Libyan International Medical University

Faculty of Information Technology

Health Informatics Department

An outpatient electronic health record augmented with ICD-10

A graduation project document submitted to the Dep. of Health Informatics as partial fulfillment for the Requirement for the Degree of B.Sc. in Information Technology

By:

Aynur Tariq Saad Eldressy

Supervised By:

Prof.Dr.Adel Ibrahiem Eltwati

July,2017

Dedication

Despite all the obstacles that I have faced during my journey to get this degree but I've always had support. This work is dedicated to everyone helped me to get to this moment of achievement.

This simple and humble dedication is for :

- The soul of my father ***The Martyr Col. Tariq Eldressy*.**
- The greatest women I have ever met and who is inspiring me to go so far. My mother ***Mrs. Salwa Albanoni*.**
- My **dear faculty members** for giving this much of effort and for having faith in me from the beginning of this journey.
- For all the people who supported me and for those who did not.

Aynur Eldressy

Acknowledgment

First of all I thank GOD for finishing this project, also **Dr. Adel Ibrahiem Eltwati** for his supervision and for all the notes and advices he gave me to complete this project

Also I would like to thank :

Mr. Shokri Skiek & Mr. Mohammed Skiek

from Ibnsina Clinic for all the help and knowledge you provided to me during my internship and after. Thank you.

Thank you for all of the teaching staff of the faculty for what they taught me and for the help and recourses they provided. Specially :

Dr. Towfik Altwoiel & Mr. Ehab Elfallah

Last but not least, Thank you for:

Mr. Nabiel Gwiery & Mr. Mohammad Elawami

Literally I would not have completed this work without your help, time, patience and knowledge you provided.

Thank you.

Abstract

This document presents an information system designed for the pediatric Out Patient Department (OPD) in Benghazi Medical Centre. This system represent an electronic solutions to some of the problems facing the department, it worked on enhancing the quality of the health services delivery and to ease the work done by both Doctors and receptionist .

The previous paper-based system have made it quite difficult to maintain a certain level of quality due to the issues relating to the disadvantages of the systems (paper-based) have in common. We worked to eliminate all the faults by developing an easy to use, error free and medically centered information system. Including the ICD-10 feature inside the system for the first time here in Libya.

This enables the doctors and receptionist to electronically store patients medical records and manage them faster and saver.

Table of content

List of tables

List of figures

CHAPTER I : INTRODUCTION

1.1 Background

In our present time health facilities have been noticing a huge change in its administrative and medical procedures, trying to make it all computerized and systemized has opened the opportunities to these facilities to grow and develop itself in an organizational level.

By applying information technology to health and health care we present the (HIT) Health Information Technology. It supports health information management systems and the secure exchange of health information between consumers, providers, and quality monitors. Based on an often-cited 2008 report on a small series of studies conducted at four sites that provide ambulatory care – three U.S. medical centers and one in the Netherlands – the use of electronic health records (EHRs) was viewed as the most promising tool for improving the overall quality, safety and efficiency of the health delivery system.**(1)**

Although the benefits of implementing the EHRs are promising and can deliver a huge difference in the quality of the health sector here in Libya but the limitations and obstacles are still ahead of this step, having a standardized and effective paper-based system is the main objective before adopting the electronic system. However we as health informtionist are looking forward to enhance the quality of the healthcare delivery by working to provide electronic and informatics solutions to the health facilities here in Libya.

According to an article published in the International Journal of Medical Informatics, health information sharing between patients and providers helps to improve diagnosis, promotes self care, and patients also know more information about their health. Healthcare information in Electronic Medical Records EMRs are important sources for clinical, research, and policy questions. Health information privacy (HIP) and security has been a big concern for patients and providers. Studies in Europe evaluating electronic health information poses a threat to electronic medical records and exchange of personal information.**(2)** Moreover, software's traceability features allow the hospitals to collect detailed information about the patients treatment plan, creating a database of every treatment that can be used for research purposes.

