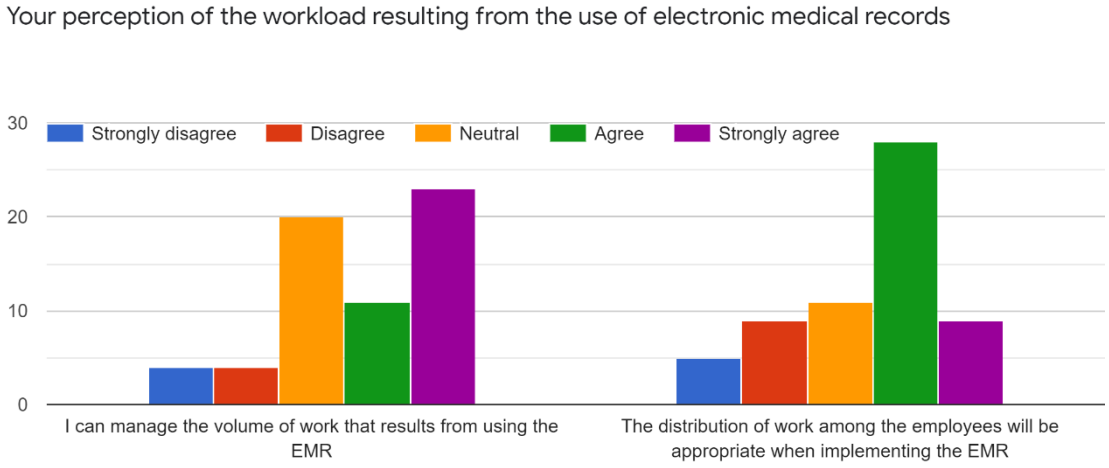


figure 5.18 workload result response

The result of suitability of electronic medical records framework, question options were divided into strongly disagree, disagree, neutral, agree, strongly agree the result is that this framework is suitable figure 5.19 show the result.

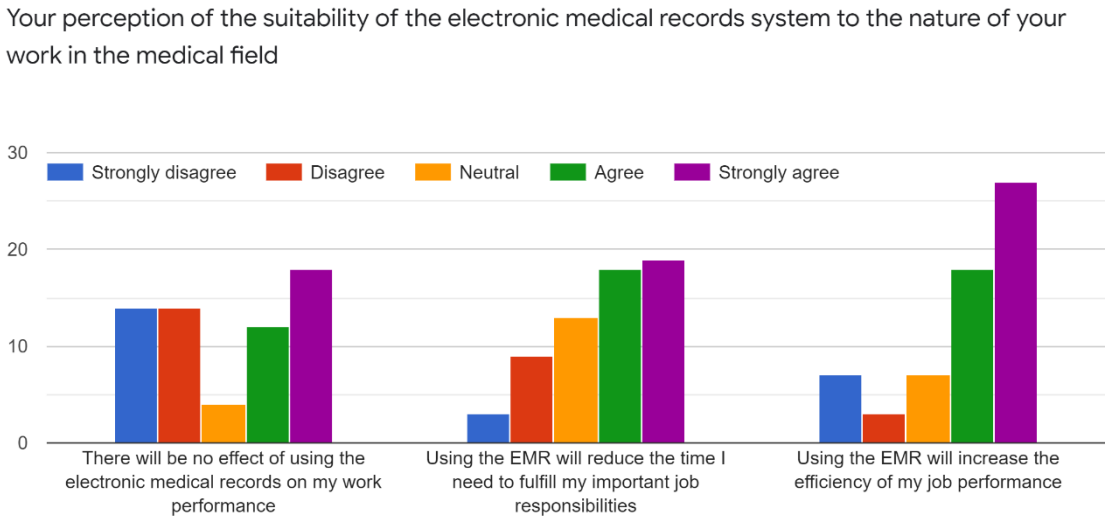


Figure 5.19 suitability response

the result of doctor's intention to use the electronic medical records framework, question options were divided into strongly disagree, disagree, neutral, agree, strongly agree the result is the majority expressed their intention to use this framework as soon as it is available and is also very helpful figure 5.20 show the result.

