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Addis Ababa University  
School of Information Science  
And  
School of Public Health  
M.SC in Health Informatics program

**Designing Electronic Medical Record System for the  
Ministry of Defense Command and Staff Hospital**

Prepared by: **Yonatal Girma**

**June, 2015**

**Addis Ababa**

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A project Paper submitted to the School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Masters of Science in Health Informatics.

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**Name and signature of the members of the examining board**

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## **Dedication**

I dedicate my Project work to God who allowed me to start and finish this journey

And

My fiancé (EMMA) for her unreserved support and understanding and unforgettable MOM.

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## **Acronyms**

DFD= Data Flow Diagram

DSS=Decision Support System

EMR=Electronic Medical Record

FMOH=Federal Ministry of Health

HER= Electronic Health Record

HIT=Health Information Technologies

HSDP=Health Sector Development Program

ICT=Information Communication technology

IT= Information Technology

MMRS= Mosoriot Medical Record Systems

OOAD=Object-oriented Analysis and Design

PASDEP=Ethiopian Plan for Sustainable Development to End Poverty

PHR= Personal Health Record

PR=Paper-based Record

SSADM= Structure System Analysis and Design Methodology

TUTAPE= Tulane University's Technical Assistance Program for Ethiopia

UML=Unified Modeling Language

## Abstract

*Electronic Medical Record is a computerized system of accessing the history of a patient's care within a single practice. The content of an EMR is analogous to the paper record, but the electronic format creates usable data in medical outcome studies, improves the efficiency of care, and makes communication among providers more efficient and easier management of health plans.*

*The objective of this project was to design an electronic medical record system for the Ministry of Defense Command and Staff Hospital.*

*The project used structured system analysis and design methodology with the incremental waterfall approach which includes requirement collection, analysis and design phases. Requirement was collected using tools such as interviews, observation and relevant document review techniques to collect sufficient data needed for the system to be developed. Analysis and design of the proposed system was performed using tools like the data flow diagram, ER diagram, and flow chart diagrams.*

*The current business process include registration, outpatient, laboratory and pharmacy departments of the hospital was described in detail. According to the assessment most of the staffs did not take training on basic computer skill and EMR system. The infrastructure of the hospital is difficult to run the system and the internet connection is good but it is interrupted most of the time. The numbers of the available hardware is not enough to run the system. The new system has functionalities such as register users of system and patient personal information, search patient information, record patient diagnosis and treatment data, register patient laboratory and medication order. The system has also non functionality requirements such as security, availability, maintainability and user interfaces.*

*Electronic medical record significantly reduces medical errors, solve illegible hand writhing of records, improve the quality and completeness of data and increase patient satisfaction by reducing patient waiting time. The requirements of the new system were collected using data nonfunctional tools and techniques. The business process of the current system, functional and nonfunctional requirement and system requirement were described. The analyses of the proposed system were analyzed using the analysis model (use case diagram and use case description) and process model (contextual and DFD) the data model of the system was presented using the entity relationship diagram. Therefore, designing the EMR system at the hospital will lead to significant change in giving quality of patient care and solve the current problems.*

# Chapter One

## 1. Introduction

### 1.1 Background

The Ministry of Defense Command and Staff Hospital, is one of the defense hospitals in Ethiopia. The Hospital was established 35 years ago. It is found in Addis Ababa. (1)

Electronic medical record (EMR) is a computerized system of accessing the history of a patient's care within a single practice in real time. The content of an EMR is analogous to the paper record, but the electronic format creates usable data in medical outcome studies, improves the efficiency of care, and makes communication among providers more efficient and easier management of health plans. (2)

In a traditional medical record system, the patient's information is stored in the ways given below.

**Paper-based system:** Every test, medication, and visit for a patient is manually recorded on paper. These records are called charts. Each department of the hospital has its own set of records. In traditional system, Security of the data is the main concern. Traditional system requires space, cost and time.(36)

**File system:** The complete patient record is maintained in a single file on the computer. Traditionally patient records in the hospitals were kept in the form of written documents. One of the most important developments in the medical practice was use of computers, later on, the internet. (36)

EMR makes data easily accessible and enables physicians to use their own data to improve quality of care. EMR systems can generate automated appointment reminders for periodic checkups and for monitoring chronic diseases and conditions. Monitoring patient responses to these reminders enables practices to follow up with patients who need medical attention but are not responding to the practice's automated messages. Successfully implementing electronic

medical record into an office practice can bring improvements in both quality of patient care and practice profitability. (3)

EMR systems have many benefits. They would improve the legibility of clinical notes and provide decision support for drug ordering, including allergy warnings and drug incompatibilities. They also provide reminders to prescribe drugs and administer vaccines and warnings for abnormal lab results. Moreover, they help support program monitoring, including reporting outcomes, budgets, and supplies. They support clinical research and help with the management of chronic diseases such as diabetes, hypertension, and heart failure. (3)

The Ethiopian Plan for Sustainable Development to End Poverty (PASDEP) 2005, created an added impetus for better coordination and alignment of external support. In 2005, the Ministry of Health and partners developed HSDP III as a single program framework aligned with health MDGs for coordinating health sector action (one plan). One of the components in HSDP is E-Health. An EMR is considered by some to be one of several types of EHRs (electronic health records), but in general usage EMR and EHR are synonymous. In Ethiopia, the implementation of EMR is through software called SmartCare. Federal Ministry of Health Ethiopia (FMOH) is developing the SmartCare software in partnership with *PEPFAR/CDC* and *TUTAPE*(Tulane University's Technical Assistance Program for Ethiopia). (9)

This paper has been examined with varying degrees of adoption of one particular unit of information technology in healthcare, the EMR. The paper first looked at the development and the progression of the EMR in the Ministry of Defense Command and Staff Hospital, identifying elements that allow for interest and continuous development, focusing on the emergence of the Personal Health Record and its potential benefits for healthcare. Then it looked at the challenges faced in the hospital that hinders the development and progression of the EMR, and concluded with a look at systems in hospital attempting to facilitate electronic management of patient information.

This paper aims to highlight the benefits of EMR and issues that may arise, and suggest various ways by which the hospital can benefit from adopting EMR systems. The paper concludes with a summary of findings and future thoughts.

## 1.2 Statement of the problem

The use of EMRs within healthcare enterprises is already a common and well-appreciated practice. It facilitates the documentation process required for medico-legal reasons, administrative procedures, and bio-clinical research. It also increases the availability of clinical data at the point of care. (7)

The Ministry of Defense Command and Staff Hospital has been providing health care service for long time. However, patient registration, data storage, backup, laboratory ordering, diagnosis and treatment, pharmacy and reporting mechanism are still being carried out in a traditional way (Manual system).

Thus, there are many problems with manual medical record system. They are:

- Manual based patient registration is time taking to register patient information;
- Storing patient history take space and also hard to search patient documents;
- Patient documents might be lost and easily perish;
- Manual based patient diagnosis and treatment time taking to diagnosis and give treatment in a given time;
- Continual data entry errors because the data is collected, organized and analyzed manually so data completeness, timeliness and quality will be compromised;
- Illegible hand writing in records and prescriptions and also incompleteness of patient records happened within the hospital;
- Creating delay in patient registration, diagnosis and treatment and
- Duplication of records and medical errors, problems with accuracy of diagnosis and health treatments and problems with data confidentiality and security.

In addition, administration among clinicians is poor in the hospital; patients are being admitted unnecessarily stays in the clinic, multiple tests are being ordered, and adverse drug reactions are happening because clinicians are not aware of drugs prescribed. Clinic staff and patients are receiving conflicting treatment information and advice from doctor. Since medical errors are a leading cause of death and paper records can be easily lost, misplaced, or are often illegible, the use of electronic health record technology would reduce many of these issues and lead to major improvements in the health care and safety of patient care. Clinical administrators are realigning

business strategies to make sure they have the proper healthcare systems in place to store the amounts of patient-related data and information. (7)

Designing EMR system will have advantage of solving the above problems. This is because EMR to reduce clinical errors, provide more effective methods of communicating and sharing information among clinicians, and better manage patient medical records need to embrace Information and Communication Technology (ICT) in healthcare. It introduces a solution which presently involves transformation of the information from the Paper-based Record (PR) to an EMR which is seen as key to the vital inter-operability required for healthcare efficiency, effectiveness and safety of health delivery and increase customer satisfaction.(7)

## 1.3 Objective of the study

### 1.3.1 General objective

The objective of this project is to design EMR System, for the Ministry of Defense Command and Staff Hospital.

### 1.3.2 Specific objective

- To identify the requirements of the EMR system,
- To analyze the requirements for the EMR system,
- To design the EMR system and
- To design user interface of the EMR system.

## 1.4 Significance of the project

Designing EMR System in the Ministry of Defense Command and Staff Hospital system could have the following significances.

**1.4.1 For patients:** Since the primary goal of a hospital is to give quality service for patients, if the design part of this project is developed and implemented patients could benefit from this project by getting quality service which includes good documentation of their records, quality and complete record and prevent their records from damage or lose.

**1.4.2 Administrators:** Other benefits are to health administrators. Administrative benefits include easier increasing reports, organizing and locating clinical information, managing plan care, enhancing claiming and ordering processes, reducing the time for billing processes and providing better customer service. Therefore, it can be concluded that in administration tasks, EMR can increase patients care time, reduce health cost and improve the health quality. Traditional ways in administrative processes may face many problems, for examples missing in diagnostic information, unstructured patient data stored May cause difficulty in finding information on demand with time limitation and needing storage space. In addition, the person in charged in claiming and ordering processes mayalso doa mistake.

**1.4.3 Clinicians:** EMR also gives advantages to clinical processes such as better access to chart, improve clinical decision making and disease management, enhance documentation, simplify patient education, and increase free time to spend with patients, and improved perception of care and quality of work life. The introduction of decision support system (DSS) in drug management, test result and disease management give significant impact to clinical processes. Alert flag and reminder provided by DSS in EMR can improve physician work and patient care. DSS also provides the audit trail for security concern that list admissions and modifications by users to each patient's file with a record of the date and time.

Therefore, the accessibility and the modification of the patient's file can easily be traced. Moreover, specific advantages to physician are:

1. All information such as medical and family history, clinical history vital signs, weight of time of current visit, chief complaints, and most recent lab test results are organized in proper format and readily retrievable,
2. The system prompts the physician to ask the right questions, reviews medications, updates information, and checks to see that screening and monitoring test are completed on schedule, and
3. Prescriptions and patient education materials can be printed with the click of button

**1.4.4 Policy makers and researchers:** As for the policy makers and researchers, EMR can contribute knowledge to improve long term planning for health care industry, accountability and health resource allocation. Overall, the implementation of EMR can improve the quality of care, reduce cost in managing care environment and improve provider efficiency.

**1.4.5 For the hospital:** The EMR could have a benefit for the hospital for giving a better health care service, for adequate planning and budgeting, for keeping adequate records, with diagnosis and service reporting purposes as a source of relevant information.

### **1.5.1 Project scope**

The scope of this EMR project is to design an electronic medical record system which will support the following business processes.

**1.5.1.1 Registration department:** The system will provide a patient registration feature for the registration department which includes demographic data capturing and unique identification of the patient.

**1.5.1.2 Outpatient department:** Electronic order entry and clinical data entry of the registered patient will also be supported by the system. Electronic order entry will include a real time pharmacy and laboratory requests from OPD. Clinical data entry refers to capturing of patient history, clinical diagnosis, laboratory investigation and medication of the patient.

**1.5.1.3 Pharmacy service:** Drug information, consumption of pharmaceuticals and stock management of drugs including stock outs will be supported by the system. Drug information includes dose, side effect and administration frequency of a drug.

**1.5.1.4 Laboratory service:** From laboratory data of a patient record through timely laboratory report generation will be supported by the system. The lab department could also send a lab result via the system.

**1.5.1.6 Report generating:** The system will generate monthly, quarterly and yearly activity reports for each department. It could also generate the trends and prevalence of clinical cases. Therefore, the system has been done requirement collection, analysis and the design phase of the registration, outpatient, and laboratory and pharmacy departments.

**1.5.2 Limitation:** In these study major activities of the hospital but not included in design of this study such referral and phases not followed or done so far in this study implementation, maintenance and review of the software and final testing are not done because of time and resource constraints.

# Chapter Two

## 2. Literature review

### 2.1 General literature

#### 2.1.1 Introduction

Information and Communication Technology (ICT) has become the information resource of both selection and requirement and has thus motivated from the margin of healthcare. Quick advances in ICT with reduced costs, improved reliability and better robustness are enabling a new wave of transform in how and where healthcare can be delivered.(5)

Many researchers consider that the electronic record will considerably modify healthcare, rather than merely replacing the Paper-based Record (PR). This alteration allows data to be used for a wide variety of purposes ranging from direct patient care, decision maintain, quality promise, scientific research, and management of healthcare facilities (10). In their review of the medical related work, the use of electronic medical records is linked with enhanced surrogate outpatient care outcomes. (10), (11)

Electronic Medical record system started during the second half of the 20th century, the national expenditure on healthcare increased dramatically. Even as the developed countries are leading the electric record revolution they are struggling to adapt to the new system, and at the current time only 9% percent of hospitals in the United States have adopted electronic medical record keeping (6). This figure is in stark contrast to the 60% of Indian Hospitals which are using electronic medical record keeping in their surgery rooms (7).

Information technology has offered great advantages to improve efficiency and effectiveness in many industrial fields, e.g. commercial business, airline, manufactures, and so on (13). Despite well-established evidence seen in other industries, the adoption of Information Technology in health care organizations has been growing slowly (14). Such delayed implementation implies some certain obstacles are dismaying willingness of health care provider to take part in this movement.

Computer-based techniques have been introduced to health care throughout decades, e.g. computerized physician order entry system, clinical decision support system; picture achieving and communication system, laboratory results management, etc. Among these, EMR is drawing much attention from society, professionals, managers as well as policy-makers (15). This reflects

recognition of EMR's role in improving health care quality – one of the fundamental concerns in health care services. EMRs are expected to ameliorate problems that paper-based records encountered, e.g. inaccuracy, illegibility, incompleteness, expensive storage, difficult to retrieve needed information, discontinuity of care or the service would be duplicated and fragmented patient information if this was not shared between health sectors (16). On the other hand, the EMR repository will create a huge database that makes better use of patient's information. In addition, EMR systems are particularly important when patient-centered concept of health care is prominent and integration of health care information about patient care becomes imperative.

The main objective of the health care system is to improve access and equity of healthcare services. This would require availing quality and timeliness patient information at various levels of clinical services and decision points. In this respect, EMR technology will play a significant role in increasing the quality, accuracy and timely of health/patient information data and is widely considered as a potential to improve the effectiveness of health care systems (2).

EMR is a computerized system of accessing in real time the history of a patient's care within a single practice. The content of an EMR is analogous to the paper record, but the electronic format creates usable data in medical outcome studies, improves the efficiency of care, and makes for more efficient communication among providers and easier management of health plans (2).

Current health care publications highlight an increased interest in EMRs and personal health records. These forms of health information technologies are ways to help resolve multiple issues within the health care system. With decreasing physician reimbursement, increasing overall costs of health care, and an increasingly uninsured and underinsured population, the dialogue is shifting from simply managing costs to include quality improvement (4).

EMR makes data easily accessible and enables physicians to use their own data to improve quality of care. EMR systems can generate automated appointment reminders for periodic checkups and for monitoring chronic diseases and conditions. Monitoring patient responses to these reminders enables practices to follow up with patients who need medical attention but are not responding to the practice's automated messages. Successfully implementing Electronic medical record into an office practice can bring improvements in both quality of patient care and practice profitability (4).

EMR systems have many benefits. They would improve the legibility of clinical notes and provide decision support for drug ordering, including allergy warnings and drug incompatibilities. They also provide reminders to prescribe drugs and administer vaccines and warnings for abnormal lab results. Moreover, they help support program monitoring, including reporting outcomes, budgets, and supplies. They support clinical research and help with the management of chronic diseases such as diabetes, hypertension, and heart failure (6).

EMR is an application environment composed of the clinical data repository, clinical decision support, controlled medical vocabulary, computerized provider order entry, pharmacy and clinical documentation applications. This environment supports the patient's electronic medical record across inpatient and outpatient environments, and is used by healthcare practitioners to document, monitor, and manage health care delivery within a care delivery organization. The data in the EMR is the legal record of what happened to the patient during their encounter at the care delivery organization and is owned by the care delivery organization (6).

The medical record is a multifunctional document that is used to communicate and document critical information about patients' medical care among health care professionals (17). Comprehensive medical records are a cornerstone in the quality and efficiency of patient care during the hospitalization and in subsequent follow-up visits, as they can provide a complete and accurate chronology of treatments, patient results and future plans for care (18). Despite the importance of medical records to high quality and efficient care, management of medical records, particularly in developing countries, has not been a priority. Whereas in many high-income countries the medical records function is supported by extensive use of information technology, medical records in developing countries are generally inadequately supported and poorly managed. Although there are some exceptions with new open-source medical records systems becoming available, these are yet not widely used (19).

Health Information Technology is a newly blossoming field that has only recently started to receive much attention. One important aspect of Health Information Technology that has shown a lot of promise is the Electronic Medical Record. Originally conceived as a means to simply document patient records electronically, EMR has expanded in a matter of years to enable quick and easy acquisition and retrieval of all of a patient's medical information (20). As a result of a great deal of expansion in Internet and cellular technologies, there has been a lot of research done to find new and innovative ways for such technology to expand the scope of EMR systems

even farther beyond just data entry during a hospital visit. Despite much growth in terms of technology development, however, there seems to be no standard framework for EMR. This problem can be seen most prevalently in the United States, where the health care system is highly diverse and decentralized. As a result, it is difficult for data to be easily translated electronically across various different systems. Additionally, medical practitioners have and continue to use various different methods to document rendered care. Medical records can take the form of documents that are hand-written, typed, dictated (sometimes into recorded audio) and transcribed, or created with a paper or computer check-off system (invariably augmented with free-text) (20).

There are many instances in the developing world where we see these and additional problems, which make the implementation of any sort of EMR challenging, including limited resources, lack of health care infrastructure, and a need for proper training of health personnel. Regardless of these issues, the use of EMR in developing countries has the potential to play as significant a role as in developed countries, if not even more so(21).

In deciding what EMR systems to develop and deploy in developing countries, promising ideas are not enough: they need to be validated in the field. It is important to look closely at systems that have been successfully deployed in challenging environments, and any available evaluation data. The introduction of IT systems to remote sites with no communication should provide good opportunities to evaluate the impact of data management and/or communications tools. Specific outcomes should be measured, such as time to change patient management in response to new laboratory results, or better monitoring of patient compliance (22). There is some evidence of benefit to patient care from access to communication, including the use of telemedicine consultations to improve diagnostic accuracy and reduce unnecessary patient transfers. Improvements in drug supply management using medication data from EMR systems could offer the most measurable cost benefits at present; a well-managed drug supply also improves availability and quality of patient care (23).

In creating or choosing a new EMR, it is essential that the underlying data model is designed with a long-term vision of the functions that will need to be supported: it can be very difficult to scale from a simple flat file data model to a larger clinical system or one that can be deployed in other sites. Furthermore it makes little sense to recreate the same functions and tools at each site. Collaborative development between projects using an open source model (even if the underlying

operating system is not open) has great potential to improve quality of software and reduce costs (23).