Even more important subject in a medical record is the International Classification of Diseases(ICD) "standard diagnostic tool for epidemiology, health management and clinical

purposes". Its full official name is **International Statistical Classification of Diseases and Related Health Problems.**[3]

The ICD is maintained by the World Health Organization (WHO), the directing and coordinating authority for health within the United Nations System.[4] The ICD is designed as a health care classification system, providing a system of diagnostic codes for classifying diseases, including nuanced classifications of a wide variety of signs, symptoms, abnormal findings, complaints, social circumstances, and external causes of injury or disease. This system is designed to map health conditions to corresponding generic categories together with specific variations, assigning for these a designated code, up to six characters long.

In 1994, WHO developed the tenth revision of the ICD system. The purpose of the revision was to expand the content, purpose, and scope of the system and to include ambulatory care services, increase clinical detail, capture risk factors in primary care, include emergent diseases, and group diagnoses for epidemiological purposes.

In 1997, the National Center for Health Statistics began the first round of testing following the development of ICD-10-CM. A timetable for the implementation of ICD-10-CM has not been determined. Terminology and disease classification have been updated to be consistent with current usage and medical advances.

In August of 2000, the Department of Health and Human Services released the final rule for transaction and medical code sets as established under the Health Insurance Portability and Accountability Act (HIPAA). To be designated as a HIPPA standard, a code set had to:

- Improve the efficiency and effectiveness of the healthcare system by leading to cost reductions for or improvement in benefits from electronic healthcare transactions,
- Meet the needs of the health data standards user community, particularly healthcare providers, health plans, and healthcare clearinghouses,
- Be consistent and uniform with other HIPAA standards-their data element definitions and codes and privacy and security requirements; secondarily, with other private and public sector health data standards,

- Have low additional development and implementation costs relative to the benefits of using the standard,
- Be supported by an ANSI-accredited standards developing organization or other private or public organization that will ensure continuity and efficient updating of the standard over time,
- Have timely development, testing, implementation, and updating procedures to achieve administrative simplification benefits faster,
- Be technologically independent of the computer platforms and transmission protocols used in electronic health transactions, except when they are explicitly part of the standard,
- Be precise and unambiguous, but as simple as possible,
- Keep data collection and paperwork burdens on users as low as is feasible, and
- Incorporate flexibility to adapt more easily to changes in the healthcare infrastructure, such as new services, organizations, provider types, and information technology. [(4)]

There are many uses of coded data, including:

- Designing payment (reimbursement) systems with emphasis on the processing of claims specifically for reimbursement,
- Measuring the safety, quality, and efficacy of medical care,
- Designing delivery systems and setting healthcare policy,
- Monitoring the utilization of resources while improving financial, clinical, and administrative performance,
- Providing healthcare consumers with data regarding the cost and outcome(s) of various treatment options,
- Identifying, tracking, and managing public health risks and disease processes,
- Recognizing and identifying abusive or fraudulent reimbursement practices and trends, and
- Conducting healthcare research and clinical trials and participating in epidemiological studies.[(5)]
- Data auditing.
- Quality control using key performance indicators.
- Mortality and morbidity report.
- Health care facility police.

The classification allows doctors and hospitals to generate statistics for the terms of the frequency of a specific diseases outbreak, by comparing patterns of diagnosis healthcare facilities management and professionals can use the data for research needs.

Although at this point it's hard to implement the standard ICD system here in Libya due to the lack of the documentation and for all the defects facing the health sector infrastructure nowadays, but we worked to customize the systems and features used to be feasible in the facility targeted .

Having the best and most up-to-date EMR system will significantly ease the ICD transition and implementing in the health facility system, Specific EMR features and functionalities exist within these software systems that can assist healthcare providers with ICD as they train and integrate these codes into their specialty-specific practice. By storing health information electronically through EMR systems, health care providers are able to finish their patient charting quicker, allowing for the scheduling of more patients. This heightened efficiency of this type of medical records storage fosters a more effective medical practice. Having instant access to electronic health records allows providers to chart during their patient encounters as opposed to several hours later. In theory, this enhances accuracy of the patient's health record.

Here are the must-have, key EMR features to look for when purchasing or updating their software to fulfill ICD and Meaningful Use requirements.

- **EMR clinical documentation templates**

Since ICD-10-CM is characterized by a much higher level of detail, physicians need to capture medical data that matches ICD-10-CM's specificity. Clinical documentation for each medical encounter doesn't have to increase in volume, but it does need to increase in precision (e.g. laterality, anatomic location, etc.).