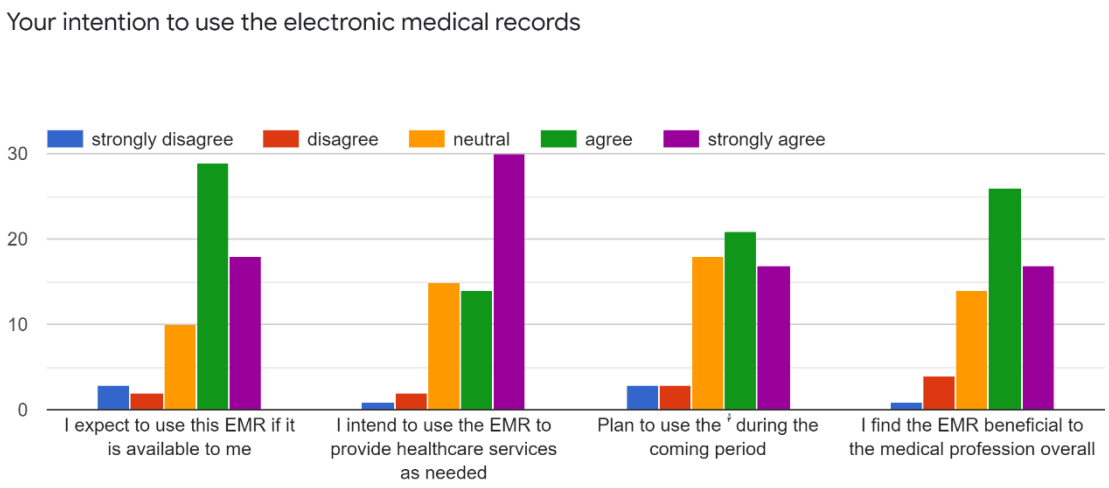


figure 5.20 intention of use response

And by asking about the EMR framework data items the options were divided into strongly disagree, disagree, neutral, agree, strongly agree the result about "Fit for purpose and includes all the important fields" 15 of the survey participants (neutral) and 16 agree 26 strongly agree.

And the question *"It can be used with reports issued by the Federal Ministry of Health"* 14 of the survey participants (neutral) and 31 agree 16 strongly agree, question *"The Items are sufficient without the need to manually use the form"* 7 of the survey participants (neutral) and 27 of the survey participants (agree) and 17 of the survey participants (strongly agree)

question *"It can be dealt with in all non-governmental hospitals Sudan"* 13 of the survey participants (neutral), 21 agree ,27 strongly agree. and question *"The final patient record can be taken outside the country"* 14 of the survey participants (neutral), 21 agree ,19 strongly agree. from this result conclude the EMR framework data item is useful and It can be used. Figure 5.21 show EMR data Items questions results.

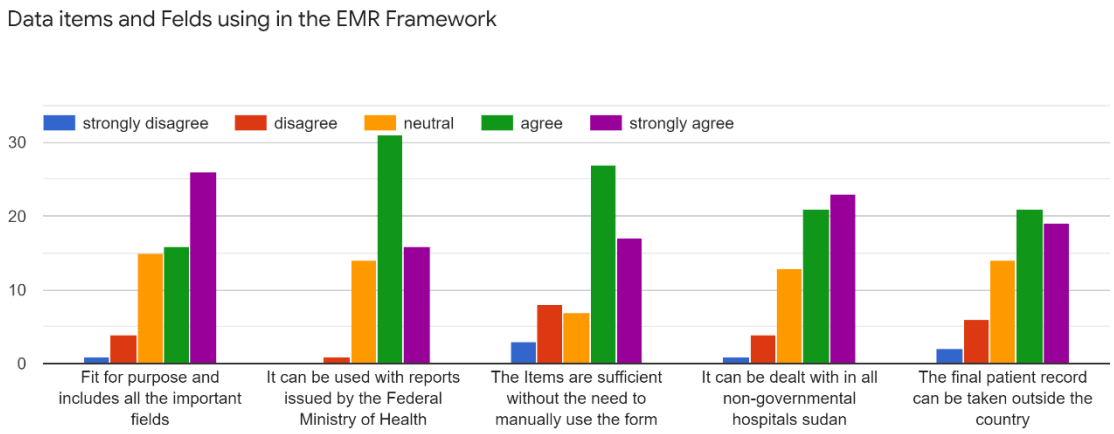


Figure 5.21 EMR data items

The other part of the survey asked 3 questions, options were divided into Yes, No and their content is as follows:

Question 1: Have you dealt with any ĖMR before? The results 25 participants response (Yes), and 33 response (No) from all of the survey participants 63.

Question 2: Is it suitable to use the EMR framework in Sudanese educational hospitals? The results 52 participants response (Yes), and 11 response (No) from all of the survey participants 63.

Question 3: Based on your practical experience in the medical field, is it necessary to apply electronic medical records? The results 59 participants response

(Yes), and 4 response (No) from all of the survey participants 63. figure 5.22 show Appropriability of the EMR framework.