### **2.1.2 Existing EMRS in Developing Countries**

Even as the developed countries are leading the electronic record revolution they are struggling to adapt to the new system, and at the current time only 9% of hospitals in the United States have adopted electronic medical record keeping (24). This figure is in stark contrast to the 60% of Indian Hospitals which are using electronic medical record keeping in their surgery rooms (6).

In Kenya, the Mosoriot Medical Record System (MMRS) was developed and the system serves 60,000 patients, and runs Microsoft Access on two networked computers. These are powered by an Uninterruptable Power Supply and backed up with a solar battery. Patients register in the system on their arrival to the clinic and travel through the clinic with a paper visit form. In comparison with the clinic before and after the system was implemented, there were great improvements. Patients visits were 22% shorter, provider time per patient was reduced by 58%, patients spent 38% less time waiting in the clinic, clinic personnel spent 50% less time interacting with patients, 67% less time interacting with each other, and more time in personal activities. The downside is that clerks must perform the registration and transcribe visit data, which is prone to errors (7).

In Uganda, the NACP and MOH participated in the demonstration project, choosing three sites differing in size, location, and university affiliation: Mbarara Regional Hospital affiliated with the Mbarara University of Science and Technology, Masaka Regional Hospital and Mbale Regional Hospital. HIV clinicians from these hospitals attended the April 2006 meeting in Kenya. Mbarara already had an MS-Access database (for data copied from patients' clinic notes) to support collaborative research with the University of California, San Francisco (UCSF). They contracted with a computing consultant at Makerere University in Kampala to install and maintain Open MRS at all three Ugandan sites.

Each Ugandan site developed local encounter forms that captured data required by the Ugandan NACP and data that local clinicians needed to manage HIV-infected patients. The computing consultant installed Open MRS at each site and programmed it to capture data from encounter forms and produce Patient Summary Reports and required reports to the NACP and MOH.

Currently, Open MRS use continues at all three Ugandan sites. But Masaka has had problems paying for printing encounter forms, and data managers at all sites are being paid with research

funds from Indiana University as part of an NIH funded global HIV/AIDS epidemiology network (25).

In late 2005, leaders of the National AIDS Control Program (NACP) of Tanzania expressed interest in participating in Open MRS demonstration. At the time, the NACP had implemented a paper-based HIV/AIDS registry that collected a core set of data on enrollment and at each visit, including vital signs, lab data, and treatments. The NACP had an electronic database for this registry, but few of these forms had been entered into the database or analyzed. Subsequently, there was scant information to support program management and strategic planning. NACP leaders selected three sites Open MRS for that varied in size, location, and experience with electronic data: Morogoro Regional Hospital (a large referral hospital), Tumbi Special Hospital (a district hospital), and Ocean Road Cancer Institute (the site of care for AIDS related malignancies). Neither of the latter two sites had any experience with electronic records of any kind.

Among these three sites Open MRS was first implemented at Morogoro in January of 2008. By the demonstration project's end in December of 2008, Open MRS had been successfully deployed at all 3 sites, more than 11,000 patients had been enrolled, and Open MRS had captured data from more than 58,000 visits. Patient summary reports were printed for most visits (25).

### **2.1.3 Electro Medical Record System in Ethiopia**

Ethiopia's population is estimated to be around 90 million where 85% resides in the rural. Ethiopia has around 3,000 Health Facilities (200 Hospitals and 2800 Health Centers). The majority of these health facilities have access to electricity and some kind of communication infrastructure (national ICT resource mapping survey). The Ethiopian Telecommunication infrastructure is government owned and renders various services including PSTN, CDMA phones and broadband technologies.

The FMOH gives more attention for EMR System and trying to use the software Smartcare and deployment in Ethiopia which follows the HMIS reform executed by the FMOH task force. The introduction of Smartcare to the health facilities does not alter the HMIS system but works to compliment and make the system more effective.

The deployment of Smartcare includes building/strengthening ICT infrastructure (Hardware, Software, and Networking components) and the installation and training of Smartcare software application at the health facilities.

In order to make data available at real-time to all points of service within the Health Facility, Smartcare is installed in a centralized mode (client/server). This mode operates on an online communication infrastructure within the Health Facility. Wireless Local Area Network (WLAN) demonstrated as the appropriate technology for building the online communications infrastructure. The major advantage of WLAN includes easy, fast, and affordable networking solution for Health Facilities.

Smartcare is installed and introduced in phases. The initial installation/introduction phase starts at the Medical Record Room and the Triage Room where the bulk of data encoding takes place followed by other Clinics including Out Patient, In Patient, MCH, Laboratory, Pharmacy, ART, VCT and TB.

Smartcare is used by Clinicians, the Health Facility Heads, data entry clerks, and the HMIS officers. Patient information is encoded in Smartcare by either clinicians or data entry clerks depending on their allowed role security which defines the module, they get access to. Data could be encoded and/or viewed either while the Patient is within the health facility or after the patient has left.

#### **2.1.4 Organizational and user issues**

##### **2.1.4.1 Data quality and completeness**

Data quality and completeness are critical to the success of any information system. Achieving high standards is a particular challenge in sites with limited computer literacy and experience. It is important to design systems that are easy to use and have good instructions and training. The system should collect the minimum data necessary for the task, and data items should be structured and coded where possible to simplify data checking and optimize reuse. This does not mean that free text must be excluded; doing so prevents the system from capturing any data that do not fit the normal pattern. Such data will either be lost or recorded in hard-to-locate paper records. Structured data such as laboratory test results might benefit from double entry. In some projects physicians and other staff enter data directly (26). This has the advantage of avoiding transcription errors, and also allows order entry systems to be deployed to check for potential

medical errors. A well-trained local data manager is fundamental in maintaining data quality. They need good communication skills as well as technical training. In addition to training and supervision they should perform regular surveys of data quality and investigate problems. Maintaining regular communication with users through a data manager and meetings is also important. While some users will offer unsolicited information about data issues, many do not (27).

#### **2.1.4.2 Data security and confidentiality**

Views of medical data security and confidentiality vary in different developing countries. In some sites, the use of electronic databases is treated with great suspicion; in other sites staff thinks nothing of emailing sensitive medical data. Patients can face serious risk if their communities discover their HIV status or other sensitive medical information. It is imperative that healthcare providers protect this information. However, it has been suggested that the very limited access to health care makes it critical to avoid barriers that might be created by excessive adherence to principles of confidentiality (27).

The capability to look up patient details securely in a web-based EMR removes the need to send patient information by non-secure email, a potential problem in many countries. Users can simply click on a link to open the web page and log in. Nevertheless, as it is difficult to abolish completely the use of non-secure clinical email (even if a better, more secure alternative system is available), organizations should consider setting up their own secure web-based email systems.

## **2.2 Related works**

EMRs are increasingly deployed in countries across the globe. They enable critical, real-time information services that empower both patients and health care workers. Just a few years ago, the use of EMRs in resource-poor, developing nations was experimental at best. Few organizations believed that using EMRs was realistic in these regions and fewer still had deployed such systems. Times are rapidly changing. Information technology is more widely available in resource-poor areas, and it is allowing health advocates tackling difficult challenges such as managing HIV/AIDS and drug-resistant tuberculosis. Successful EMR projects are now operating in such diverse locales as Zambia, Peru, Haiti, Rwanda, Kenya and Malawi. Future expansion is predicted. The global market for electronic medical records is expected to grow an astounding 23.8 percent by 2012, including EMR projects in both the developed and the developing world.

Despite the difficulties in deploying information systems in developing countries, several have successfully integrated into clinical workflows. While none represent a complete or ideal solution, their successful use over several years, with combined patient records numbering in the hundreds of thousands, offers valuable insights into successful future deployments. This is not intended to be an exhaustive list; other systems might contain important ideas and designs but need to be validated in appropriate environments. Some brief descriptions of systems deployed in developing countries are mentioned below.

**Cameroon** MEDCAB is a locally designed EMR system for primary healthcare practitioners in Cameroon. Which was released at the beginning of 2003. It is important to note that as with any other place in sub Saharan Africa, the public sector is the principal healthcare provider. MEDCAB was designed after in-depth observations and interviews, and modeling of the provider-patient encounters. Using the International Classification for Primary Care (ICPC-2) disease classification, and Visual Basic 6 programming language, the system development platform was Microsoft Windows, i.e. MS-Access and My SQL as the system's databases. The system consists of many user interfaces with multiple functionalities including; users' administration, medical encounter, patient registration, appointment management, report generation, patient card generator, diagnosis, etc. (28).

**Haiti** Since 1999, PIH has run a community based HIV treatment program in Haiti with its sister organization ZanmiLasante, expanding to seven public health clinics in an area with virtually no roads, electricity or telephone service (27).

**Design:** Based on the PIH-EMR. Satellite-based internet access at each site supports email and web communication. 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 Bilingual English and French.

**Data entry:** Doctors enter case histories and medications directly, whereas technicians enter laboratory results and pharmacists enter stock records. The data entry staff is being expanded.

**Functions:** The system functions were history, physical examination, social circumstances and treatment recorded. Decision support tools provide allergy and drug interaction warnings, and generate warning emails about low CD4 counts. An offline component of the EMR was developed to overcome unreliable internet communications in some sites. This allows data entry and case viewing when the network is down, and has proven to be reliable and popular with clinical staff

**Significance:** the HIV-EMR shows the feasibility of implementing a medical record system in remote clinics in a remote area with virtual no infrastructure and limited technical expertise.

Indiana University School of Medicine and Moi University School of Medicine have been collaborating for over 15 years. In February 2001, this collaboration led to the Mosoriot Medical Record System (MMRS). The MMRS was installed in a primary care healthcare centre in rural Kenya. In November 2001, the MMRS software was adapted to support the AMPATH (Academic Model for the Prevention and Treatment of HIV/AIDS) project and renamed to AMRS (29).

**Design:** two networked computers running Microsoft (MS) Access™, powered by a UPS with solar battery back-up. For the AMPATH project, the network has expanded to seven networked computers linked to a single MS Access database.

**Data entry:** In the MMRS, patients are registered in the system upon arrival, travel through the clinic with a paper visit form, and present the visit form as they depart. Clerks perform the registration and transcribe visit data. AMRS data are collected on paper forms at each visit, delivered to a central location for data entry, and then returned to the patient's paper chart.

**Function:** MMRS provides both patient registration and visit data collection functions. Data are collected on all patients seen in the medical clinic, including their laboratory results and medications. AMRS supports comprehensive HIV care as well as mother-to-child transmission prevention, while serving as a rich database for quality improvement and answering research questions.

**Significance:** The growing AMRS and MMRS databases serve both clinical and research needs, generating clinical summary reports for providers and providing a centralized source of data for epidemiological research. The next generation of the database, called AMRS, has a completely revamped data model, and uses new technology (MySQL, Python-based Zope and Plone, and MSInfoPath to allow web-based data entry).

**PIH-EMR, Peru** in 1996 Partners in Health (PIH) started a treatment program for drug-resistant tuberculosis in the slums of Lima, Peru. A patient that is multi-drug resistant is infected with bacteria resistant to isoniazid and rifampin, the two most efficacious anti-tuberculous drugs.) The PIH-EMR is a web based EMR developed to support the two-year treatment regimen for these patients. It was implemented in 2001 (30).

**Design:** Open source web system backed by an Oracle database Bilingual English and Spanish.

**Data entry:** Forms filled out by the chest physicians, as well as laboratory result forms. Medication data is entered by the nurses and their assistants who manage the patients in each district on advice from the chest physicians.

**Function:** The PHI-EMR includes a clinical record with initial history, physical examination, laboratory results and medications on all patients receiving individualized treatment for MDR-TB. The custom medication order entry system provides advice on potential problems and feedback to the nurses, who can consult the physicians if, for example, a patient has new evidence of resistance to the drug they have been prescribed. Laboratory tests for second-line drug resistance are entered in Boston and Peru and accessible by staff in both sites.

The PIH-EMR is also used to create monthly reports for the Global Fund and the Health Ministry. There is an extensive suite of web-based analysis tools for reporting and outcome monitoring. These include graphs of culture conversion rates (time until sputum culture becomes negative) and search tools for patients with particular resistance patterns and drug regimens. Analysis tools are used to assess drug requirements based on the medications prescribed. The system is being extended to include all MDR-TB patients in Peru and linked to the main tuberculosis laboratories there. The PIH-EMR demonstrates the strength and flexibility of a web-based approach when internet connectivity is available.

A team at the US Department of Health and Human Services has developed a medical record system to support HIV treatment via the Care ware system in Uganda (31).

**Design:** They system run over a local area network and Stand-alone database built with MS Access.

**Data entry:** the data's or information's are filed out direct by users, both on paper forms and computers this includes the patient personal information, laboratory results, and medication data's.

**Function:** The system provides functions comprehensive tools for tracking HIV patients and their treatment, including clinical assessment, medications and billing data. It is widely used in health centers and hospitals in the US, and has recently been internationalized and deployed in Uganda in October 2003.

**Significance:** Care ware is an example of a US-based stand-alone EMR that is being adapted to developing country environments. An internet-accessible version that is under development will allow local data entry offline but provide networked communications and back-up.

**Lilongwe EMR, Malawi** Kamuzu Central Hospital located in Lilongwe, Malawi has made extensive use of a touch screen patient management information system for a wide range of clinical problems in the 216-bed pediatric department since 2001 (26).

**Design:** of the system runs over a local area network built on Linux/ MySQL with Visual Basic™ for the client programs.

**Data entry:** Physicians, nurses and pharmacists perform all data entry using touch screens, including medication orders.

**Functions:** Data are collected on patient demographics, medication, laboratory tests and X-rays. A potential limitation of the touch screen approach is that it is difficult to enter free text, though an ‘on-screen’ keyboard is available and has been used by local staff to enter all the patients’ names.

**Significance:** The extensive use of this system directly by healthcare workers in a poor country with limited IT skills is a convincing demonstration of the potential of EMRs with user-friendly data entry mechanisms.

**SICLON, Brazil** the Brazilian public health system uses the ‘Computerized System for the Control of Drug Logistics (SICLON)’ to deliver ARV treatment to over 100 000 patients – by far the largest group in the developing world. They used Separate EMR databases on each physician’s desktop periodically connect to the central server by dial-up to update records. Language: Portuguese. It used to support prescribing and track medication supplies (limited information available) and also it is considered a ‘key factor(s) helping to overcome logistical challenges to delivery of antiretroviral treatment in Brazil’ (33).

**FUCHIA** was developed by Epicentre, the epidemiology group of Médecins Sans Frontières, to support their HIV treatment projects (34). It supports clinical care and long-term follow-up of patients, including scheduling of visits; it includes data on medications and investigations and generates reports. It was developed as a standalone system using MS Access and the Delphi programming language.

An information system was developed in Botswana to support the TB program and is built using EpiInfo (a free stand-alone program from the US Centers for Disease Control [CDC] designed for data collection and analysis in developing countries). It includes reporting and analysis tools and has been successfully deployed to multiple sites in several countries.

**PDA/Palm systems** a variety of PDA-based medical information systems have been proposed or implemented for projects in developing countries on the basis that handheld devices will be easier to use and support in remote sites. Such devices would seem to provide particular benefits for community health care, being simple and relatively unobtrusive to carry around. Palm-based devices tend to be favored due to their excellent battery life and generally lower cost. In KwaZulu Natal, South Africa, a Palm-based system allows secure access to HIV results in remote clinics. In rural India, a Pocket PC-based system has been used to store health records for community nurses visiting remote villages. Palm or Pocket PC systems can be easily set up to view pages offline from a web-based EMR, though care is required to maintain data security. Satel life is using the mobile phone network in Uganda to link PDA-based medical records to a central site. Local healthcare workers collect data on Palm Pilots™ and then connect to a local battery-powered server that connects to a central database via a mobile phone modem (35).

#### Web-based collaboration and telemedicine systems

The web allows data sharing for remote consultation, and several projects have established systems that can be used to support diagnosis and treatment decisions in remote sites with limited bandwidth. The RAFT project permits remote collaboration, case discussion and data sharing over low-bandwidth networks between Geneva University Hospitals and Bamako, Mali. The IPATH server is a web-based tool for image sharing in pathology and radiology being used in South Africa and the Pacific as well as Switzerland. Telemedmail is a secure email and web-based telemedicine system under evaluation in South Africa and Peru. (35)

EMR implementation in Malaysian government hospitals, patient is the main customer. They have their own right to request a good service from the hospital. Every information is given to the patients must be well informed. Staffs can access the patient medical records by using IT facilities. All staffs are using computer to do their work starting room the creation of the records until patient discharge from the hospital. Thus, it can save a lot of time and more patients can be treated from time to time. (35)

Since there are different documents to design and implement EMR system in different country and organization from those reviewed documents I have use different approaches to gather the identified requirement and followed the most appropriate methodology for my project and also the mechanism how to make things easier to understand for the end user.

# Chapter Three

## 3. Methodology

### 3.1 Study area/Setting

The Ministry of Defense Command and Staff Hospital, is one of the defense hospitals in Ethiopia. The Hospital was established 35 years ago. It is located in Western part of city of Addis Ababa. Currently there are 60 health professionals and 80 supportive staffs currently working in the Hospital. The total population is about 350 with the staff population of about 210, academic staff and student, 140 health professionals and support staff. Since the Hospital gives serves only for militaries and their family.

### 3.2 Source population and Study population

Target population for the study consists of health professionals, academic staff, students and supportive staff who work in the hospital. The study included the hospital chief executive officers, medical director, user of the system, students and all staff members that fulfill the inclusion criteria of age above 15 years old, registered as a regular second year or above student who are capable to write and read. First year, short term training students are not included because we're not being admitted during the data collection period.

### 3.3 Data Collection

Data was collected using data collection tools from both primary and secondary sources. The primary data gathered with the use of interview, personal observation, and focus group discussion by all group of the hospital members. Secondary data has been gathered through document review of relevant written sources.

**Interviewee:** In this project, managers, HMIS focal persons and senior health professionals were interviewed about the current paper based system and related business. Among the managers according to their position and overall controlling system the chief executive officer (CEO), medical director, pharmacy department, laboratory department and registration department heads were interviewed. In addition to this since the work flow and process are followed by the HMIS focal person, HMIS focal person were interviewed. Interviews was also conducted with users of the system.

**Observation;** The current business process, the data flow of the current system in general and the day today activities were observed in order to identify problems with the current system which is the manual system.

**Document review:** Related literature reviews, formats which are patient registration, history taking, diagnosis and treatment, laboratory investigation and medication /prescription formats were reviewed to understand and define problems.

### **3.4 Data Analysis and design**

#### **3.4.1 Methodology**

The project used structure analysis and design method to design the EMR and use cases and data flow diagrams were applied for the analysis and design model of the system. It is an appropriate description notation to design the system. Hence it provides a clear requirement statement that everyone can understand and is a firm foundation for subsequent design, they use diagrammatical and other modeling techniques to give a more precise definition, It is easily understandable by the users and developers and they structure a project into small, well defined activities and specify the sequence and interaction of the activities. In addition the method used for this project was the incremental water fall approach.

#### **3.4.2 Incremental water fall approach**

The incremental methodology is an evolution of the waterfall model, where the waterfall model is incrementally applied using the iterative philosophy of prototyping. With incremental development, the project is designed, implemented and tested incrementally with a little more is added each time until the product is finished. It involves both development and maintenance. The product is defined as finished when it satisfies all of its requirements. (7)

Iterative and incremental software development begins with planning and continues through iterative development cycles involving continuous user feedback and the incremental addition of features concluding with the deployment of completed software at the end of each cycle.