EMR templates help physicians incorporate all necessary elements for proper ICD-10 clinical documentation in a clear, organized, and structured manner. Another crucial advantage is that EMR templates can be used to remind physicians to ask patients specific questions for documentation purposes. Having correct and complete patient data to enter into the documentation template will expedite the process of finding the appropriate ICD-10 code for the medical

diagnosis and treatment. Here in our project customized templates are available for various kinds of patients and medical services.

- **ICD-10 code search interface**

Standard, updated EMR system should have an intuitive, easily navigable interface that makes it possible for healthcare professionals (and users) to input a word, term, or phrase and receive a list of matching ICD-10 codes.

Those are the key features used by the healthcare professionals and providers. In our project we customized the ICD system and interfaces to ease the search tools and to provide an acceptable performance in the EMR documentation procedures.

1.2 Problem Statement

As stated previously the incredible growth of the technologies in the health sector is driving the improvements plans and efforts done in this sector. According to what we have studied as health informatics students and by witnessing a little of working experience in our health facilities as interns we noticed the difference between what should be implemented and what's been used. After finishing the first part of the internship as a health informatics in Benghazi Medical Center (BMC) a list of problems and obstacles were facing the electronic systems as a whole in the facility, more specific if we talk about the recording and documentation of the patients data and visits we found the center is very poor and merely covering what is required in an EMR.

In this project we are trying to create electronic solution for the Out Patient Department (OPD) problems in BMC, The department targeted is the Pediatrician clinic of the center. The OPDs receptionist performs as a clinical one that means there are no need to implement an Admission, Transfer And Discharge system ATD as a package because there is no patients admitted or discharged. We developed a system that solves the key problems that faces the department which are :

Patient medical record redundancy ;

Lack of medical records availability;

Difficulties of including the ICD in the record; and

Lack of reports and statistics generated by the department.

We tried to provide a reasonable, feasible and easy to implement system without complicating the workflow of the department and without adding new procedures.

1.3 Aim and Objectives

This project aims to enhance the quality of the health services delivered by the center, this system in its optimum statues will provide an instant access to a patient medical record any time. Moreover the built-in features and properties are aiming to ease the health delivery processes by providing a medical database of the procedures used by the doctors and practitioners.

Objectives of this project are basically focused on achieving the best performance done by both the department and the system to have an effective system outcomes as possible. They can be stated as levels, for the clinical/Medical part of the project is focused on representing an EMR that is covering all of the patient data needed for each session, also presenting a new built-in ICD feature to the record that enable the user or the doctor to insert or search for the diagnosis or treatment listed in the patient record. Another essential goal or level to achieve is to have an electronic database that is available instantly for the use of reports and research requirements.

1.4 Scope and Limitation

This project is a computer-based medical information system that processes medical data to patients in the OPDs of BMC, the information system is programmed using Microsoft Visual Studio 2010. English is the language used in the display and design of the system. After acknowledging the majors of the system we can clearly identify the limitation facing the

implementation of the system in a medical center, firstly the qualification of the terminals and clerks of the department whom operating the system, on previous attempts to systematize the processes of the BMC medical services, employees tend to resets the change, which led to another problem of redundancy of the medical record, also may be hard to allocate all the patient records completed from the archive department. Moreover the problem of having enough informatics personnel to operate the system, this also can be beneficial by creating a field of jobs for Health informatics.

1.5 Risk Management.

When developing an information system as a capstone there are two risks which are more likely to face developers:

1- The change of the system requirements or miss-understanding them, that why it's important to focus on the requirement gathering and analysis.
2- Time, running out of time available to complete the project is one of the huge risks that faces developers.

CHAPTER II : INITIATION

2.1 Feasibility Study.

This study aims to adopt and analyze three types of feasibilities:

Economic Feasibility.

Whatever the cost of this system would be , it's still too little regarding to the positive impact to the OPD and the patients visiting the clinic.

Technical Feasibility.

This information system can operate on any personal computer (PC) that have at least a Windows 7 operating system or newer versions.

Operational Feasibility.