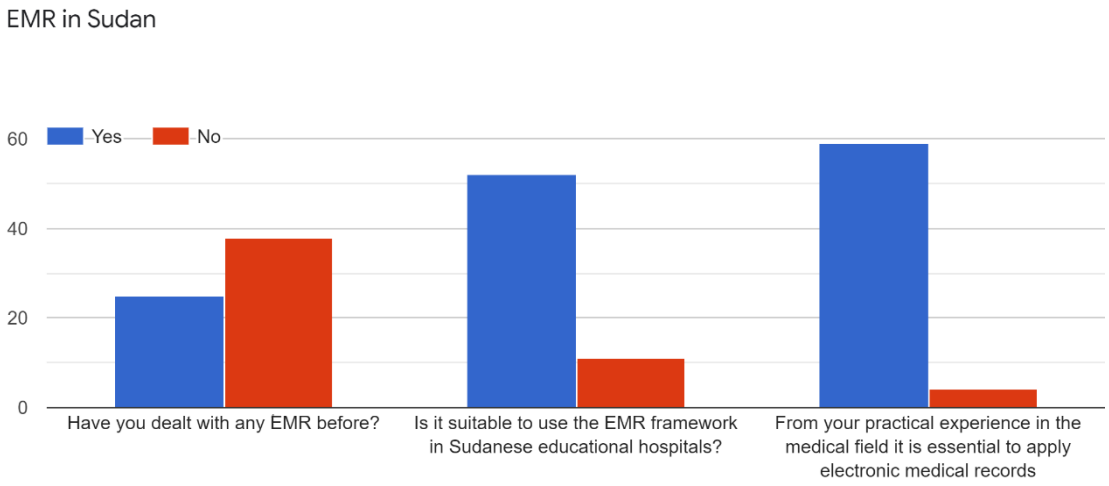


Figure 5.22 Appropriability

5.6 Summary

In this chapter have shown the results of the research and the presentation of the inquiries in addition to the presentation of the final record of the patient, the export of data to other document format and the results of evaluation of Electronic Medical Records framework.

Through the results of this evaluation of EMR framework, the research concluded that this framework is effective and clearly serves the health sector in Sudan through satisfactory performance, ease of use, understandability and can be relied upon in performing the main tasks, extracting reports and the final record of the patients that ensure provides a pool of data source.

CHAPTER VI: CONCLUSION AND RECOMMENDATION'S

6.1 Conclusion

The main idea in this research is to developing EMR framework for Sudanese educational hospitals to handle and deal with Medical records. The objectives of this research create database to register all medical data related to patients such as, personal info medications, lab investigation, prescriptions, final diagnosis, this objective was achieved through its implementation and is explained in the chapter four. Also provides ability to make different type of queries for required information to make reports. objective was achieved by implementing a framework and allow to make multiple types of queries that is explained in the chapter Five results and discussions.

To evaluate the EMR framework a survey was conducted targeting a group of doctors working in various hospitals in Sudan, who numbered sixty-three 63. Questions were drawn about effectiveness, ease of use, suitability, possibility of understanding and dealing with it as showing in Appendix B2. through their responses, analysis and presentation of results that reached it was dealt with in detail in chapter Five results and discussions, It turns out that it can be an effective framework and serve the purpose for which the study was being conducted.

The other objective of this research is to ensure provides a pool of data source to enhance healthcare delivery, especially in the healthcare sector. After implementing this framework, it is ensured that a permanent source of medical data is available for studies, scientific research or other relevant studies. The survival of healthcare organizations depends on who develops the best EHR and IT systems. Those who do not will fail and will have to close their operations (Milliard, 2012).

The future of healthcare will remain to be challenging but, at the same time, the improvements in care and quality are exciting. The future of healthcare, and the ability of the Sudanese people to be able to afford healthcare, are depending on the healthcare industry to make EMR and EHR technologies a successful venture.

We're in lucky now. Our fortune is that now the costs of information technology have decreased, a significant improvement in computer literacy and an increase in

resources, as well as evidence of the successes of electronic medical records in several regions around the world as well as their resources similar to Sudan. A critical challenge is to create well-designed, efficient, and cost-effective systems by sharing resources and learning from others' experiences.

6.2 Recommendations

The EMR framework developed is secured and dynamic enough to provide exclusivity and integrity of patient's data, and to circumvent every problem associated with the paper-based in hospitals. Given the constant increase in the development of Information and Communication Technology (ICT) in every sector of our economy, there arises a need to continue to harness both as tools for delivering qualitative and secured healthcare services. Hence, this framework if adopted I recommend the following recommendations:

- Filter the available data and make it available for use in scientific research.
- Create national centralized database for all clinics and hospitals in Sudan.
- Develop this framework to become HER and Connect all the parts of Health care under the Network of Clinical Information to Works together to grantee integration of Electronic Health Records, and to enhance Exchange these Records.

References

Dr. Ananya Mandal, MD, 2019. *What is Body Mass Index (BMI)?*. [Online] Available at: https://www.news-medical.net/health/What-is-Body-Mass-Index-(BMI).aspx[Accessed 27 november 2020].

Richards, R.J., Prybutok V.R. & RyanS, 2012. Electronic medical records: tools for competitive advantage. *International Journal of Quality and Service Sciences,* 4(2), p. 120 – 136.