### **3.4.3 Data analysis design (tools and techniques)**

After requirement was captured using the interview, observation and document review the result was analyzed. The result was presented being summarized from the notes taken during the requirement collection. The result of the system modeling that helps to understand the system models used for analysis of the system was done using tools like the use cases, use case diagram, contextual diagram, flow chart, system object modeling, DFD (Data flow Diagram).

**3.4.3.1 Tools;** A tool in software development is software support that helps create models or other components required in the project. The tools used for analysis and design in this project were.

- Microsoft Visio for use case diagrams, contextual diagram, flow chart, system object modeling, DFD.
- Microsoft project for planning
- C# for system user interface

**3.4.3.2 Techniques:** A technique in system development is a collection of guidelines that help an analyst complete a system development activity or task. The techniques used in SSADM are logical data modeling, data flow modeling and entity behavior modeling.

**Logical data modeling:** The process of identifying, modeling and documenting the data requirements of the system has been designed. The result is a data model containing entities (things about which a business needs to record information), attributes (facts about the entities) and relationships (associations between the entities).

**Data flow modeling:** The process of identifying, modeling and documenting are how data moves around information system. Data Flow Modeling examines processes (activities that transform data from one form to another), data stores (the holding areas for data), external entities (what sends data into a system or receives data from a system), and data flows (routes by which data can flow) by using DFD.

**Entity event modeling:** A two-stranded process: Entity Behavior Modeling, identifying, modeling and documenting the events that affect each entity and the sequence (or life history) in which these events occur, and Event Modeling, designing for each event the process to coordinate entity life histories.

In general the method, techniques and tools used in each phase of the project are summarized below in the table.

Table1: Method, Techniques and tools

Phases of the software development	Techniques	Tools	Methods
Feasibility, requirement gathering /planning phase	<ul style="list-style-type: none"> <li>• Interview</li> <li>• Observation</li> <li>• Document review</li> </ul>	<ul style="list-style-type: none"> <li>• Interview</li> <li>• Observation checklist</li> </ul>	Incremental water fall approach
Analysis phase	<ul style="list-style-type: none"> <li>• Data flow modeling</li> <li>• Contextual diagram</li> <li>• Use case diagram</li> </ul>	<ul style="list-style-type: none"> <li>• Microsoft Visio</li> <li>• Microsoft Visio</li> <li>• Microsoft Visio and C#</li> </ul>	
Design phase	<ul style="list-style-type: none"> <li>• Entity Event Modeling</li> <li>• Relational data base design</li> <li>• System object process</li> </ul>	<ul style="list-style-type: none"> <li>• Microsoft Visio</li> <li>• Microsoft Visio</li> <li>• Microsoft Visio and C#</li> </ul>	

### **3.5 Methods of dissemination of result**

After the study is completed, the report will be forwarded to the Ministry of Defense Command, Staff Hospital where the study was conducted and to AAU as partial fulfillment of MSc degree in health informatics and publication.

### **3.6 Operational definition**

**Data design:** Is concerned with how the data is represented and stored within the system.

**Data flow diagram:** Is a graphical representation of the "flow" of data through an information system, modeling its process aspects. Often they are a preliminary step used to create an overview of the system which can later be elaborated.

**Entity relationship diagram:** An entity-relationship diagram (ERD) is a data modeling technique that graphically illustrates an information system's entities and the relationships between those entities. An ERD is a conceptual and representational model of data used to represent the entity framework infrastructure.

**Outpatient department:** Part of a hospital where different clients get different services as an outpatient.

**Structured systems analysis and design methodology (SSADM):** is a set of standards for systems analysis and application design.

**Use case diagram:** Is a graphic depiction of the interactions among the elements of a system.

**User interface design:** Is concerned with how users add information to the system and with how the system presents information back to them.

### **3.7 Ethical consideration**

Prior to data collection, ethical clearance was obtained from School of Public Health and school of information science of AAU. In addition, concerned bodies in the hospital were informed about the study (Commandant, Research department and Medical director of the hospital).

# Chapter four

## 4. Discussion of results

### Analysis and Design of the System

#### 4.1 Analysis

##### Introduction

In this chapter the current system, the business process, the functional and nonfunctional requirements, use cases, process models, data models, and the design of the system are presented.

##### 4.1.1 Current system

Within the existing system at the Ministry of Defense Command and Staff Hospital, the patient information was collected information about patients is done by just writing the patients name, age and gender. Whenever the patient comes his information is stored freshly. Bills are generated by recording price for each facility provided to patient on a separate sheet and at last they all are summed up. Diagnosis information to patients is generally recorded on the document, which contains Patient information. It is destroyed after some time period to decrease the paper load in the office. Immunization records of children are maintained in pre-formatted sheets, which are kept in a file. Information about various diseases is not kept as any document. Doctors themselves do this job by remembering various medicines. All this work is done manually by the receptionist and other operational staff and lot of papers are needed to be handled and taken care of.

##### Business process description

###### Registration department

The business process of the registration department is described as follows;

The patient presents in the registration department and if the patient is new the data clerk asks the patients full information (personal information and address) and register and gives identification number and also the data clerk tell to make payment after the patient paid and send

to the triage office and the triage officer screen the patient. After screening the patient will sent to the outpatient department.

Whereas if the patient is repeats or come with appointment, the patient goes to the registration department and gives the card to the data clerk then the data clerk receives the identification card from the patient and modifies some information like date, finally the data clerk sends the patient to the outpatient department which is the patient visited before.

### **Outpatient department**

The business process of the outpatient department is described as follows;

The patient arrives in the outpatient department with patient card and the nurse registers patient name, ID, age and sex. The physician/nurse/Ho/Msc takes the identification information which includes the socio demographic, visit and ID of the patient. The physician performs the chief compliant activities from the patient side if the patient has insight and from the family if the patient does not have insight. Then the physician takes/registers the history of present illness which includes family history (genetic factor, substance use, income, occupation) and patient history (early child hood, Adolescence, substance use, educational status, work performance, friend's status and martial relationship, support), per morbid history (aggressive, calm), mental status examination of the patient which include general appearance and attitude towards the examination, mood and effect, speech and thought disturbance like delusion. After the patient examine the diagnosis and differential diagnosis, if further investigation is needed the physician order laboratory investigation. According to the laboratory result the physician prescribe medication takes place or if the patient doesn't need laboratory investigation the physician prescribe medication and appoint the patient to the next visit. Finally patient card is archived.

### **Laboratory department**

The business process perform in the laboratory department currently is described as follows.

The patient comes in the laboratory department with laboratory request. Then the receptionist accepts the laboratory request and asks the name of the patient from which department he/she came. The receptionist explain to the patient about the sampling (from where it is taken, why the sample is needed and other related information) and takes sample, the receptionist tell to the patient to come back after some time to take his sample result. The receptionist register the test order in the logbook which includes the department which ordered the test, name of the patient, sample id ,date and the type of test. After test order register the sample distributed to the sections

(chemistry, parasitology, urinalysis, hematology, serology CD4) and each sections perform quality check of the machine or reagent status after this the lab tech. check sample quality whether the sample mix for example urine mix with stool, stool mix with blood and so on. After checking sample quality sample examines and the result cross checked or review. The result record in the result logbook and send back to the receptionist. The receptionist put the result on a shelf and gives to the patient when the patient comes.

### **Pharmacy department**

The business process of the pharmacy department is described as follows;

The patient arrives at the pharmacy department with prescription order. The pharmacist/evaluator accept the prescription from the customer and evaluate the prescription the legality, fulfilled the information and other. After evaluated the pharmacist determine the price of the drug and write the code of the price and the patient go to the cashier to perform payment. The cashier accepts the prescription and sees the price and calculates the total price and tells to the patient to pay. The patient performs payment. The cashier issued receipt and the patient come back to the pharmacist. The pharmacist/dispenser receives the prescription with the receipt and dispenses the drug to the patient with appropriate counseling.

### **4.1.2 The Proposed system**

The proposed system works on computers via local area network in line with the requirements of departments. There is a centralized database to store the patients' EMRs as well as to integrate the department's registration, triage, laboratory, pharmacy and outpatient departments. The users use computers to record and review the patient information.

#### 4.1.2.1 Functional requirements

A functional requirement relates directly to a process the system has to perform or information it needs to contain. Accordingly the functional requirements are describes as follows.

- The system registers users of the system.
- The system should authenticate the user and assign privileges according to the assigned rights
- The system should be able to register patient personal information, address and identification number or medical record number.
- The system searches patient information.
- The system updates the patient information
- The system updates user account.
- The system records patient assignation information.
- The system records patient diagnosis and treatment data.
- The system registers the appointment date of the patient.
- The system registers the patient laboratory order.
- The system records patient laboratory result.
- The system records medication order.
- The system should be able to generate reports of outpatient, laboratory and pharmacy departments.

#### 4.1.2.2 Non functional requirements

A non functional requirement describes user behavioral properties that the system must have, such as performance and usability. The ability to access the system through a Web browser would be considered a nonfunctional requirement. The non functional requirements correspond to the process of explaining the features, characteristics, attributes, and constraints of the information system used to limit the boundaries of the proposed solution. The nonfunctional requirements describe a variety of characteristics regarding the system:

**Security:** Since the system is going to handle personal information which is confidential, it should be protected from unauthorized users and intruders. No one can log into the system without a registered user name and corresponding password. The system has two groups of users: the data base administrator and limited user. The data base administrator user has full

privilege to perform on the system. Whereas the limited user can only perform limited operations, For example in laboratory department, the lab techs allows only to access the information of laboratory department and can change their own username and password but it is impossible to access information others department.

**Virus Control Requirements:** systems require that all information systems permitting the import or upload of user files check those files for viruses before they are stored in the system.

**Availability:** The system should be available all the time 24 hours/ 7 days a week, and there should be 24 hours/day of electricity and back up source such as generator to work the system without interruption.

**Maintainability:** The system will be easily maintained by the developer as well as other authorized trained person. The system will also be modifiable at any time to enhance features based on the office needs. As needs change from time to time the original system will be made available to fill the gap between the system and the newly emerging needs. The system could be enhanced by adding new functionalities without necessarily changing the basics.

**Error handling:** The system is expected to handle errors encountered during run time. Errors could arise from users and from the system. Errors that occurred from the wrong doing of users will be handled by appropriate exception handling mechanisms.

**Performance:** Performance is an important issue for the system because one of the drawbacks of the current system is performance issue. So this system makes fast the activities by making the server fast and the software should be fast enough to respond in real time.

**User interfaces:** This is basically concerned on what kind of Graphical User Interface (GUI) the system should provide or what is the level of expertise of the user. Since the system is going to be used by different user categories, it should have a very simple and user friendly interfaces for everyone to understand the functionalities easily.

### 4.1.3 Analysis model

**Table 2: Identified actors**

Actor name	Description
Data clerk	Data clerk refers to a person who gives service in the registration department or enters the patient personal information and address to the system.
Triage officer	Triage officer refers to a professional who screens patients status
Physician/HO/nurses	Refers to professionals who diagnosis and treated patients and enters the diagnosis and treatment data's to the system.
Laboratory technician	Laboratory technician refers to professionals who perform the diagnostic services and enters laboratory information to the system.
Pharmacist	Pharmacist/druggist refers to professionals who give services towards medication/drug and enters drug information to the system.
Administrator	Administrator is refers to the person who administer the system.

### Identified use cases

- Login
- Register patient
- Update patient information
- Assign patient
- ADD diagnosis and treatment data
- Order laboratory tests
- Register test result
- Perform medication
- Generate report
- Search patient
- Manage user account

## System Use Case Descriptions

**Table 3: login Use Case**

Use Case ID	UC_1
Use case Name	Login
Priority	High
Stake holder and interests	Wants to log into the system
Primary actor	User (data clerk, triage officer, physician, pharmacist and laboratory tech.)
Summary description	This Use case describes how the user logs into the system to view or modify requests.
Precondition	The user must have user name and password
Post condition	The user logs into the system
Main success scenario	<ol style="list-style-type: none"> <li>1. The Use Case starts when the user clicking the login screen.</li> <li>2. The system displays the log in screen.</li> <li>3. The user enters the username and password</li> <li>4. The system verifies the information and set access permission.</li> <li>5. The system will display the main screen.</li> <li>6. Use case ends</li> </ol>
Alternative path	<p>4a. If the username or password is not valid, an error message is displayed.</p> <p>4a1. The user clicks an ok button.</p> <p>4a2. The user is returned to login screen and reenter user name and password for three times? If still fails ...</p>

**Table 4: Register Use Case**

Use Case ID	UC_2
Use case Name	Register Patient
Priority	High
Primary actor	Data clerk
Summary description	This Use Case describes the process how the data clerk is entered personal information and address of the patient into the registration department.
Precondition	The data clerk has successfully passed through Authentication and Authorization.
Post condition	The patient is registered on the system.
Main success scenario	<ol style="list-style-type: none"> <li>1. The Use Case starts when a data clerk clicks on the registration link.</li> <li>2. The system displays the registration form.</li> <li>3. The data clerk enters the name or demographic information of the patient and search.</li> <li>4. The data clerk confirms that the patient is not registered in the system</li> <li>5. The data clerk enters the data (patient personal information and address)</li> <li>6. The system checks the entered data and compares with data restriction.</li> <li>7. The system validates the correctness of the data and registers the patient.</li> <li>8. The system automatically generate patient ID and the data clerk ID click submit button.</li> <li>9. The data clerk stored/save the record in the system</li> <li>10. Use case ends</li> </ol>
Alternative path	<p>4a. If the patient is already registered or repeat.</p> <p>4a1. The data clerk enters the patient name or ID of the patient and search the patient.</p> <p>4a2. The system displays the patient data.</p> <p>4a3. The data clerk updates patient visits.</p> <p>4b. if the patient is appointed.</p> <p>4b1. The data clerk enters the patient name or ID of the patient and search the patient.</p> <p>4b2. The system displays the patient data.</p> <p>4b3. The data clerk updates patient appointment.</p> <p>5. Use case ends.</p> <p>6a. If the data clerk makes error while enters the data, the system displays error message.</p> <p>6a1. The data clerk clicks an ok button.</p> <p>6a2. The system informs the data clerk to re-enter patient information.</p> <p>7. Use case ends.</p>

**Table 5: Patient Record Use Case**

Use Case ID	UC_3
Use case Name	Update patient information
Priority	High
Stake holder and interests	Wants to Update patient information
Primary actor	Data clerk
Summary description	The data clerk updates the patient record.
Precondition	Patient is registered.
Post condition	The patient record is updated.
Main success scenario	<ol style="list-style-type: none"><li>1. The Use Case starts when a data clerk clicks on the registration department link.</li><li>2. The system displays the registration form.</li><li>3. The data clerk enters the name or demographic information of the patient and search.</li><li>4. The system displays patient record.</li><li>5. The data clerk enters the data to be update.</li><li>6. The system checks the entered data and compares with data restriction.</li><li>7. The system validates the input data and updates the record.</li><li>8. The data clerk stored/save the record in the system.</li><li>9. Use case ends.</li></ol>
Alternative path	<p>6a. If the data clerk makes error while enters the data, the system displays error message.</p> <p>6a1. The data clerk clicks an ok button.</p> <p>6a2. The system informs the data clerk to re-enter patient information.</p> <p>7. Use case ends.</p>

Table 6: Assign/screen Use Case

Use Case ID	UC_4
Use case Name	Assign /screen patient
Priority	High
Stake holder and interests	The triage officer wants to assign patients to the outpatient department
Primary actor	Triage officer
Summary description	The triage officer assigns the patient to the outpatient department.
Precondition	Patient is registered
Post condition	The patient is assigned
Main success scenario	<ol style="list-style-type: none"> <li>1. The Use Case starts when the triage officer clicks on the triage link.</li> <li>2. The system displays the screening form which contains name of the patient and outpatient departments.</li> <li>3. The triage officer enters the data (name of the patient and assign to the respective outpatient according to the illness of the patient) and click submit button.</li> <li>4. The triage officer save the data's on the system</li> <li>5. Use case ends.</li> </ol>
Alternative path	.....

**Table7: Add diagnosis and treatment data Use Case**

Use Case ID	UC_5
Use case Name	Add diagnosis and treatment data
Priority	High
Stake holder and interests	The physician/nurse/Ho wants to treat patient
Primary actor	The physician/nurse/HO/
Summary description	This use case describes the process used to diagnose the patient.
Precondition	Patient registered, Patient is assigned, The physician logs in to the system.
Post condition	The patient diagnosis and take a treatment Patient history is registered
Main success scenario	<ol style="list-style-type: none"> <li>1. The Use Case starts when a physician clicks on diagnosis and treatment link.</li> <li>2. The system provides the physician diagnosis and treatment form (which contains personal information and Address of the patient, general examination, diagnosis, and laboratory and medication order.</li> <li>3. The physician enters the data.</li> <li>4. The physician click on the medication link and enter treatment order and click submit button</li> <li>5. The system saves the data to a data base.</li> <li>6. Use case ends</li> </ol>
Alternative path	<p>4a. Laboratory investigation is needed.</p> <p>4a1.The physician click on the lab order link under the diagnosis button</p> <p>4a2. The system provides the physician lab request form.</p> <p>4a3.The physician enter laboratory order and click send button.</p> <p>4a4.The system sends lab. Request order to the laboratory dep't.</p> <p>4a5. The system displays laboratory result message.</p> <p>5. Use case ends.</p> <p>5a. If the patient needs follow up.</p> <p>5a1. The physician fills the appointment date and appoints the patient.</p> <p>5b. If the patient needs admission.</p> <p>5b1. The physician fill the admission criteria.</p> <p>5c. If the patient needs further investigation.</p> <p>5c1. The physician fills the referral information and refers the patient.</p> <p>6. Use case ends.</p>

**Table 8: Order Laboratory test Use Case**

Use Case ID	UC_6
Use case Name	Order laboratory order
Priority	High
Stake holder and interests	The physician wants to orders laboratory test.
Primary actor	Physician
Summary description	The use case describes the process used to order laboratory test.
Precondition	The physician is authenticated.
Post condition	Laboratory test order is registered.
Main success scenario	<ol style="list-style-type: none"><li>1. The Use Case starts when the physician clicks on the laboratory request button.</li><li>2. The system display list of laboratory request button.</li><li>3. The physician selects types of orders from the listed button.</li><li>4. The physician click on the send button.</li><li>5. The system save the request and send a message for the laboratory department.</li><li>6. The system saves the data on the system.</li><li>7. Use case ends.</li></ol>
Alternative path	.....