As stated previously will trained personnel are needed to use the system, it might be necessary to train the human resource of the clinic on the system, never forgetting the operational costs of the development team / company producing the system and the cost of any gadget or devices needed.

CHAPTER III: ANALYSIS

3.1 Requirement Gathering.

For this project the requirement gathering method were two stages of collecting information needed, firstly an interviews conducted with the (Doctor , Receptionist) the users of the system to address the problems in the current system(paper based) and what is required specific to solve them. It follows the interviews a visit to the OPD in Benghazi Medical Center, this visit addressed the real-time requirements and stated the main problem by observing the workflow.

3.1.1 Functional Requirement

A functional requirement, in software and systems engineering, is a declaration of the intended function of a system and its components. Based on functional requirements, an engineer determines the behavior (output) that a device or software is expected to exhibit in the case of a certain input.

Priority	Functional requirements description	Function name	Req. no.
3	The system will authorize users to log in using a username and password	US2	FR1
3	If the user is the system manager(admin),the following interfaces will be displayed : patient	US2	FR2

	registration, listing of appointment, follow-up sessions, patient medical record, generate report and control authorization.		
3	If the user is the receptionist, the following interfaces will be displayed : patient registration, listing of appointment, follow-up sessions, generate report.	US2	FR3
3	If the user is the Doctor, the following interfaces will be displayed : patient medical record and generate report.	US2	FR4
3	The system will allow the users to add patient data (patient name, patient ID, Age, gender, nationality, …, etc) *detailed data will be discussed in ch5	US3	FR5
2	The system allows users to edit patient data	US3	FR6
2	The system allows users to delete patient data	US3	FR7
3	The system allows receptionist to book appointments	US4	FR8
2	The system allows receptionist to cancel an appointment	US4	FR9
2	When asking for follow-up the system check the patient ID	US5	FR10
3	The system allows the doctor to add medical session data	US6	FR11
2	The system allows the doctor to edit medical session data if necessary	US6	FR12
2	The system allows the doctor to delete medical session data if necessary	US6	FR13
3	The admin can generate (daily, monthly and yearly) reports, doctors can generate reports about patient medical record and the receptionist generates reports of the(daily, monthly and yearly) patient registration data	US7	FR14
3	System manager (Admin) can add, edit and delete users	US8	FR15
3	System manager (Admin) determines the use authorization for each user	US8	FR16

Table (3.1) functional requirement

3.2 Nonfunctional Requirement

It's the description of performance and external requirements:

1- Back-up and recovery plan.

2- Accessibility.

3- Debugging and trouble shooting.

4- Security.

5- Quality Requirement.

Non functional req.	**Req. no.**
The system gives the availability of making back-up for the database files and recovering them as when needed, back-ups are very important feature regarding the sensitivity of the medical records.	NFR1
It is not possible to access or log into without authorization given.	NFR2
There are controls designed on the added data by the users such as: no redundancy allowance, controls on numerical data , date controls, confirmation dialog for edit and delete before saving	NFR3

Table (3.2) non functional requirement

3.3 Introduction to analysis

at this stage all the component and detailed procedures of the system are studied, the analysis process is the scientific method used to explore the current system problems and determine the best solutions to avoid them.

3.3.1 Introduction to UML Unified Modeling Language

UML was meant to be a unifying language enabling IT professionals to model computer applications. The primary authors were Jim Rum Baugh, Ivar Jacobson, and Grady Booch, who originally had their own competing methods (OMT, OOSE, and Booch). Eventually, they joined forces and brought about an open standard. One reason UML has become a *standard* modeling language is that it is programming-language independent. (UML modeling tools from IBM Rational are used extensively in J2EE shops as well in .NET shops.) Also, the UML notation set is a language and not a methodology. This is important, because a language, as opposed to a methodology, can easily fit into any company's way of conducting business without requiring change.