Anon., 2009. The American Recovery and Reinvestment Act of 2009 (ARRA) XIII. *HEALTH INFORMATION TECHNOLOGY.*

Anon., n.d. *Difference Between EHR and EMR.* [Online] Available at: http://www.differencebetween.net/science/health/differencebetween-ehr-and-emr [Accessed march 2019].

biohealthmatics, 2006. *biohealthmatics.* [Online] Available at: http://www.biohealthmatics.com/technologies/clinical-information-systems [Accessed oct 2019].

Boulus, N., 2014. *Managing the Gradual Transition from Paper to Electronic Patient Record (EPR),* Oslo: Cand Scient Thesis, Department of Informatics ,University of Oslo.

Chang F, Gupta N, 2015. Progress in Electronic Medical Record Adoption in Canada. In: *Canadian Family Physician.* s.l.:s.n., pp. 1076-1084.

Chaudhry B, Wang J, Wu S, 2016. *Impact of Health Information Technology on Quality, Efficiency, and Costs of Medical Care. Annals of Internal Medicine.* s.l.:s.n.

Committee, R. o. E. S., 2013. *Recommendations on Electronic Medical Records in india,* India: Ministry of Health &Family Welfare.

Darius Jazayeri MEng, Carole D Mitnick ScD, Joia S, 2010. *Infonmatics Tools To Monitor Progress And Outcomes Of Patients With Drug Resistant Tuberculosis In Peru,* Boston,: s.n.

Darius Jazayeri, Patrice Nevil, Yusuf Karacaoglu, Paul E Farmer, Evan Lyon, 2012. An information system and medical record to support HIV treatment in rural Haiti.

Darius Jazayeri, Patrice Nevil, Yusuf Karacaoglu, Paul E Farmer, 2012. *An information system and medical record to support HIV treatment in rural Haiti,* rural: s.n.

Dave Garets, Mike Davis, 2005. Electronic Patient Records- EMR's and EHR's. *Healthcare InformaticsOnline,* pp. 1-6.

Delpierre C, Cuzin L, Fillaux J, Alvarez M, Massip P, Lang T., 2014. A Systematic Review of Computer-Based Patient Record Systems and Quality of Care: More Randomized Clinical Trials or a Broader Approach?. *International Journal for Quality in Health Care,* pp. 407-416.

Dr.mustafa, m., 2019. *Patient record data items* [Interview] (23 9 2019).

Euclid, Seeram, 2012. *Digital Radiography Physical Principles and Quality Control.* 2nd ed. s.l.:s.n.

google forms, 2021. *Google forms.* [Online] Available at: https://docs.google.com/forms/d/e/1FAIpQLSdXPe_NPxHTmhP8d3H_A3Xqx5pjK9RhebgVoTWbuHvIqX7DjA/viewform?usp=pp_url [Accessed 72 jan 2021].

Hamade, Noura, 2017. Improving the Use of Electronic Medical Records in Primary Health Care: A Systematic Review and Meta-Analysis. *Electronic Tesis and Dissertation Repository.*

Hamish SF Fraser,Paul Biondich, Deshen Moodley, Sharon Choi, Burke W Mamlin, 2015. Implementing electronic medical records in developing countries. *The Journal of Innovation in Health Informatics,* 2(13), pp. 83-95.

Hamish SF Fraser,Paul Biondich, Deshen Moodley, 2005. Implementing electronic medical records in developing countries. *The Journal of Innovation in Health Informatics 13(2):83-95,* p. 13.

H, J., 2011. Virtual Mentor. 3(13), pp. 186-189.

I.C. Chang, H. G. Hwang, & J.W. Lian, 2015. Critical factors for adopting PACS in Taiwan: Views of radiology department directors. In: *Decision Support Systems.* s.l.:s.n., pp. 1042-1053.

Ibrahim Zakaria, dr. diaa Mustafa, 2016. *clinical information systems,* oumdurman: university of science and technology.

Inc., A. I., 2020. *Management information system.* [Online] Available at: https://paginas.fe.up.pt/~acbrito/laudon/ch2/chpt2-1main.htm [Accessed 2020].

infoway, c. h., n.d. *infoway inforoute.ca.* [Online] Available at: https://www.infoway inforoute.ca/en/solutions/digital-health-foundation/electronic-medicalrecords/benefits-of-emrs [Accessed 2020].

JOSEPH K. ROTICH, TERRY J. HANNAN,Others, 2010. Installing and Implementing a Computer-based Patient Record System in Sub-Saharan Africa: The Mosoriot Medical. *Journal of the American Medical Informatics Association,* Volume 10, p. 9.

Junji Lin,Tianze Jiao,Joseph E Biskupiak &Carrie McAdam-Marx, 2014. Application of electronic medical record data for health outcomes research: a review of recent literature. *Expert Review of Pharmacoeconomics & Outcomes Research,* 9 jan.