**Table 9 Register Test Result Use Case**

Use Case ID	UC_7
Use case Name	Register test result
Priority	High
Stake holder and interests	The laboratory technician wants to perform laboratory orders.
Primary actor	Laboratory technician
Summary description	The use case describes the process used to record laboratory result
Precondition	The laboratory technician is authenticated.
Post condition	Laboratory result is registered.
Main success scenario	<ol style="list-style-type: none"> <li>1. The Use Case starts when the laboratory technician clicks on the laboratory link.</li> <li>2. The system shows laboratory test order message.</li> <li>3. The laboratory technician clicks on the message button.</li> <li>4. The system display list of laboratory orders.</li> <li>5. The laboratory technician selects the message.</li> <li>6. The system displays the test request form.</li> <li>7. The laboratory technician fills lab results on the lab order entry form and click submit button</li> <li>8. The system sends lab result to respective outpatient department.</li> <li>7. The system saves the data on the system.</li> <li>8. Use case ends</li> </ol>
Alternative path	<p>7a. If the laboratory technician makes error while enters the data, the system displays error message.</p> <p>7a1. The laboratory technician clicks an ok button.</p> <p>7a2. The system informs the laboratory technician to re-enter patient information.</p> <p>8. Use case ends.</p>

**Table 10: Record medication Use Case**

Use Case ID	UC_8
Use case Name	Register medication
Priority	High
Stake holder and interests	The pharmacist wants to perform medication orders.
Primary actor	Pharmacist
Summary description	The use case describes the process used to perform medication Orders
Precondition	The pharmacist authenticated. The physician order medication.
Post condition	Medication record and dispensed.
Main success scenario	<ol style="list-style-type: none"> <li>1. The Use Case starts when the pharmacist clicks pharmacy link.</li> <li>2. The system shows medication order message.</li> <li>3. The system displays list of medication order.</li> <li>4. The pharmacist selects the message.</li> <li>5. The system displays the medication request form.</li> <li>6. The pharmacist enter dispensation detail (ID, date other detail information).</li> <li>7. The physician clicks the dispense button to dispense drug to the patient.</li> <li>8. The system saves the data to a data base.</li> <li>9. Use case ends</li> </ol>
Alternative path	<p>7a. If the pharmacist makes error while enters the data, the system displays error message.</p> <p>7a1. The pharmacist clicks an ok button.</p> <p>7a2. The system informs the pharmacist to re-enter patient information.</p> <p>8. Use case ends.</p>

**Table 11: Search Use Case**

Use Case ID	UC_9
Use case Name	Search patient information
Priority	High
Stake holder and interests	The user wants to search patient information from the system
Primary actor	User
Summary description	This Use case describes how the user searches information from the system to view or modify the information.
Precondition	The user is authenticated. The user should enter patient ID or name.
Post condition	The user gets the information what he/she needs.
Main success scenario	<ol style="list-style-type: none"><li>1. The Use Case starts when the user enters patient ID or name.</li><li>2. The user clicks the search button.</li><li>3. The system checks data input seen register.</li><li>4. The system validates the entered data.</li><li>5. The system displays list of result by search type (ID or name).</li><li>6. Use case ends</li></ol>
Alternative path	<p>3a. If the user makes error while enters the data, the system displays error message.</p> <p>3a1. The user clicks an ok button.</p> <p>3a2. The system informs the user to re-enter patient information.</p> <p>6. Use case ends.</p>

**Table 12: Generate Report Use Case**

Use Case ID	UC_ 10
Use case Name	Generate report
Priority	High
Stake holder and interests	The user wants to generate report from the system
Primary actor	User (Physician, Laboratory technician, Pharmacist).
Summary description	The use case describes the process used to generate report.
Precondition	The user has authentication to generate report.
Post condition	The user generates report from the system.
Main success scenario	<ol style="list-style-type: none"><li>1. The Use Case starts when the user clicks on the report button</li><li>2. The system displays a report window that contains different report options (daily, monthly, quarterly, annually).</li><li>3. The user select type of reports needed.</li><li>4. The system processes and generates the selected report.</li><li>5. The system displays and prints the result as well as save the result in the system.</li><li>6. Use case ends</li></ol>
Alternative path	.....

**Table 13: Maintain User Account Use Case**

Use Case ID	UC_ 10
Use case Name	Maintain user account
Priority	High
Stake holder and interests	The user wants to manage files and users of the system
Primary actor	System administrator
Summary description	This describes how the administrator maintains the users.
Precondition	The administrator should register as an authorized administrator.
Post condition	The administrator maintain user account/manage the system
Main success scenario	<ol style="list-style-type: none"><li>1. The Use Case starts when the user starts the application.</li><li>2. The administrator enters in to login screen.</li><li>3. The system display the login screen</li><li>4. The administrator enter user name and password</li><li>5. The System displays the user account form.</li><li>6. The administrator performs create new user, update user account</li><li>7. The System validate the information which the Administrator enters</li><li>8. End the Use Case</li></ol>
Alternative path	<p>4a the administrator username or password is not valid, an error message is displayed.</p> <p>4a1. The administrator clicks an ok button.</p> <p>4a2. The administrator is returned to login screen and re-enter user name and password.</p>

## System use case diagram

Use case diagrams describe what a system does from the standpoint of an external observer. The emphasis is on what a system does rather than how.

Use case diagrams are closely connected to scenarios. A scenario is an example of what happens when someone interacts with the system.

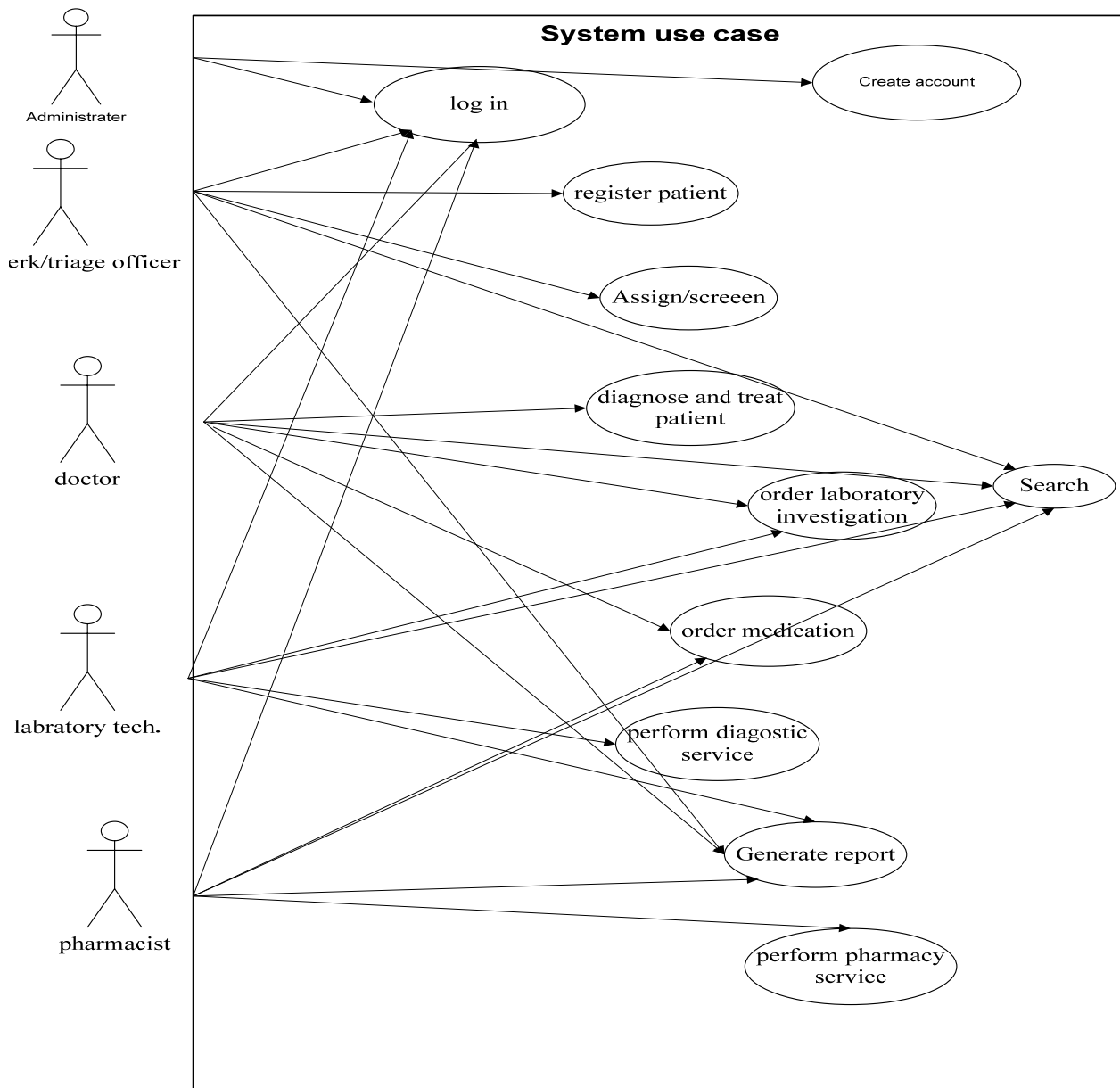


Figure 1: System Use Case Diagram

#### 4.1.4 Process modeling

A process model is a formal way of representing how a business system operates. It illustrates the processes or activities that are performed and how data move among them. A process model can be used to document the current system (i.e., as-is system) or the new system being developed (i.e., to be system).

#### Contextual diagram

The context diagram as the name suggests, the context diagram shows the entire system in context with its environment. It shows the overall business process as just one process.

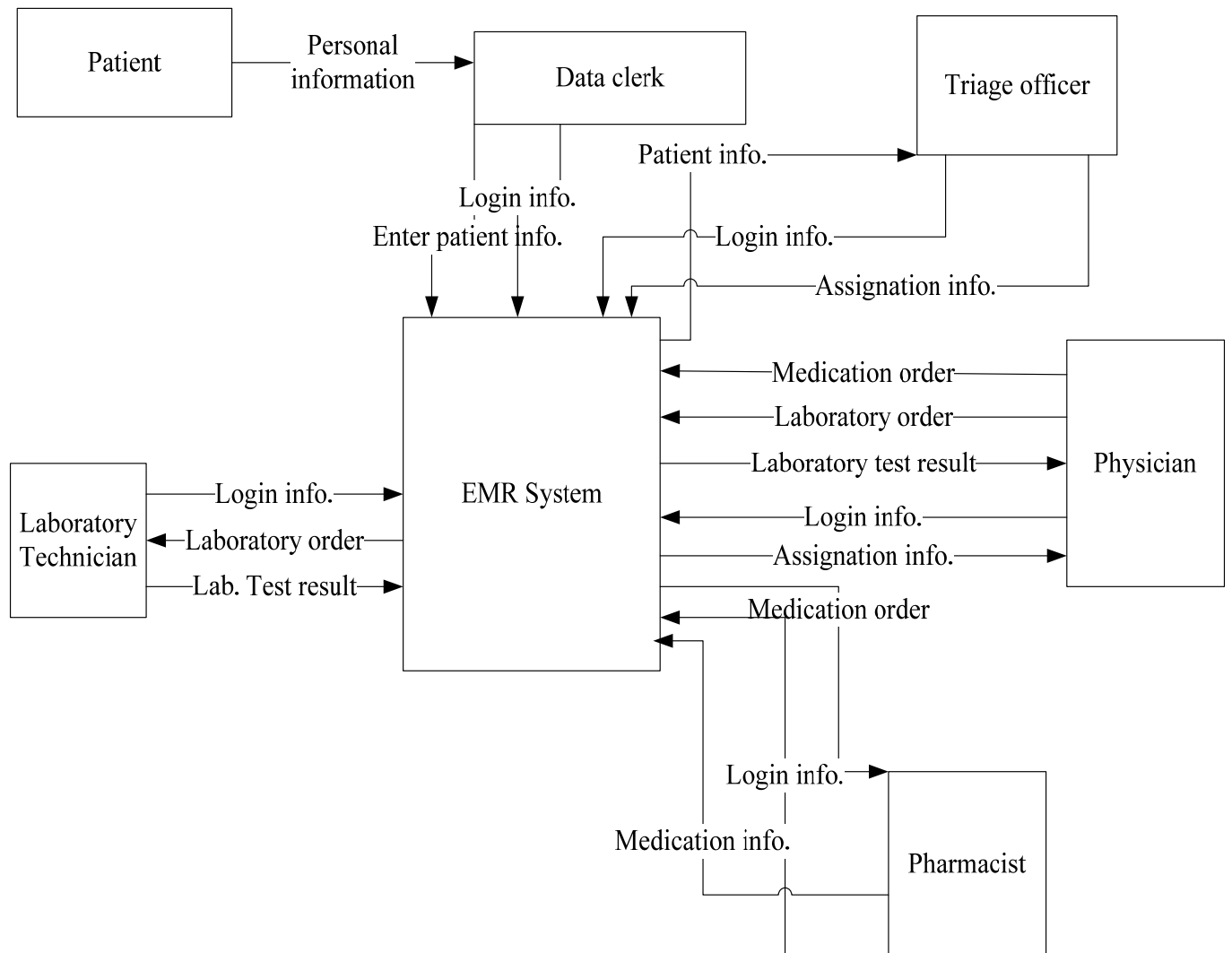


Figure 2: Contextual Diagram of the proposed system

## Data flow diagram

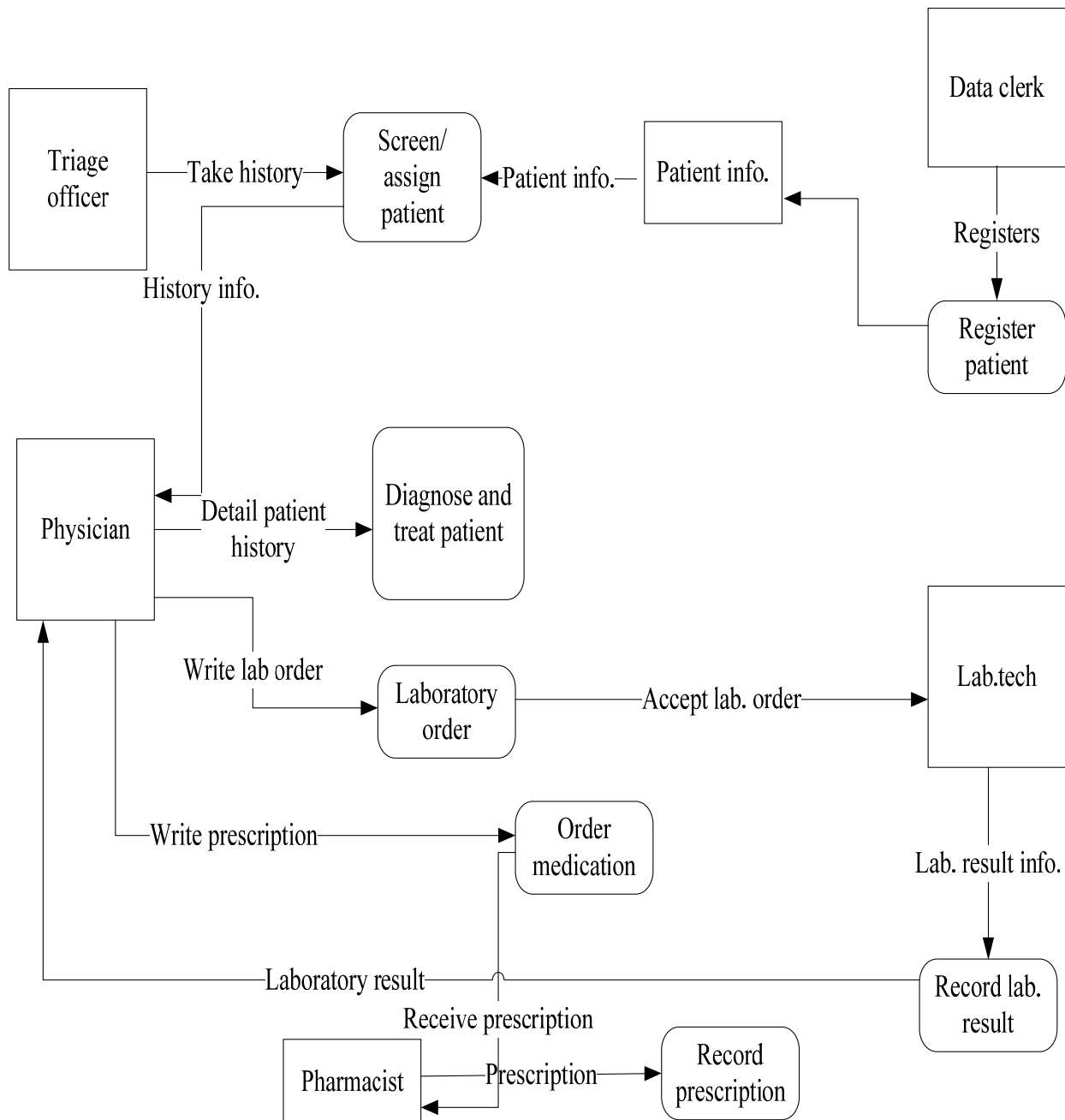


Figure3: Level 1 Data Flow Diagram of the proposed system

## 4.2 System Design

### 4.2.1 System object model

The System Object Model Section allows for a description of the subsystems in use. This allows for describing the system in overall manner to show the different groupings of parts into respective systems. The Electronic Medical Record System is decomposing in to systems in order to reduced complexity in the solution domain of the overall system.

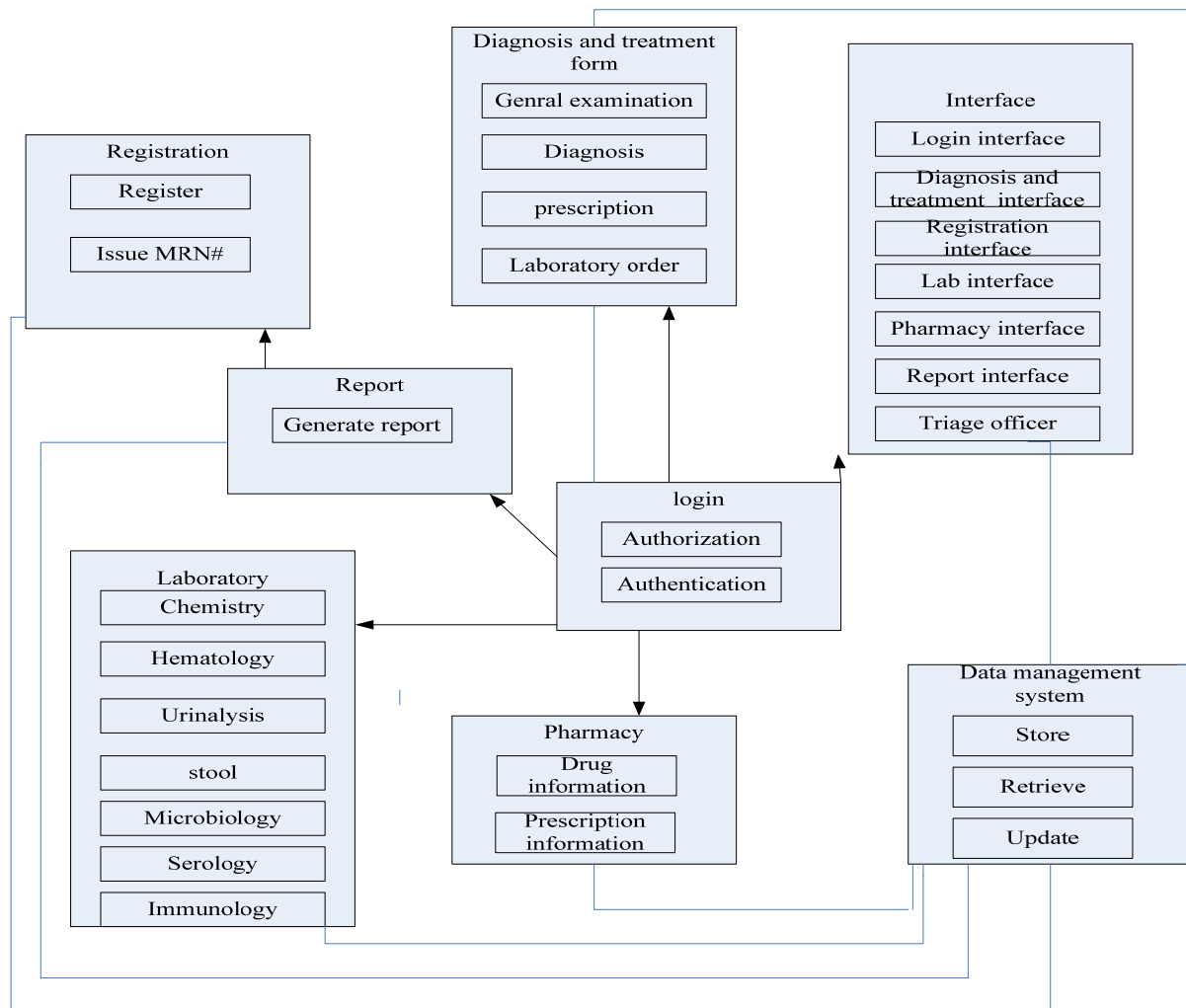


Figure 4: Sub System Interface

## 4.2.2 Data model

A data model is a formal way of representing the data that are used and created by a business system; it illustrates people, places, or things about which information is captured and how they are related to each other.