Kamadjeu, R., Tapang, E.M., & Moluh, R.N., 2005. Designing and implementing an electronic health record system in primary care practice in sub-Saharan Africa.

KHALIFA, 2017. Perceived Benefits of Implementing and Using Hospital Information Systems and Electronic Medical Records. *Informatics Empowers Healthcare Transformation.*

Kumudini Sarathchandra, Shriyananda Rathnayake, 2019. Implementation challenges and Research Gaps of Electronic Medical Records (EMR) in Public Sector. *International Journal of Scientific and Research Publications,* july, 9(7), pp. 174-181.

L, W., 2008. Medical Records that Guide and Teach. *New England Journal of Medicine.*

medicine, U. H. c. o., 2020. *USF Health coolage of medicine.* [Online] Available at: https://www.usfhealthonline.com/resources/key-concepts/ehr-vs-emr [Accessed 2020].

Milliard, M., 2012. The 5-Year Plan Where Will Healthcare be in 2017. *Healthcare IT News,* 9(1), pp. 4-5.

Ministry of Medical Services, Ministry of Public Health and Sanitation, 2014. *Standards and Guidelines for Electronic Medical Record Systems in Kenya,* kenya: I-TECH.

N. Anju Latha ،B. Rama Murthy ،U. Sunitha, 2012. Electronic Health Record. *INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT),* 1(10).

Nurul Aqilah Mohd Nor, Nur Aishah Taib, others, 2019. Development of electronic medical records for clinical and research purposes: the breast cancer module using animplementation framework in a middle income country. *BMC Bioinformatic,* pp. 140-242.

Q, H., 2012. *Study on Electronic Health Record and its Implementation,* Kristianstad: School of Health and Society, Department Design and Computer Science..

Rodriguez M, Spohr M, Lippeveld T, Edwards M, 2015. Informatics Technology for Use in HIV/AIDS Treatment in Resource-Poor Settings. *Carolina Population Center, measure evaluation.*

Saima Nisar, Abas B Said, 2012. CONCEPTUAL MODEL FOR ELECTRONIC CLINICAL RECORD INFORMATION SYSTEM. *international Journal of Information Sciences and Techniques (IJIST),* 2(1).

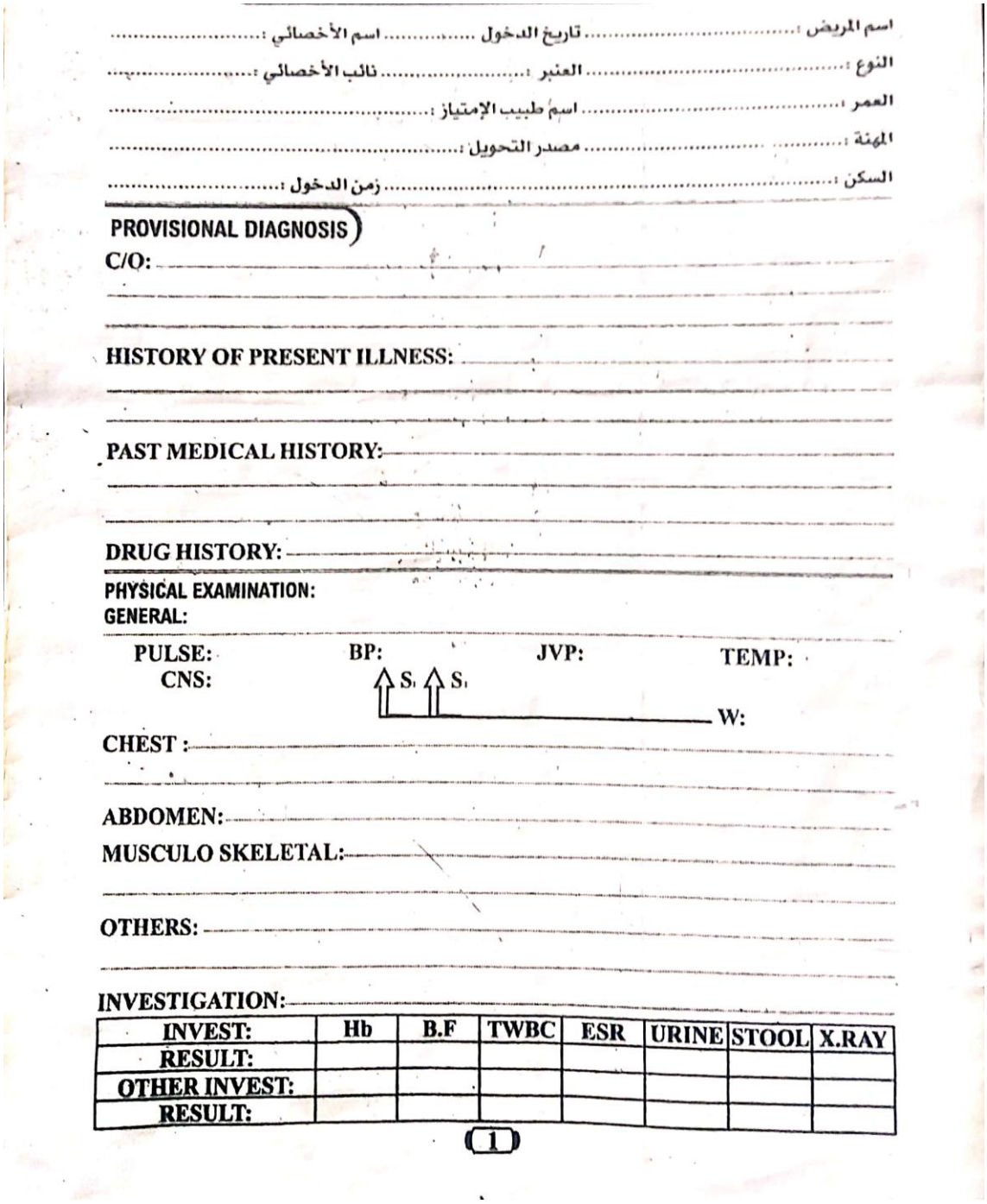
Shruti, h., 2011. *Electronic medical records concepts and data management,* s.l.: Rochester Institute of Technology.