### Entity relationship diagram

An entity relationship diagram (ERD) is a picture which shows the information that is created, stored, and used by a business system. The entity is the basic building block for a data model. It is a person, place, event, or thing about which data is collected. Relationships are associations between entities, and they are shown by lines that connect the entities together.

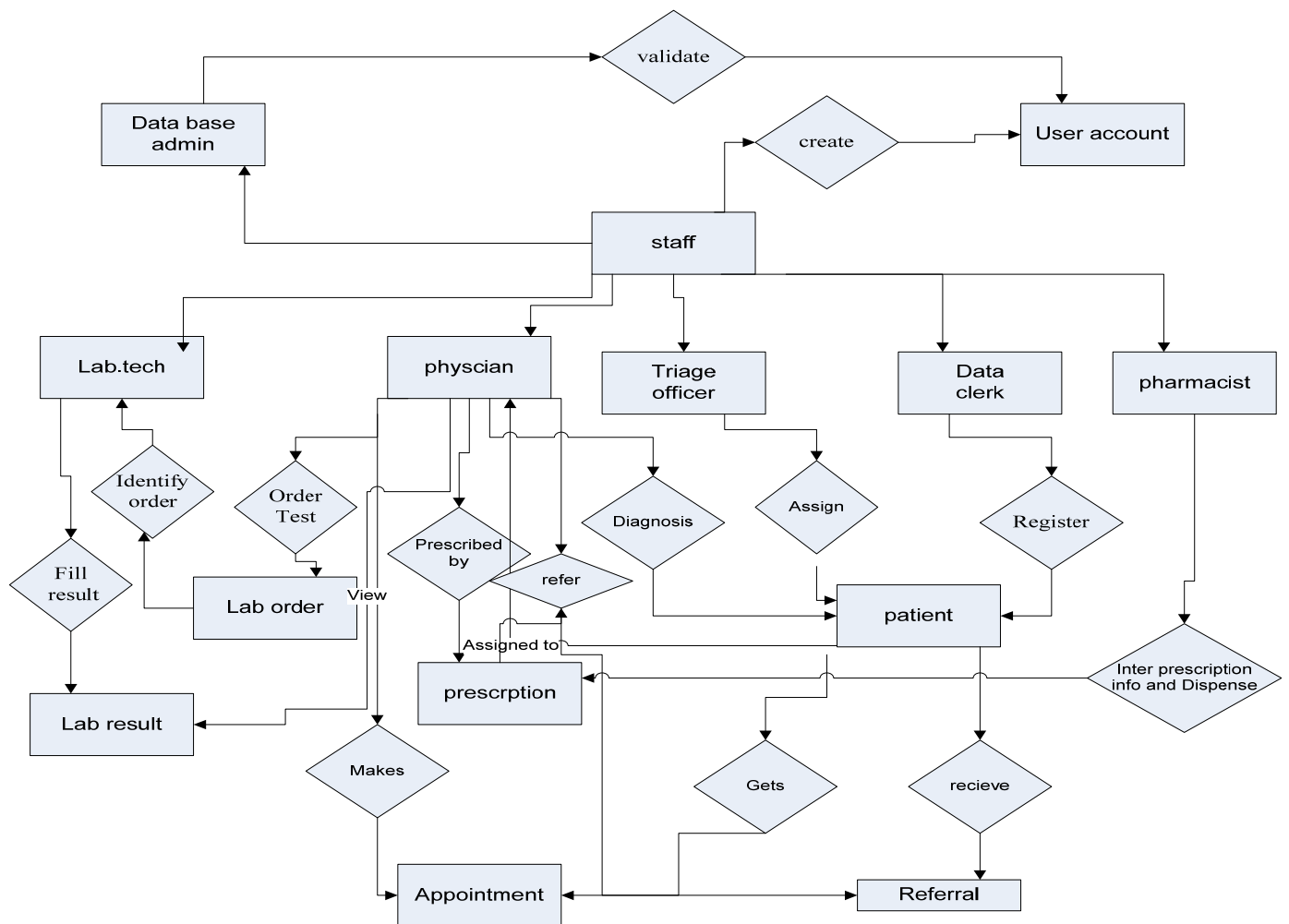


Figure 5: Entity Relationship Diagram EMR for Ministry of Defense Command and Staff Hospital

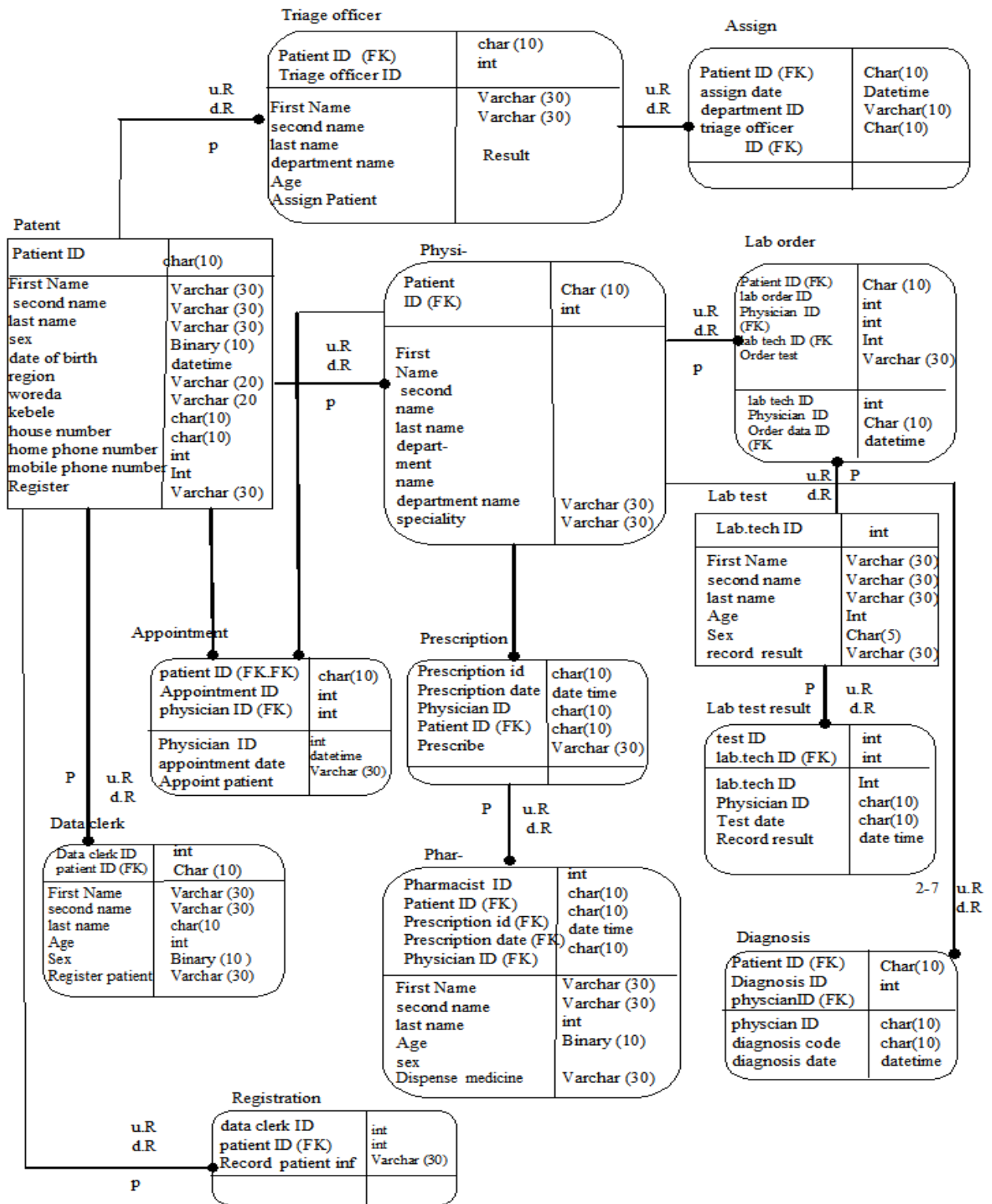


Figure 6: Database Diagram of EMR for Ministry of Defense Command and Staff Hospital



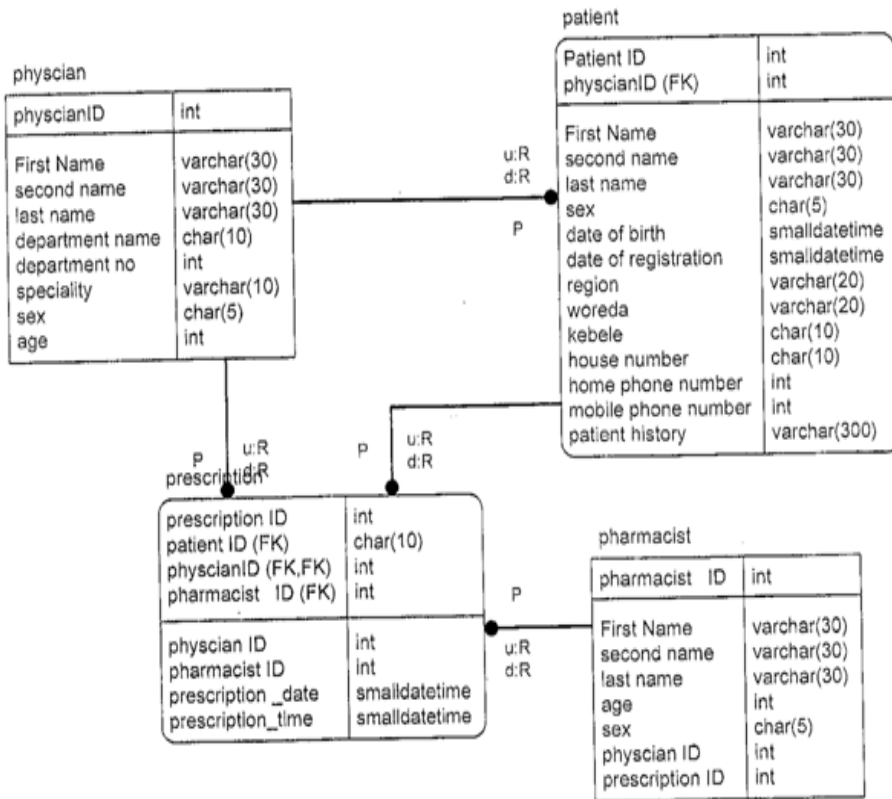


Figure 8: Data base Diagram of Physician and Pharmacy

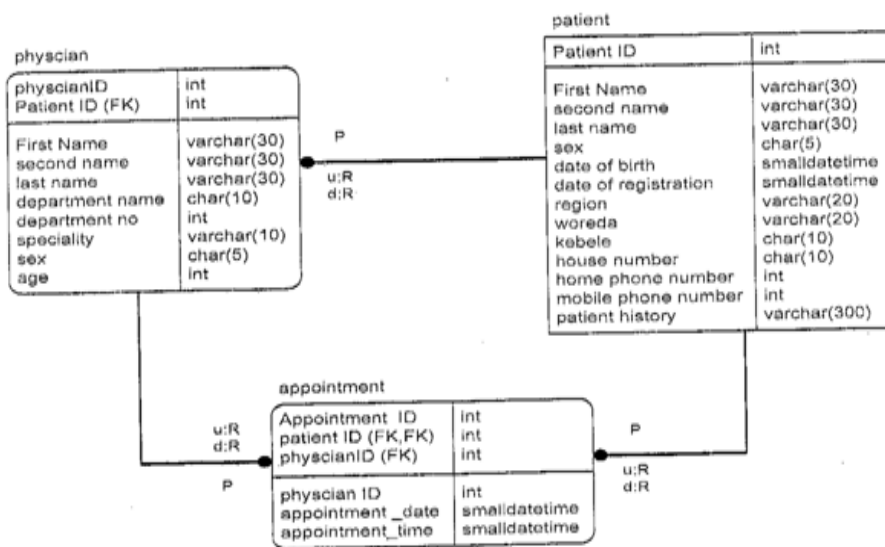


Figure 9: Data base Diagrams of Physician and Appointment

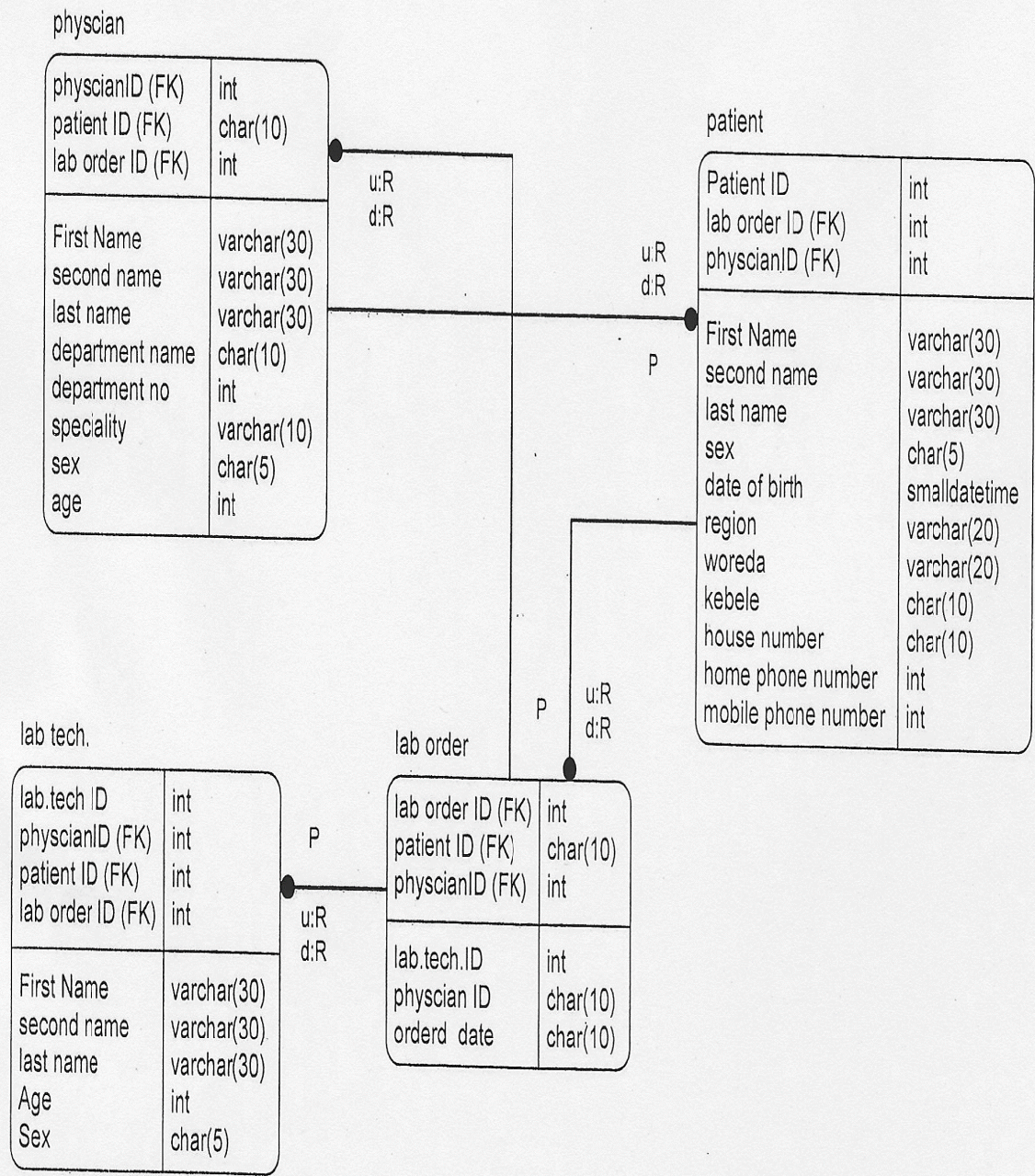
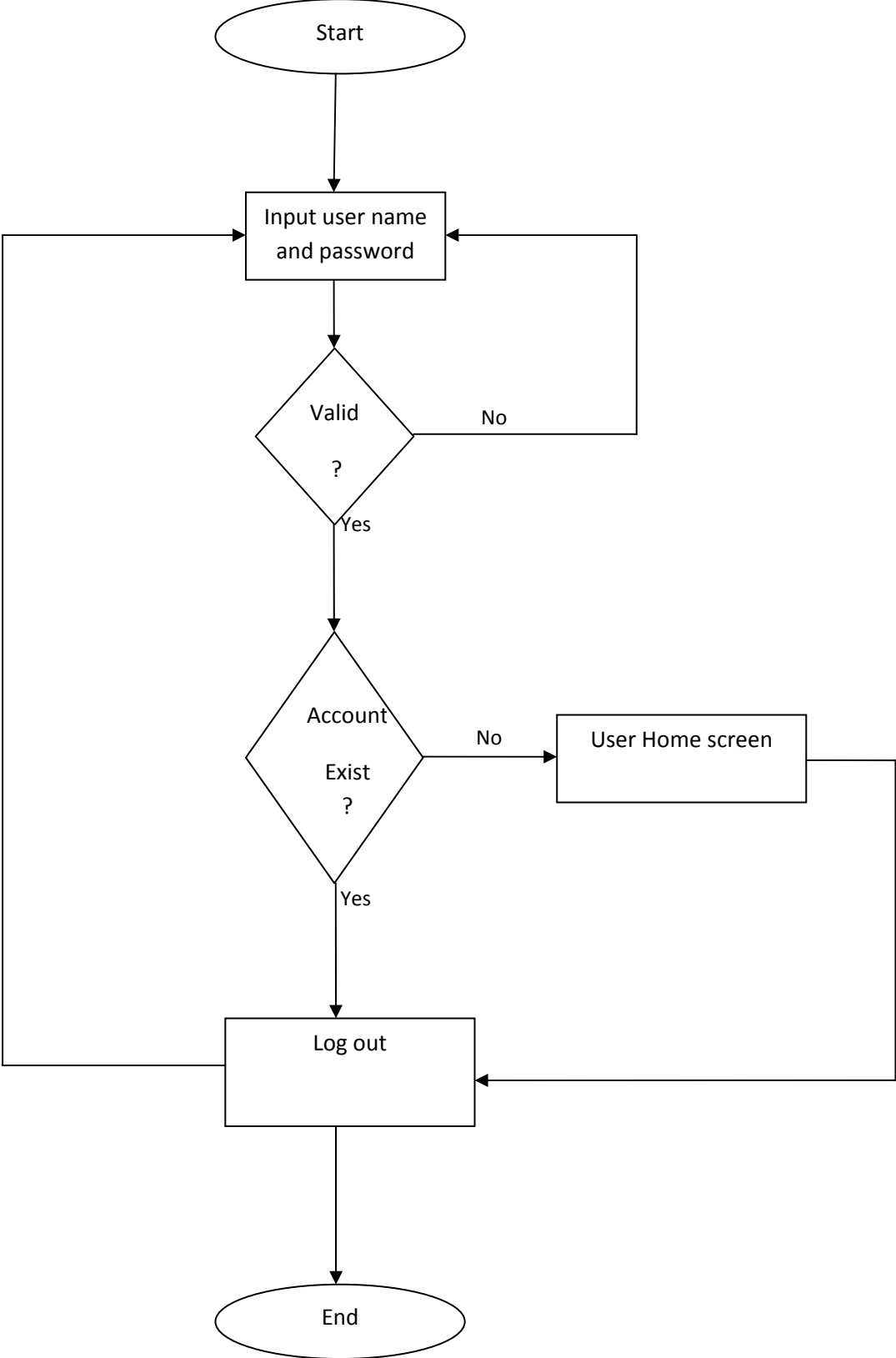
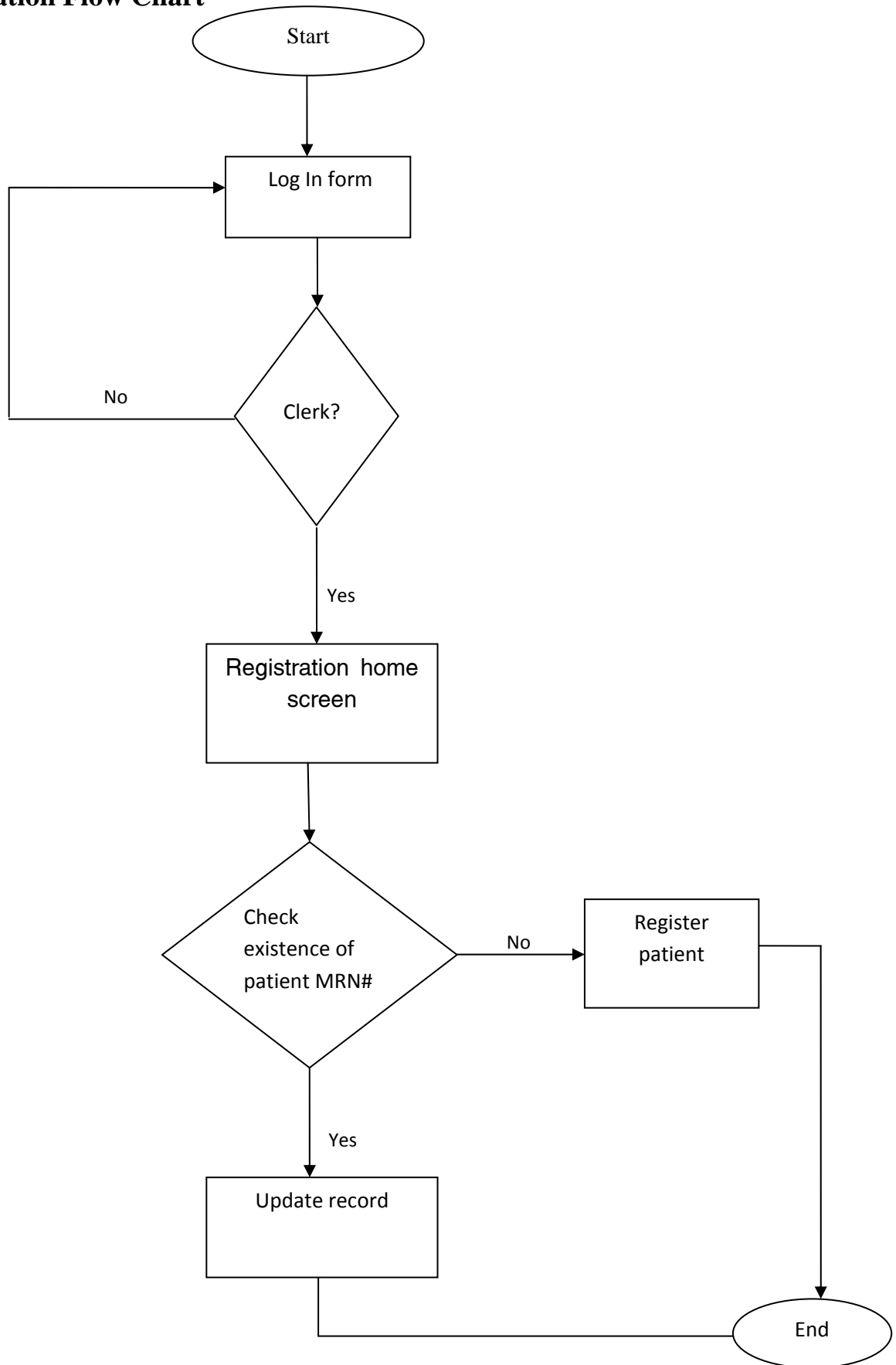


Figure 10: Data base Diagram of Physician and Laboratory Technician

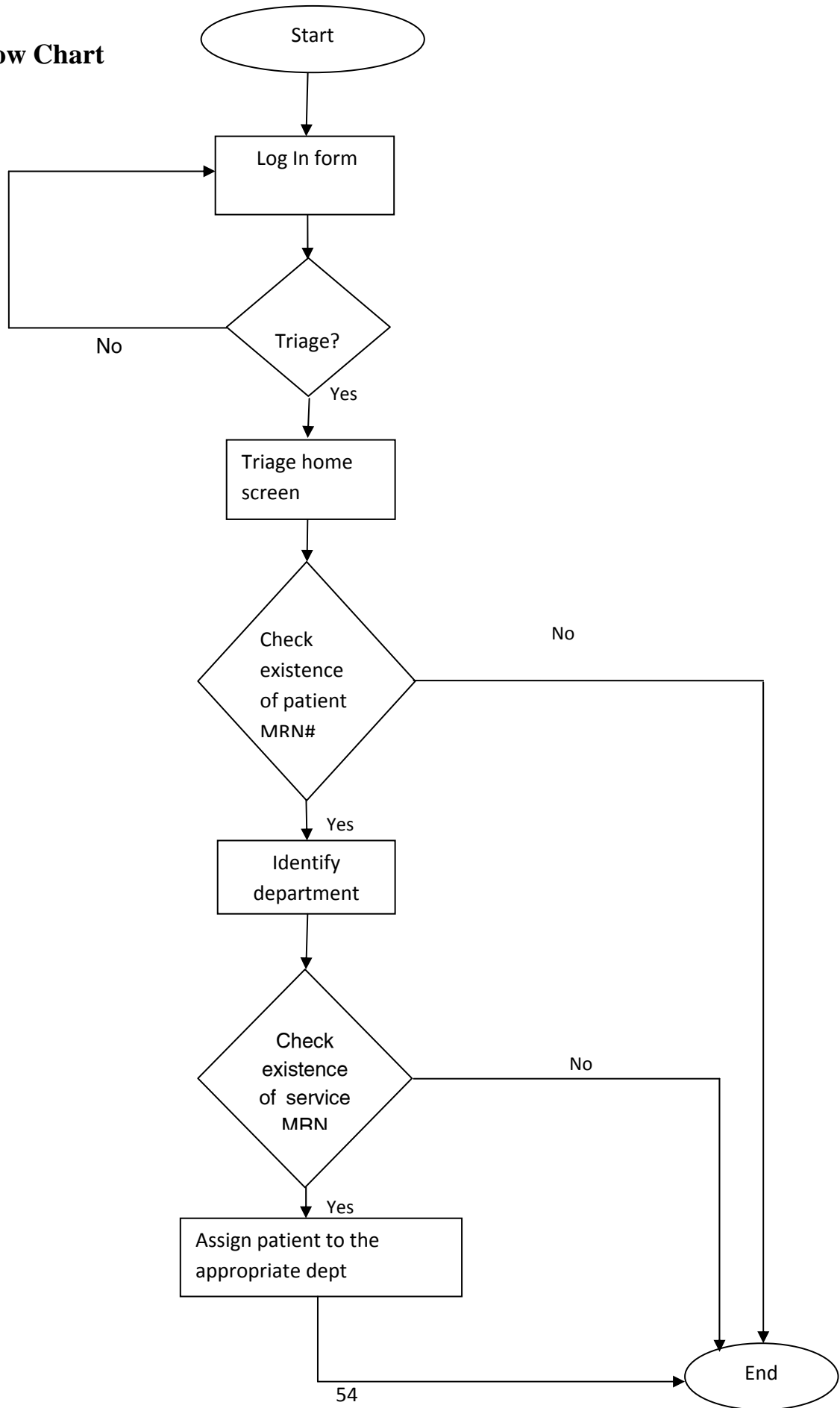
**Login Flow Chart**



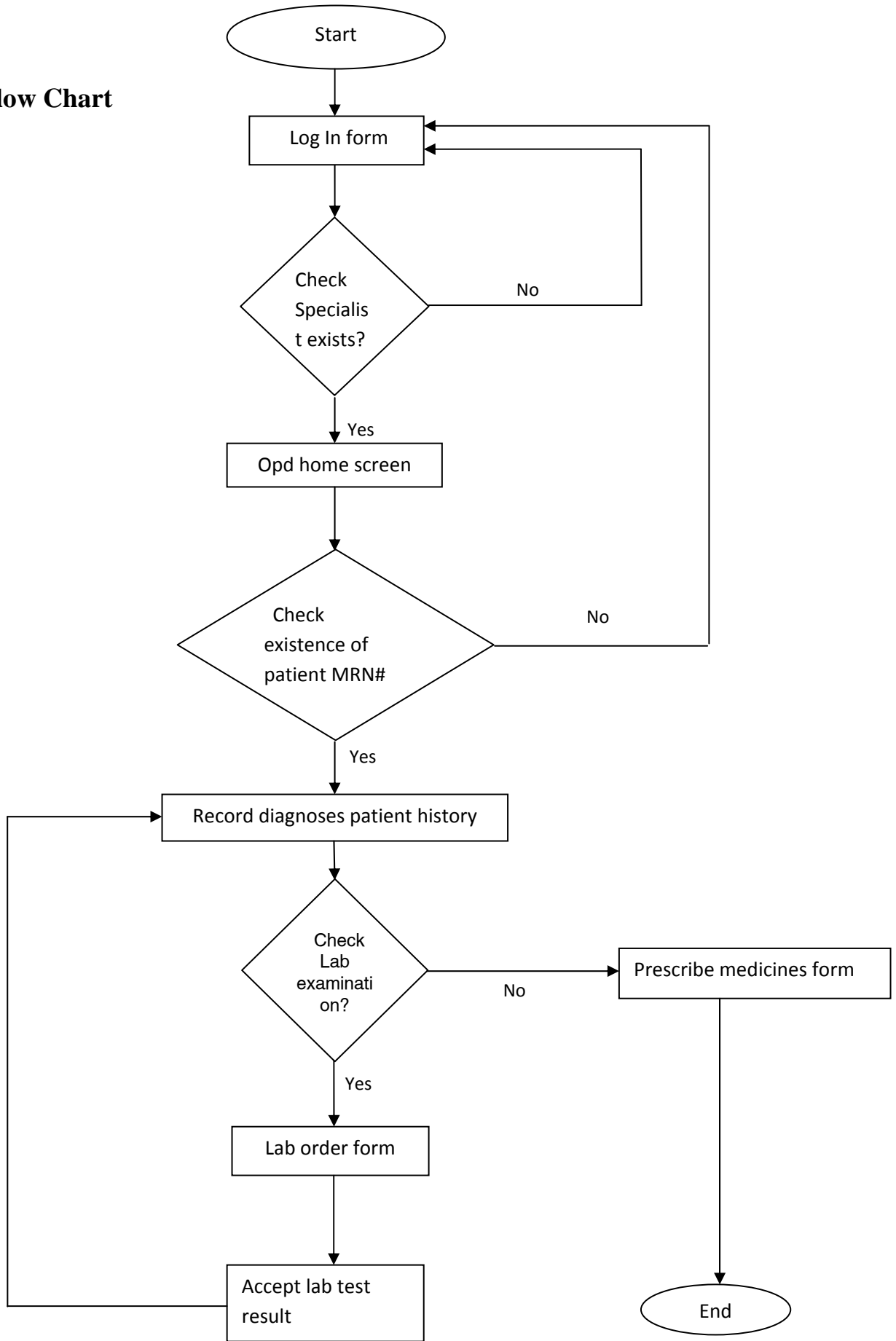
# Registration Flow Chart



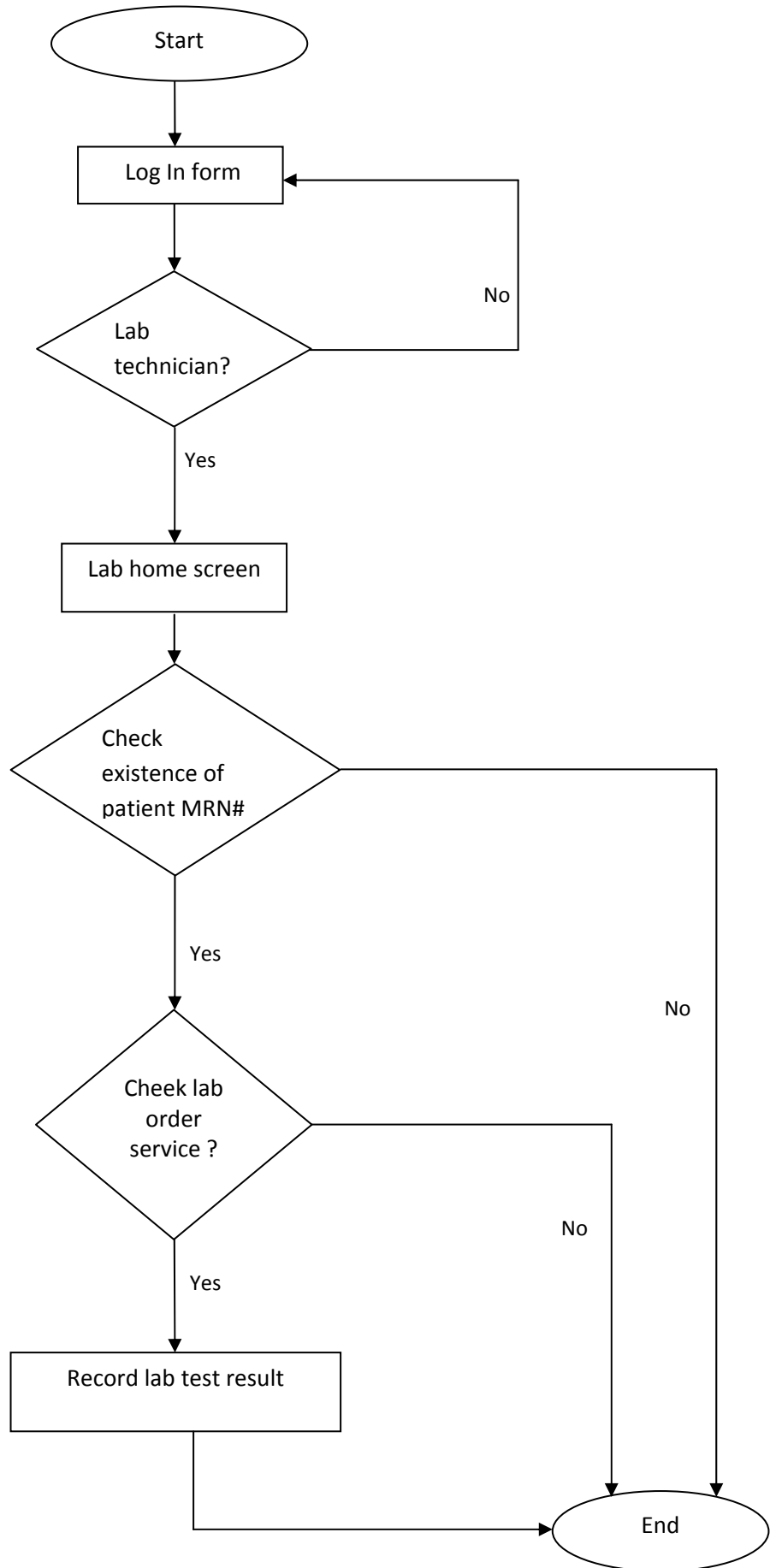
# Triage Flow Chart



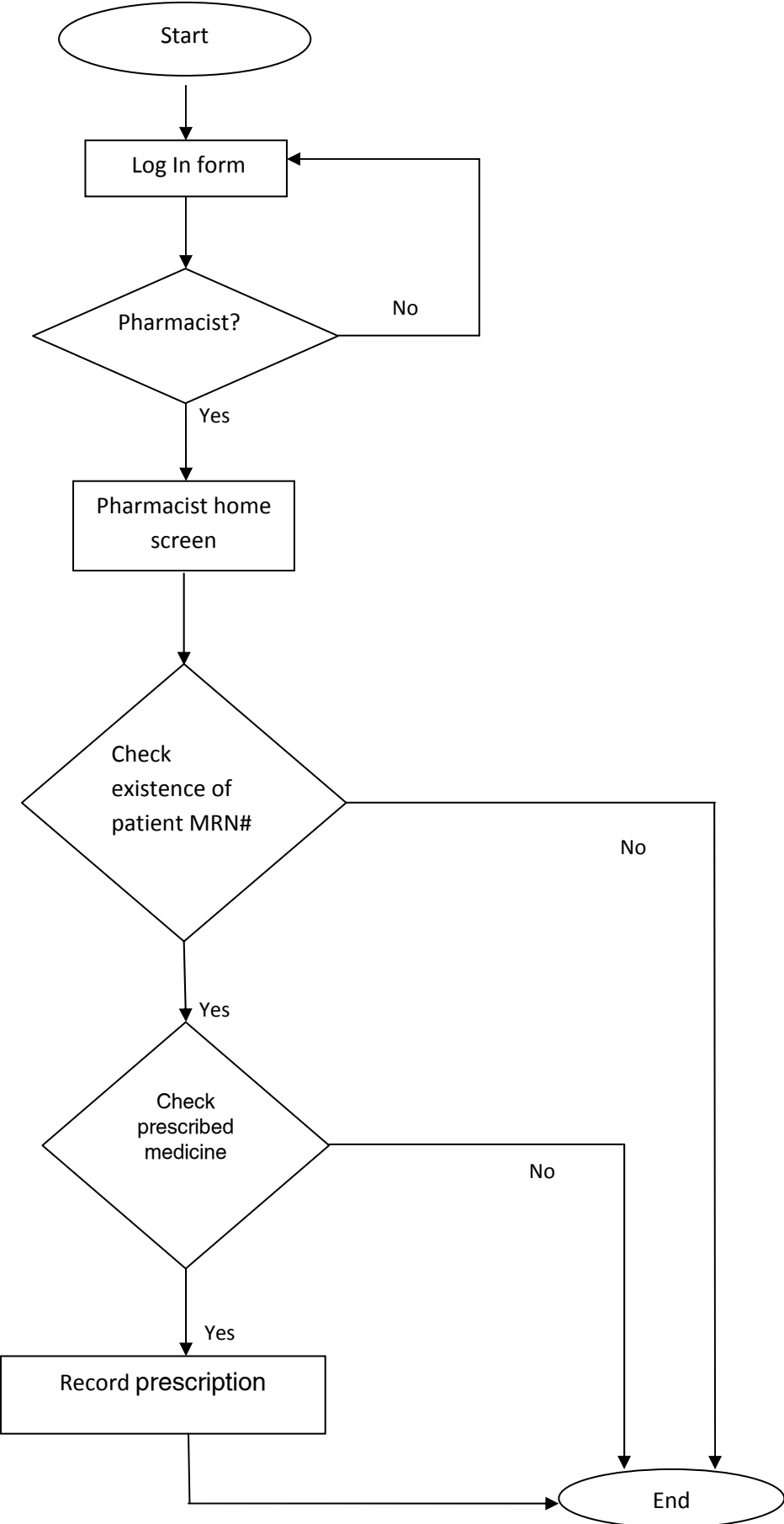
# OPD Flow Chart



# Laboratory Flow Chart



**Pharmacist Flow Chart**

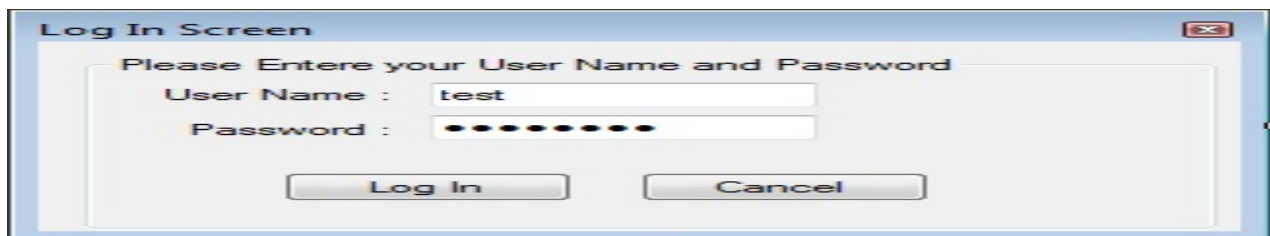


### 4.3 User Interface

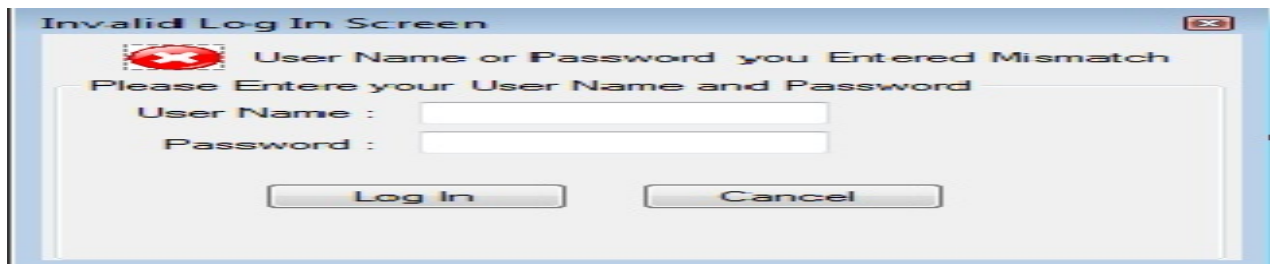
User interface is the part of the system with which the users interact. It includes the screen displays that provide navigation through the system, the screens and forms that capture data and the reports that the system produces.