Thielst, C. B., 2007. The future of healthcare technology. *Journal of Healthcare Management,* 1(52), pp. 7-9.

Tripathi, M. , 2012. EHR Evolution: Policy and Legislation Forces Changing the EHR. *Journal of AHIMA,* pp. 24-29.

Yarbrough AK, Smith TB., 2007. Technology Acceptance Among Physicians: A New Take on TAM. *Medical Care Research and Review.,* 6(64), pp. 650-672..

Appendices



اسم المريض : ..... تاريخ الدخول ..... اسم الأخصائي : .....

النوع : ..... العنبر : ..... نائب الأخصائي : .....

العمر : ..... اسم طبيب الإمتياز : .....

المهنة : ..... مصدر التحويل : .....

السكن : ..... زمن الدخول : .....

PROVISIONAL DIAGNOSIS

C/O:

HISTORY OF PRESENT ILLNESS:

PAST MEDICAL HISTORY:

DRUG HISTORY:

PHYSICAL EXAMINATION:

GENERAL:

PULSE: BP: JVP: TEMP:

CNS: S_1 S_1 W:

CHEST :

ABDOMEN:

MUSCULO SKELETAL:

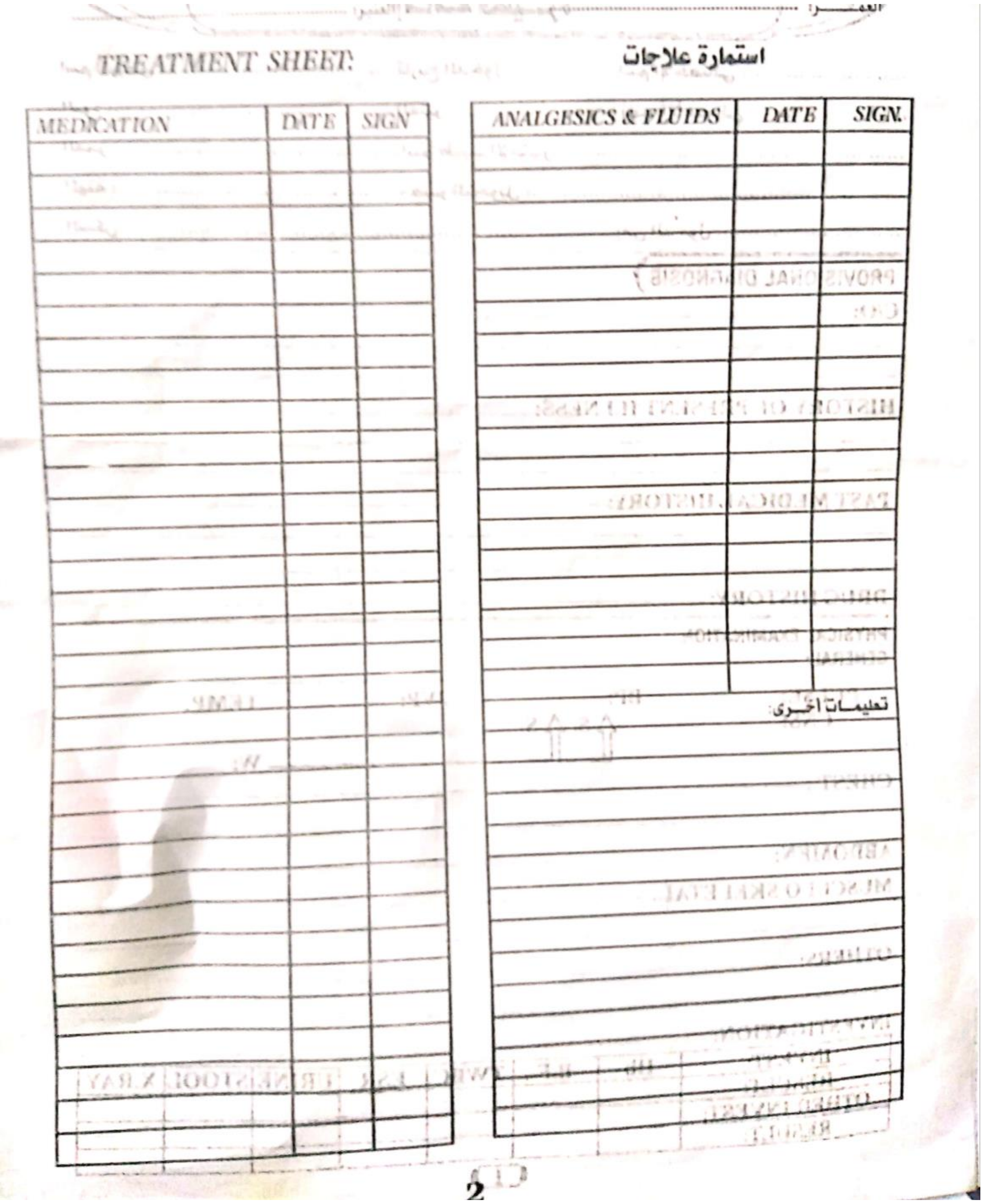
OTHERS:

INVESTIGATION:

INVEST:	Hb	B.F	TWBC	ESR	URINE	STOOL	X.RAY
RESULT:							
OTHER INVEST:							
RESULT:							

1

Appendix A1



TREATMENT SHEET

استمارة علاجات

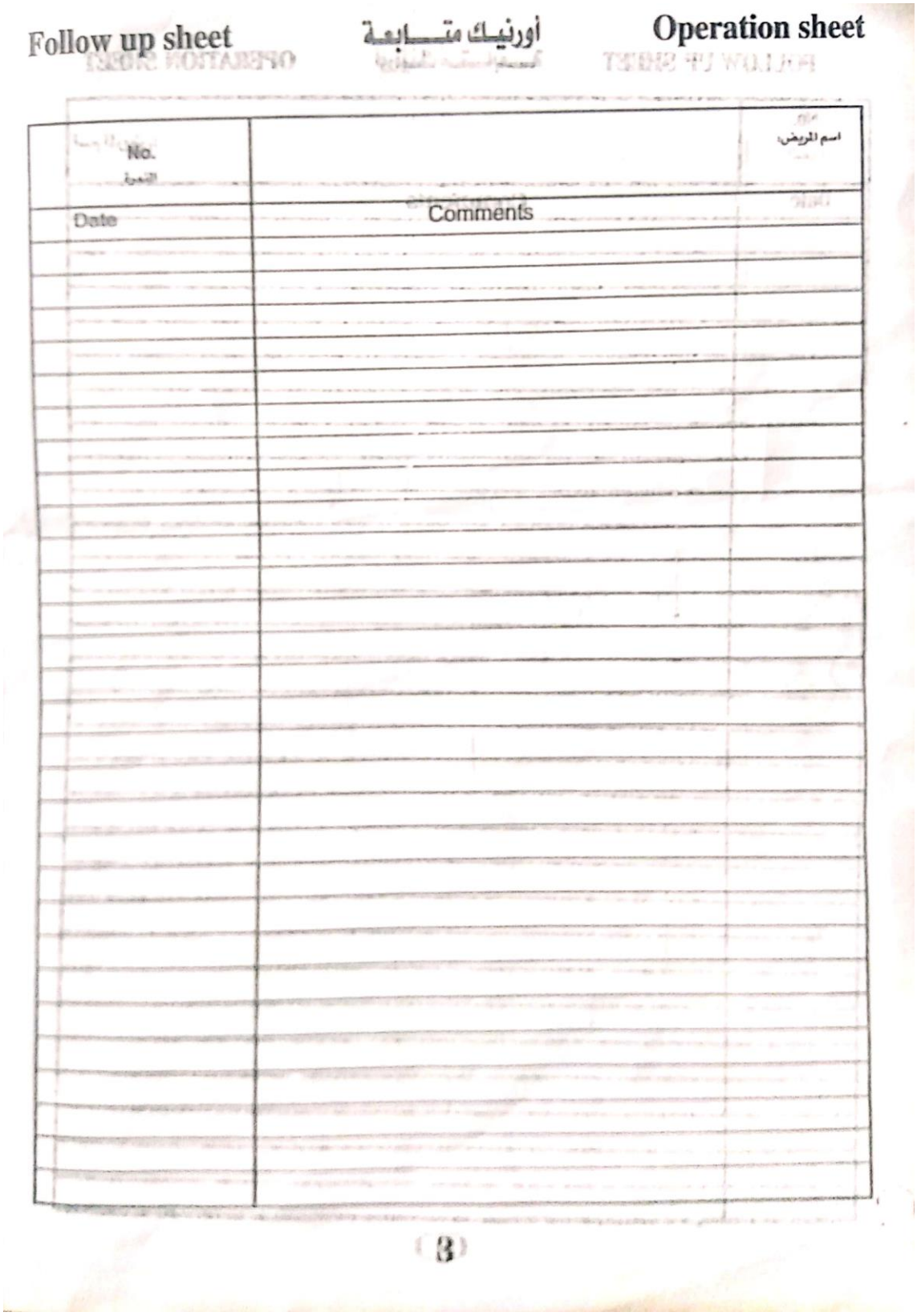
MEDICATION	DATE	SIGN

ANALGESICS & FLUIDS	DATE	SIGN.

تعليمات اخرى:

2

Appendix A2



Follow up sheet أورنيك متـــابعة Operation sheet

No.		اسم المريض:
Date	Comments	

(3)

Appendix A3

وزارة الصحة - ولاية الخرطوم

مستشفى أحمد قاسم

وصفة طبية

اسم المريض :..... العمر: .....

التاريخ:..... السكن: .....

التشخيص:.....

اسم الطبيب:..... اسم الصيدلي:.....

Appendix B1

Electronic Medical record Evaluation form

Please submit feedback regarding the EMR completed, including feedback on usability ,satisfaction , data items, effective.

* Required

1. doctor Name *

2. Hospital *

3. Your perception of the ease of use of electronic medical records *

Mark only one oval per row.

	Poor	Fair	Satisfactory	Very good	Excellent
My dealings with the electronic medical records will be clear and understandable	◯	◯	◯	◯	◯
I expect to find the EMR flexible while I use it	◯	◯	◯	◯	◯
It will be easy to use the electronic medical records	◯	◯	◯	◯	◯
It would be easy for me to become adept at using this EMR	◯	◯	◯	◯	◯

4. Using the electronic medical records in my hospital will result in: *

Mark only one oval per row.

	Poor	Fair	Satisfactory	Very good	Excellent
Facilitate data exchange between hospitals and laboratories	◯	◯	◯	◯	◯
Improve patient safety	◯	◯	◯	◯	◯
Negatively affect the relationship between the doctor and the patient	◯	◯	◯	◯	◯
Fewer cases checked due to time spent entering data	◯	◯	◯	◯	◯

5. Your perception of the workload resulting from the use of electronic medical records *

Mark only one oval per row.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I can manage the volume of work that results from using the EMR	◯	◯	◯	◯	◯