First the Administrator, Data clerk, Physician, Laboratory technician, Pharmacist enters his/her user name and password to login into the system and the password is a six character long alphanumeric string. Successful login shall direct link the hospital to the home page of the Ministry of Defense Command and Staff Hospital. The administrator that has the user name and password can be able to change the password or user name. He/she should have access to register, delete, and edit etc account. After doing all the necessary things the actors will log out from the system by clicking "Cancel".

#### UI1 System login screen

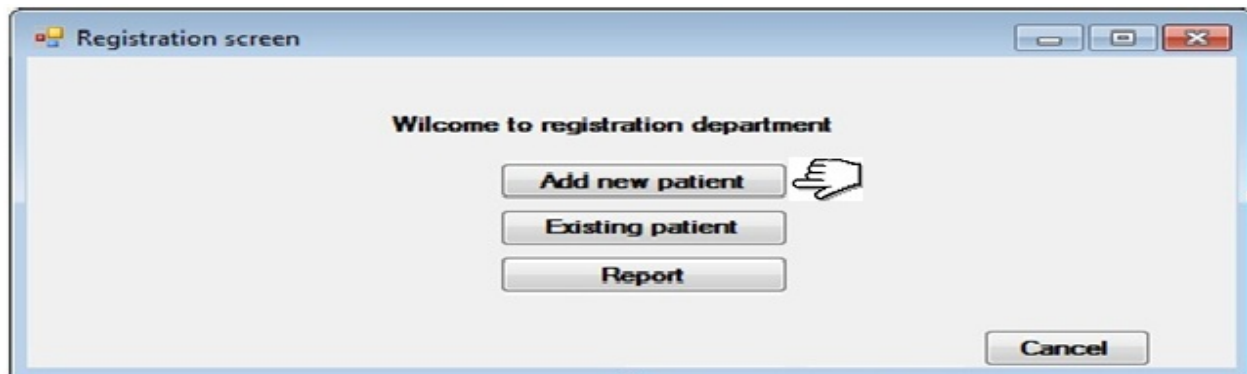


#### UI2 Invalid login screen



#### UI3. Registration Menu Screen

After login to the system for registering the new patient, the data clerk click add new patient button from the given alternative option then the new patient registration form will be displayed.



#### UI4. New Patient Registration Screen

The data clerk enters all the necessary information that is needed to register the patient as new patient then the data clerk clicks the save button to save the registered patient information.

Please enter the patient's full name, sex, age, address

personal information

First Name :  Date of Birth : Wednesday, May 06, 2015

Father's Name :  Place of Birth :

GrandFather's name :  Religion :

Gender :  Visit date : Wednesday, May 06, 2015

Age :  Martial status :

MRN# :  Occupational status :

Patient current address

Region :

Sub city / woreda :

Kebele :

House No. :

Phone No. :

Next of Key information

Name :  Relation :

Sub city / woreda :  Phone No. :

House No. :

Save Cancel

#### UI5. Existing Patient Search Screen

When the patient registers once and the data clerk wants to see the patient information for different purpose and want to update patient information the data clerk first searches the patient using patient name, MRN# and sex by clicking the search button then after he/she making some change and update the patient information by clicking update button.

Registration screen

Wilcome to registration department

Add new patient

Existing patient

Report

Cancel

Existing patient search

Please enter patient's name, MRN#, age, sex, and click search.

First name

Second name

Last Name

Sex

Age

MRN#

Search

Update

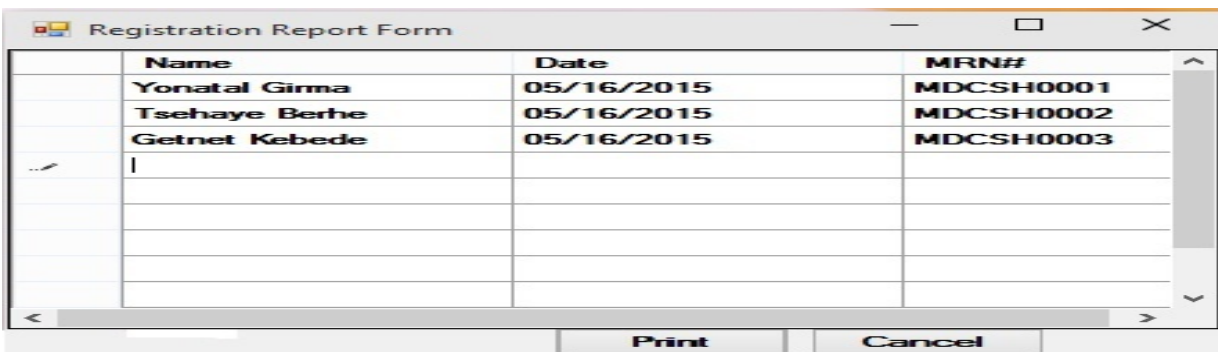
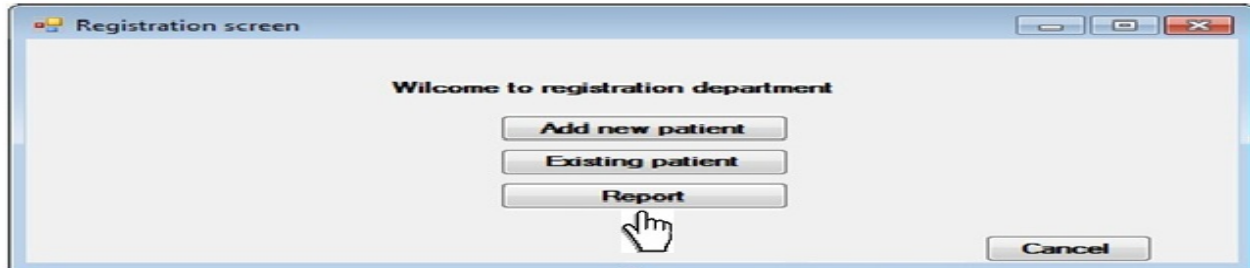
Clear

	F.name	M.name	L.name	Patient ID	Adress
*					

Back Cancel

## UI6. Registration Report Screen

When the data clerk wants to report the registered patient data as he/she requested, the data clerk first click report button from registration screen then searches the patient report by clicking the search button after that the report generated and holding patient name, date, and MRN# then the data clerk prints the report by clicking the print button.

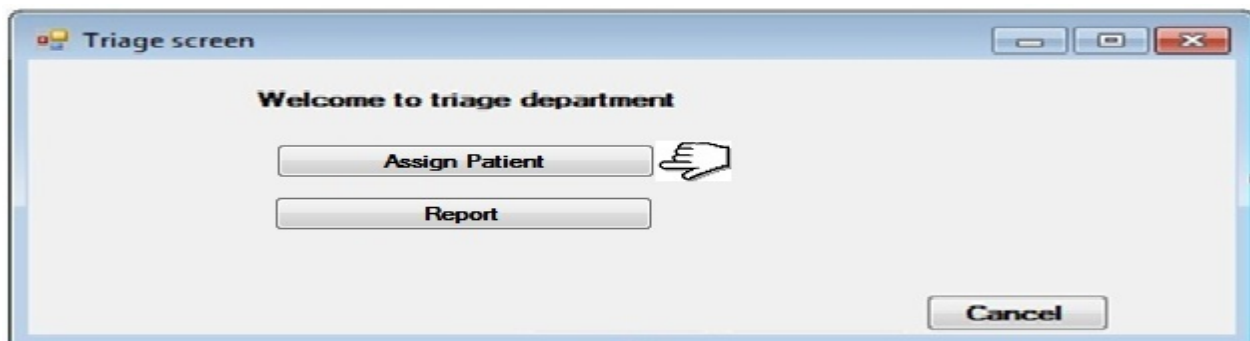


The screenshot shows a window titled "Registration Report Form" with a light blue border. It contains a table with three columns: "Name", "Date", and "MRN#". The table has three rows of data. Below the table are "Print" and "Cancel" buttons.

Name	Date	MRN#
Yonatal Girma	05/16/2015	MDCSH0001
Tsehaye Berhe	05/16/2015	MDCSH0002
Getnet Kebede	05/16/2015	MDCSH0003

## UI7. Triage Menu Screen

Triage officer after login to the system for assigning patient he/she clicks assigned patient button from the given alternative option then the assign patient form will be displayed.



## UI8. Triage Form Screen

After the assigned patient form displays the triage officer searches the patient by entering patient ID and clicking the search button. Then the patient information will be displayed after that the officer select the patient and assign the patient to the department that he/she wants to be assigned; finally the officer saves the data by clicking the save button.

To assign the patient enter patient ID

Patient ID :

Patient detail

	F.Name	S.Name	L.Name	Age	Sex	MRN#	Address
✓							
*							

To where the patient assign ? Dept.Name

## UI9. Triage Report Screen

The Triage officer after login to the triage report form he/she can report the assigned patient for different department when it is required ( requested) by clicking the print button.

Welcome to triage department

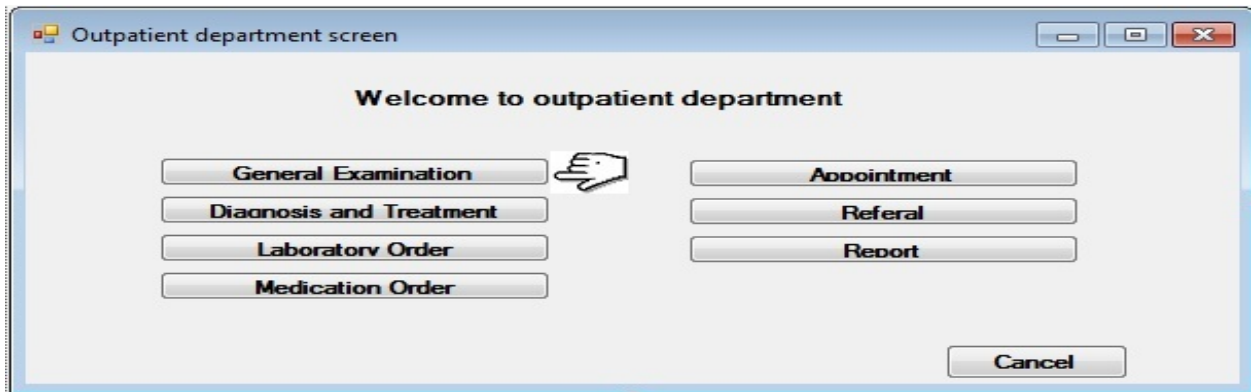
Number of assigned patients

S/R	Name of patient	MRN	Department	Date
*				

Total number of assigned patients

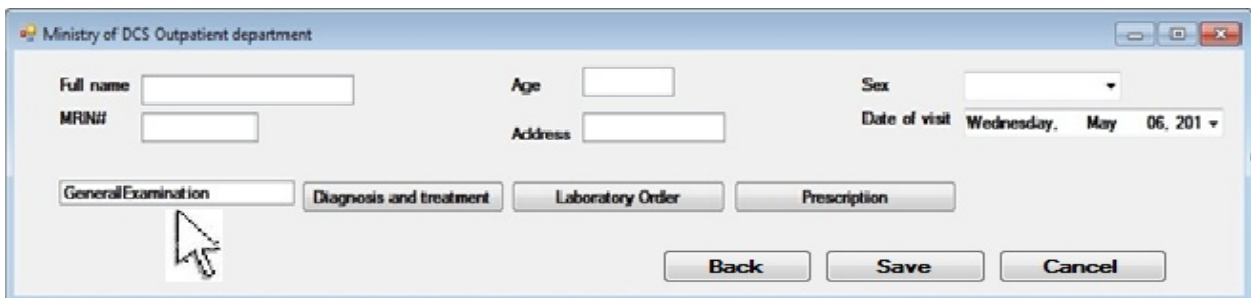
## UI10. Outpatient Department Menu Screen

The Physician after login to the system for outpatient department screen he/she click general examination button from the given alternative option, then the general examination form will be displayed.



## UI11. Outpatient Department Screen

The Physician enters all the necessary information that is needed to register the patient general examination then he/she clicks the save button to save the examined patient history information.



## UI12. Diagnosis and Treatment Screen

The Physician enters all the necessary information that is needed to register the patient diagnosis and treatment then he/she clicks the save button to save the Patient diagnosis and treatment information.



**Patient diagnosis and treatment form**

Primary diagnosis:

Differential diagnosis:

Management:

Summary note:

Buttons: Back, Save, Cancel

**OPD abstract register form**

Identification						Diagnosis			
S/N	Patient ID	Age	Date	Sex	Sub city	HIMIS disease classification	new	repeat	
*									

Buttons: Back, Save, Print, Cancel

### UI13. Laboratory Order Screen

The Physician after login to the system for laboratory order he/she clicks hematology test button from the given alternative option to order hematology lab. test.

**Outpatient department screen**

Welcome to outpatient department

Buttons: General Examination, Diagnosis and Treatment, Laboratory Order, Medication Order, Appointment, Referral, Report, Cancel

A hand cursor is pointing to the "Laboratory Order" button.

**Laboratory order form**

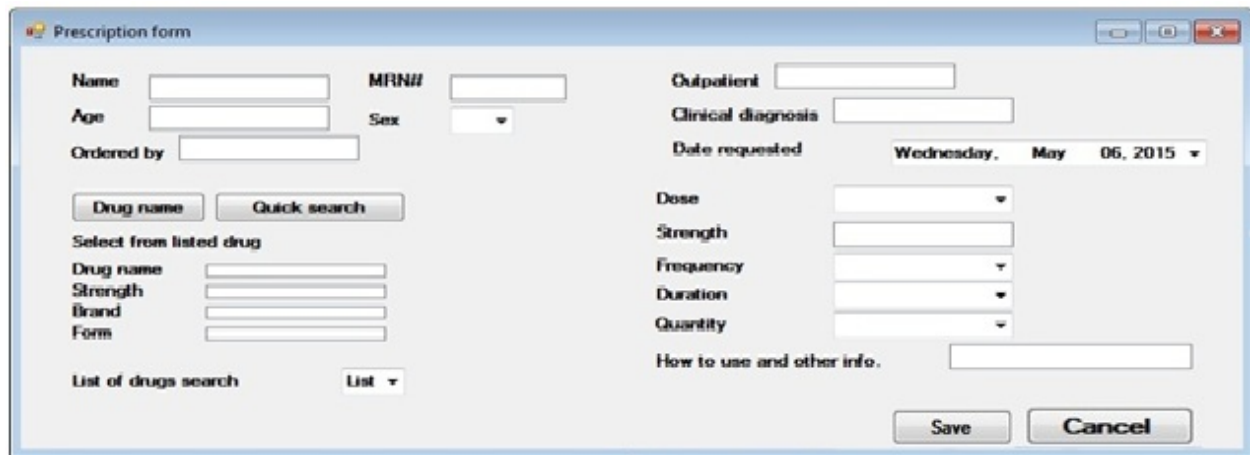
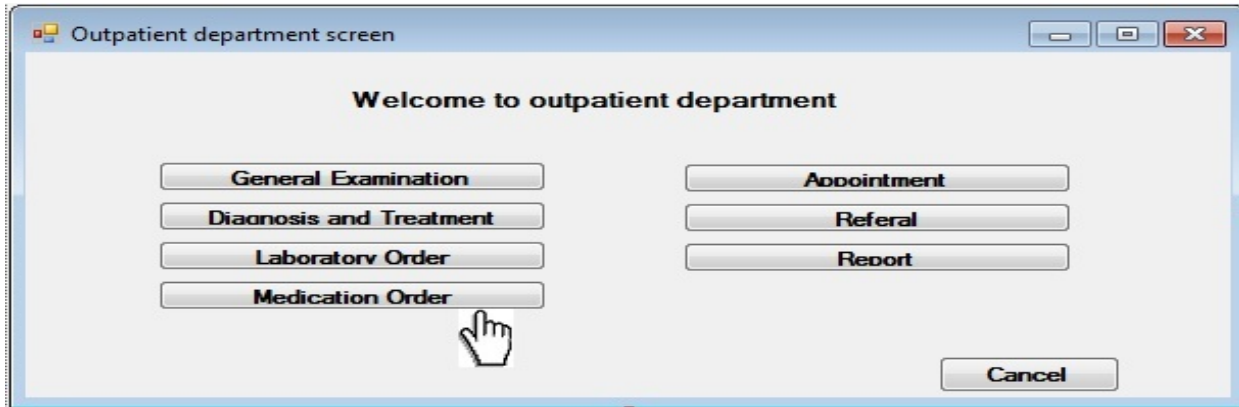
Laboratory orders

Buttons: Hematoloov, Stool, Urinalysis, Seraloov, Chemistry, Microbioloov, Immunoloov, Back, Cancel

A hand cursor is pointing to the "Hematoloov" button.

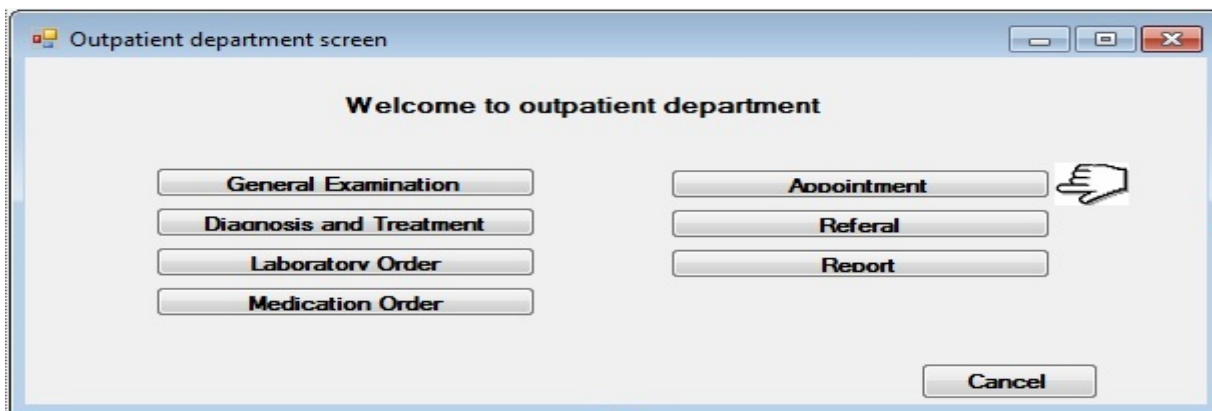
### UI14. Medication Order Screen

The Physician after login to the system for medication order he/she enters all the necessary information that is needed for order medication then he/she clicks the save button to save the ordered medication information.



### UI15. Appointment Scheduling Screen

The Physician after login to the system for appointment he/she enters all the necessary information that is needed for appointed patient for the next visit then he/she clicks the print button to print the appointment information with next visiting date and time.





Appointment form

Name  MRN#

Age  Address

Sex  Date Wednesday, May 06, 2015

Time  Appointed by

Print Cancel

### UI16. Laboratory Menu Screen

The laboratory technician after login to the system he/she click list of laboratory order request button from the given alternative option then laboratory entry form will be displayed.



Laboratory department screen

Welcome to laboratory department

List of Laboratory Order

Reception Log Form

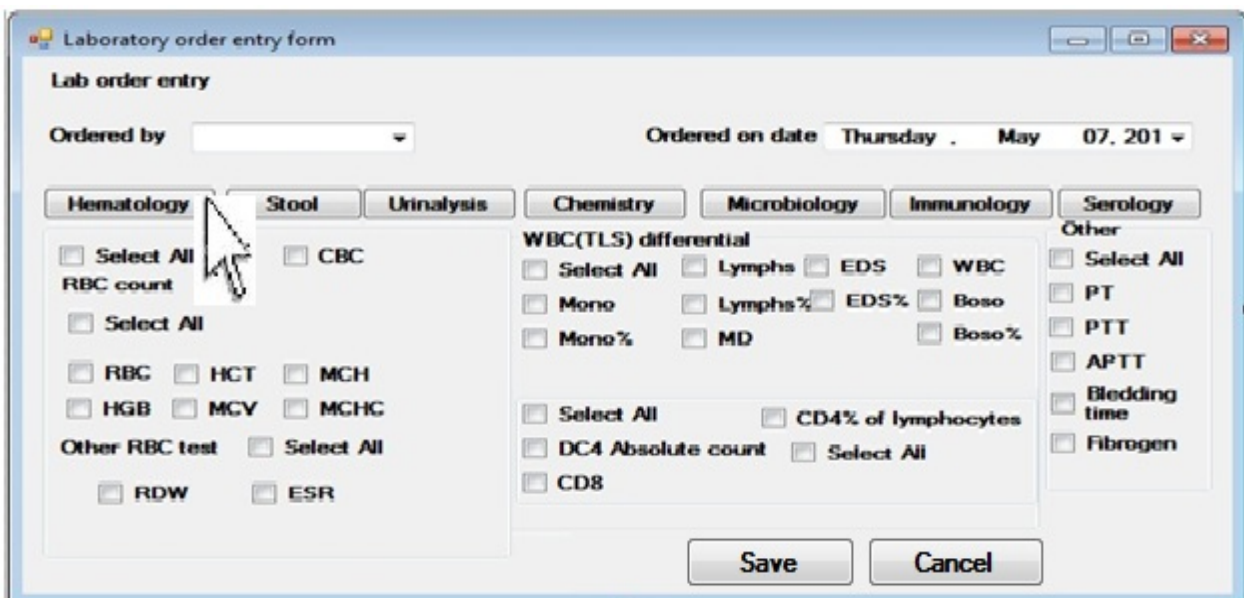
Fill Laboratory Order

Report

Back Cancel

### UI17. Laboratory Result Order Entry Screen

The laboratory technician after login to the system for fill patient laboratory result he/she enters all the lab result as requested by the physician or others. Then the laboratory technician clicks the save button to save the ordered laboratory result information.



Laboratory order entry form

Lab order entry

Ordered by  Ordered on date Thursday, May 07, 2015

Hematology Stool Urinalysis Chemistry Microbiology Immunology Serology

Select All RBC count  CBC

Select All

RBC  HCT  MCH

HGB  MCV  MCHC

Other RBC test  Select All

RDW  ESR

WBC(TLS) differential

Select All  Lymphs  EDS  WBC

Mono  Lymphs%  EDS%  Boso

Mono%  MD  Boso%

Select All  CD4% of lymphocytes

DC4 Absolute count  Select All

CD8

Other

Select All

PT

PTT

APTT

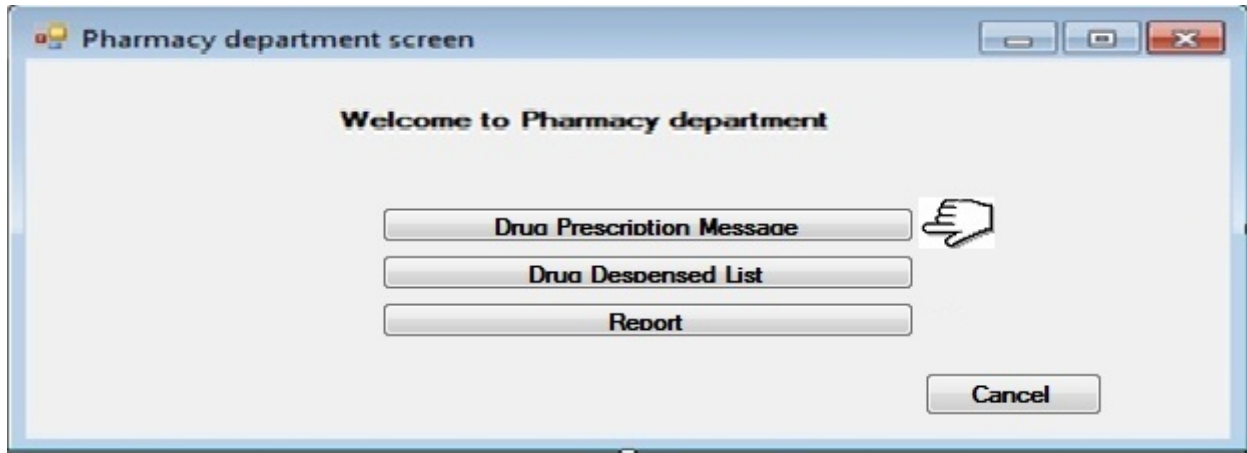
Bleeding time

Fibrogen

Save Cancel

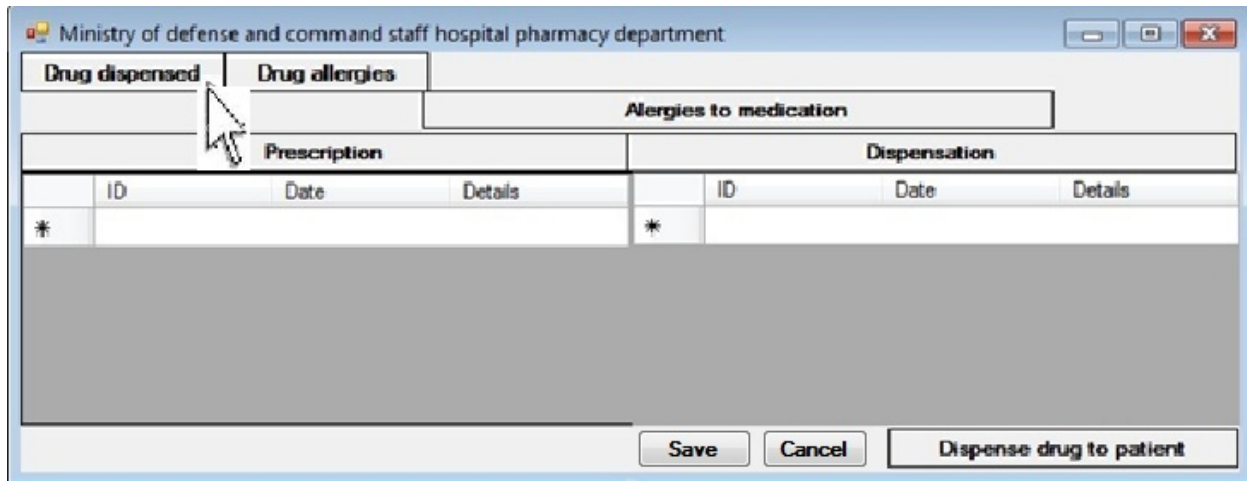
### UI18. Pharmacy Menu Screen

The pharmacist after login to the system he/she clicks drug prescription (message) list button from the given alternative pharmacy department screen option. Then drug prescription form will be displayed.



### UI19. Drug Prescription Screen

After login to the system for drug dispensed the pharmacist selects the type of medicine and click the save button to save the ordered dispensed medicine information.



# Chapter Five

## 5. Conclusion and Recommendation

### 5.1 Conclusion

Since there are different factors that affect the quality of care, EMR is considered as one factor that improves the quality of health care. Currently Ministry of Defense Command and Staff hospital uses paper based or file based manual and semi electronic system. Therefore, it has problems associated with the quality of care and patient satisfaction. This project contributed to have a better understanding of the use of EMR and to solve the current problems.

The identified requirement is useful for the use of building the analysis, design and in general for the all constructing project. Most of staff members have good motivation to use the new computer based EMR system but they have no previous skills and knowledge about how they can use the system and facilitate their work. The recommended system will solve the above problem by giving different benefit.

The requirements of the new system were collected using data collection tools and techniques, the business process of the current system, functional and non functional requirement and system requirement were described. The analysis of the proposed system were analyzed using the analysis model (use case diagram and use case description) and process model (contextual and DFD). The data model of the system was presented using the Entity relationship diagram.

Most of the staffs are not trained on basic computer skill and EMR system. The infrastructure of the hospital is difficult to run the system and the internet connection is good but most of the time it is interrupted. The number of hardware is not enough to run the system because of this the mixed system even not work properly as expected.

The methodology used in this project was the structured analysis and design. The techniques used for analysis and design in this project were DFD, contextual diagram and ER diagram. Micro soft Visio 2007 was the tool used for the analysis and design of the system.

## 5.2 Recommendation

- ❖ The hospital may use this project report as an initial document for implementation as requirement.
- ❖ The hospital should incorporate the rest departments of the hospital (inpatient department, finance, human resource, HMIS) while implementing the system, for full functionality of the hospital.
- ❖ The hospital should avail enough hardware and software like licensed SQL server 2012 and Visual studio 2013 in order to develop and install the system.
- ❖ The hospital should provide training on basic computer skill and EMR system to its staff
- ❖ The hospital should recruit IT professionals to manage problems related to IT and EMR issues.
- ❖ The hospital should provide a better infrastructure to deploy the system.
- ❖ Developers and students may use this document for further improvement and implementation of the system.
- ❖ Developers and students may use additional tools and techniques as well as other methods, tools and techniques for the improvement and development of the system.
- ❖ The hospital shall be creating a team atmosphere. Everyone in the practice will play some role in the implementation and use of the new EMR system. Though some roles are more important than others, everyone needs to understand that they are valuable to the team effort. Their value and their roles should be clearly defined and emphasized.
- ❖ The hospital should raise awareness and enthusiasm for the implementation process. Schedule meetings to discuss the importance of the project and benefits that, an EMR offers. During these meetings, realistic goals should be set for successfully implementing the system. At the same time, it is important to remember that everyone from the billing manager to the physician has other work to complete. Trying to force early and unrealistic implementation and use dates will undoubtedly slow down the process and discourage people from learning the system.
- ❖ The hospital should have a plan before starting the implementation process. The following tasks should be recognized and planned before developers begin to implement an EMR system:
  - 🚧 Assess workflow at your practice and identify which processes will change.
  - 🚧 Identify what is "good to have" versus what you "need to have" in terms of EMR capabilities.

- ✚ Focus on clinic efficiency rather than too many feature requests.
- ✚ Avoid creating extensive data entry-focused templates for physicians.
- ✚ Create a plan of action in case of emergency.
- ✚ Identify the labs with which you want to interface with your EMR.
- ✚ Determine how will you scan and import all your old charts.
- ❖ The hospital should training needs to occur on a regular basis. Training should include basic skills, application functions and live instruction. Physicians need to be an integral part of the training as a representation of the importance of EMR implementation and to increase their own ability to utilize the system. This is critical part of EMR success; if your staff is not properly trained, then the EMR implementation becomes a painful process.
- ❖ The hospital should utilize compatible hardware. Assessing your current hardware and making appropriate changes will ensure that all hardware is up and running for training, implementation and use of the new EMR system.

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## Annexes

### Annex1: Entities with their attributes

Table1: patient attributes description

*Patient*

<b>Patient ID</b>	<b>Char(10)</b>
First Name	Varchar(30)
Second name	Varchar(30)
Last name	Varchar(30)
Sex	Binary (1)
Date of birth	Datetime
Region	Varchar(30)
Woreda	Varchar(30)
Kebele	char(10)
House number	char(10)
Home phone number	int
Mobile phone number	int
Registere	Varchar(30)

Table2: Data Clerk attributes description

*Data clerk*

<b>Data clerk ID</b>	<b>Int</b>
First Name	Varchar(30)
Second name	Varchar(30)
Last name	Varchar(30)
Patient ID	int
Age	int
Sex	verchar(30)
Register patient	

Table3: Request attributes description

*Request*

<b>Request ID</b>	<b>int</b>
Patient ID	int
Request - date	date time
Request test	verchar(30)

Table4: Triage officer attributes description

*Triage officer*

<b>Patient ID</b>	<b>Char(10)</b>
First Name	Varchar(30)
Second name	Varchar(30)
Last name	Varchar(30)
Patient ID	int
Age	int
Sex	Binary(10)
Assign patient	Varchar(30)

Table5: Assign attributes description

*Assign*

<b>Assign ID</b>	<b>Int</b>
Patient ID	int
Assign date	datetime
Department name	verchar(10)
Department no	int
Assignpatient	verchar(30)

Table6: physician attributes description

*Physician*

<b>Physician ID</b>	<b>Int</b>
First Name	verchar(30)
Second name	verchar(30)
Last name	verchar(30)
Department name	char(10)
Department no	int
Specialty	verchar(10)
Sex	binary(10)
Age	verchar(40)
Diagnosis and treat	

Table7: Diagnosis attributes description

*Diagnosis*

Diagnosis code	int
Diagnosis date	datetime
Patient ID	int
Physician ID	int
Diagnose patient	

Table8: Lab test order attributes description

*Lab order*

<b>Lab order ID</b>	<b>Int</b>
Lab.tech.ID	int
Physician ID	int
Patient ID	int
Ordered date	datetime
Order test	verchar(30)

Table9: Laboratory technician attributes description

*Laboratory technician*

<b>Lab. tech ID</b>	<b>int</b>
First Name	verchar(30)
Second name	verchar(30)
Last name	verchar(30)
Patient ID	int
Age	int
Sex	binary(10)
Record result	verchar(30)

Table10: Prescription attributes description

*Prescription*

<b>Prescription ID</b>	<b>Int</b>
Physician ID	int
Pharmacist ID	int
Patient ID	int
Prescription date	datetime
Physician name	verchar(30)
Prescribe	verchar(30)

Table11: Appointment attributes description

*Appointment*

<b>Appointment ID</b>	<b>Int</b>
Patient ID	int
Physician ID	int
Appointment-date	datetime
Appoint patient	verchar(30)

Table12 pharmacist attributes description

*Pharmacist*

<b>Pharmacist ID</b>	<b>Int</b>
First Name	verchar(30)
Second name	verchar(30)
Last name	verchar(30)
Age	int
Sex	datetime
Dispensed medicine	verchar(30)

Table13: detail attributes description

*Prescription detail*

<b>Prescription ID</b>	<b>Int</b>
Drug name	int
Dose	int
Strength	char(10)
Brand	char(10)
Frequency	char(10)
Unit dispense	char(10)

**Annex 2: Interview guide and checklists**

*1) Interview Guide for Medical Directors and Chief Executive Officers*

*Recipients: Medical Directors and Chief Executive Officers*

This interview guide is to assess the EMR program in, Ministry of Defense Command and Staff Hospital. The information acquired will help to inform decision on how to design, implementation and achieving the institution mission

General information:

Particular of interviewee: \_\_\_\_\_

Responsibility: \_\_\_\_\_

- 1) Please describe your general opinion on the EMR Program

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- 2) What are the key divers to apply an EMR in your institutions?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- 3) Please describe the resource available to run EMR program (human resources, infrastructure, finance

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- 4) Is a budget in place to provide reasonable coverage for EMR support services?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- 5) Do you have enough staff in place to implement, provide support for, and maintain the new EMR system?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- 6) What key operational changes would you like to see with the implementation of the EMR?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

2) *Interview Guide for User of EMR Program*

Recipients User of EMR program (Physicians, Health Officers, Nurses, etc....)

General information

Particular of Interviewee: \_\_\_\_\_

Position/Responsibility: \_\_\_\_\_

Highest Academic Degree: \_\_\_\_\_

Age \_\_\_\_\_

Sex \_\_\_\_\_

- 1) How will you classify your general information technology and skills for EMR program use

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- 2) How do you evaluate an internet access and usage in your institution?

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- 3) Do you think EMR program is helpful to your activities? Please describe

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- 4) What are your experiences or concerns of the deployment of the EMR program?

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- 5) Do healthcare professionals understand the benefits of and EMR and are they enthusiastic about using the new system? \_\_\_\_\_

- 6) Please provide your recommendations or suggestions of how to further improve the EMR?

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**3) Observation guide for EMR Program**

Recipients: Technology, Implementation, Process of EMR Program

- 1) EMR Activities being carried out at Card Room and other Clinical Units

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- 2) EMR technology deployed and used

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- 3) EMR implementation process

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- 4) Overall observation of the EMR program regarding

No	Process to be Observed	Yes	No	Remark
1	Patient registration carried out according to standard			
2	Patient health records are placed in its places			
3	Retrieval of patient record is it time tacking?			
4	Is there any lost/damaged patient health records?			
5	Do they use all formats in OPD/Ward			
6	Do all physicians assess, Diagnose and treat patients according to standards?			
7	Does reporting generation process is time taking?			

***4) Focus group discussion point***

1. How will construct graphical user interface of the EMR system?
2. What look like the colure of the graphical user interface?
3. Which guide line is better to construct the graphical user interface?