The distribution of work among the employees will be appropriate when implementing the EMR	◯	◯	◯	◯	◯

6. Your perception of the suitability of the electronic medical records system to the nature of your work in the medical field *

Mark only one oval per row.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
There will be no effect of using the electronic medical records on my work performance	◯	◯	◯	◯	◯
Using the EMR will reduce the time I need to fulfill my important job responsibilities	◯	◯	◯	◯	◯
Using the EMR will increase the efficiency of my job performance	◯	◯	◯	◯	◯

7. Your intention to use the electronic medical records *

Mark only one oval per row.

	strongly disagree	disagree	neutral	agree	strongly agree
I expect to use this EMR if it is available to me	◯	◯	◯	◯	◯
I intend to use the EMR to provide healthcare services as needed	◯	◯	◯	◯	◯
Plan to use the ' during the coming period	◯	◯	◯	◯	◯
I find the EMR beneficial to the medical profession overall	◯	◯	◯	◯	◯

8. Data items and Felds using in the EMR Framework *

Mark only one oval per row.

	strongly disagree	disagree	neutral	agree	strongly agree
Fit for purpose and includes all the important fields	☐	☐	☐	☐	☐
It can be used with reports issued by the Federal Ministry of Health	☐	☐	☐	☐	☐
The Items are sufficient without the need to manually use the form	☐	☐	☐	☐	☐
It can be dealt with in all non-governmental hospitals sudan	☐	☐	☐	☐	☐
The final patient record can be taken outside the country	☐	☐	☐	☐	☐

9. EMR in Sudan *

Mark only one oval per row.

	Yes	No
Have you dealt with any EMR before?	☐	☐
Is it suitable to use the EMR framework in Sudanese educational hospitals?	☐	☐
From your practical experience in the medical field it is essential to apply electronic medical records	☐	☐

10. Your opinions or comments about this EMR

Appendix B2