In this project we used the following UML diagrams:

- Use Case diagrams
- Activity Diagrams
- Class Diagrams
- Sequences Diagrams

3.3.1.1 Use-case diagram:

A use case illustrates a unit of functionality provided by the system. The main purpose of the use-case diagram is to help development teams visualize the functional requirements of a system, including the relationship of "actors" (human beings who will interact with the system) to essential

processes, as well as the relationships among different use cases. Use-case diagrams generally show groups of use cases — either all use cases for the complete system, or a breakout of a particular group of use cases with related functionality (e.g., all security administration-related use cases). To show a use case on a use-case diagram, you draw an oval in the middle of the diagram and put the name of the use case in the center of, or below, the oval. To draw an actor (indicating a system user) on a use-case diagram, you draw a stick person to the left or right of your diagram (and just in case you're wondering, some people draw prettier stick people than others). Use simple lines to depict relationships between actors and use cases

3.3.1.2 Class diagram:

The class diagram shows how the different entities (people, things, and data) relate to each other; in other words, it shows the static structures of the system. A class diagram can be used to display logical classes, which are typically the kinds of things the business people in an organization talk about — rock bands, CDs, radio play; or loans, home mortgages, car loans, and interest rates. Class diagrams can also be used to show implementation classes, which are the things that programmers typically deal with. An implementation class diagram will probably show some of the same classes as the logical classes diagram.

3.3.1.3 Sequence diagram:

Sequence diagrams show a detailed flow for a specific use case or even just part of a specific use case. They are almost self explanatory; they show the calls between the different objects in their sequence and can show, at a detailed level, different calls to different objects.

A sequence diagram has two dimensions: The vertical dimension shows the sequence of messages/calls in the time order that they occur; the horizontal dimension shows the object instances to which the messages are sent.

Reading a sequence diagram is very simple. Start at the top left corner with the "driver" class instance that starts the sequence. Then follow each message down the diagram.

3.3.1.4 Activity diagram:

Activity diagrams show the procedural flow of control between two or more class objects while processing an activity. Activity diagrams can be used to model higher-level business process at the business unit level, or to model low-level internal class actions. In my experience, activity

diagrams are best used to model higher-level processes, such as how the company is currently doing business, or how it would like to do business. This is because activity diagrams are "less technical" in appearance, compared to sequence diagrams, and business-minded people tend to understand them more quickly.

An activity diagram's notation set is similar to that used in a state chart diagram. Like a state chart diagram, the activity diagram starts with a solid circle connected to the initial activity. The activity is modeled by drawing a rectangle with rounded edges, enclosing the activity's name. Activities can be connected to other activities through transition lines, or to decision points that connect to different activities guarded by conditions of the decision point. Activities that terminate the modeled process are connected to a termination point (just as in a state chart diagram). Optionally, the activities can be grouped into swim lanes, which are used to indicate the object that actually performs the activity.

3.4 System Scenario

the project is an information system for the pediatric clinic in the OPD system in BMC to record patients data and deliver healthcare services to children younger than 18 years old. The receptionist is responsible of receipting the patient and patient guardians, the receptionist then record all the patient data in the system where each patient record have a unique serial number, if the patient is not registered before the receptionist opens a new record then the system will generate a serial number to the patient, if the patient is previously registered a message will appear to notice the user then will display all the patient data, then the receptionist can add him to the daily session booking system.

in the doctor office the patient data will be displayed with the addition of the patient history if he/she have visited the center before and received a medical care, the doctor can then control the medical data operation including the investigation and diagnosis.

the receptionist handles only the administrative operation of the patient including the generation of report if required from the patient, the system admin controls the whole system cases and controls the authorization of the staff and doctors.

3.5 Use Case Diagram

The use case diagram describes the system interactions with the system and users(actors) and external systems if required, in another way it describes the functional behavior of the system in diagrams from users side. figure (3.1) describes the system use case.

Symbol	Description
 Actor	Describes the person interacting with the system
 Use Case	The User behavior with the system
Association	The link between the system users and operations

Table (3.3) the symbols used in the use case diagram

3.5.1 System Specification.

Users should be on a certain level of computer knowledge and familiar with the clinical administrative procedures, here we list the users specification:

- System Manager : considered as the system admin, adds the patient data , updates the daily appointments schedule, generate reports and control authorities.

- Receptionist : also considered as a system admin, adds the patient data , updates the daily appointment schedule, managing patient follow-up and generating reports.

- Doctor : considered as a system user , manages the medical data of the patient and generate report.

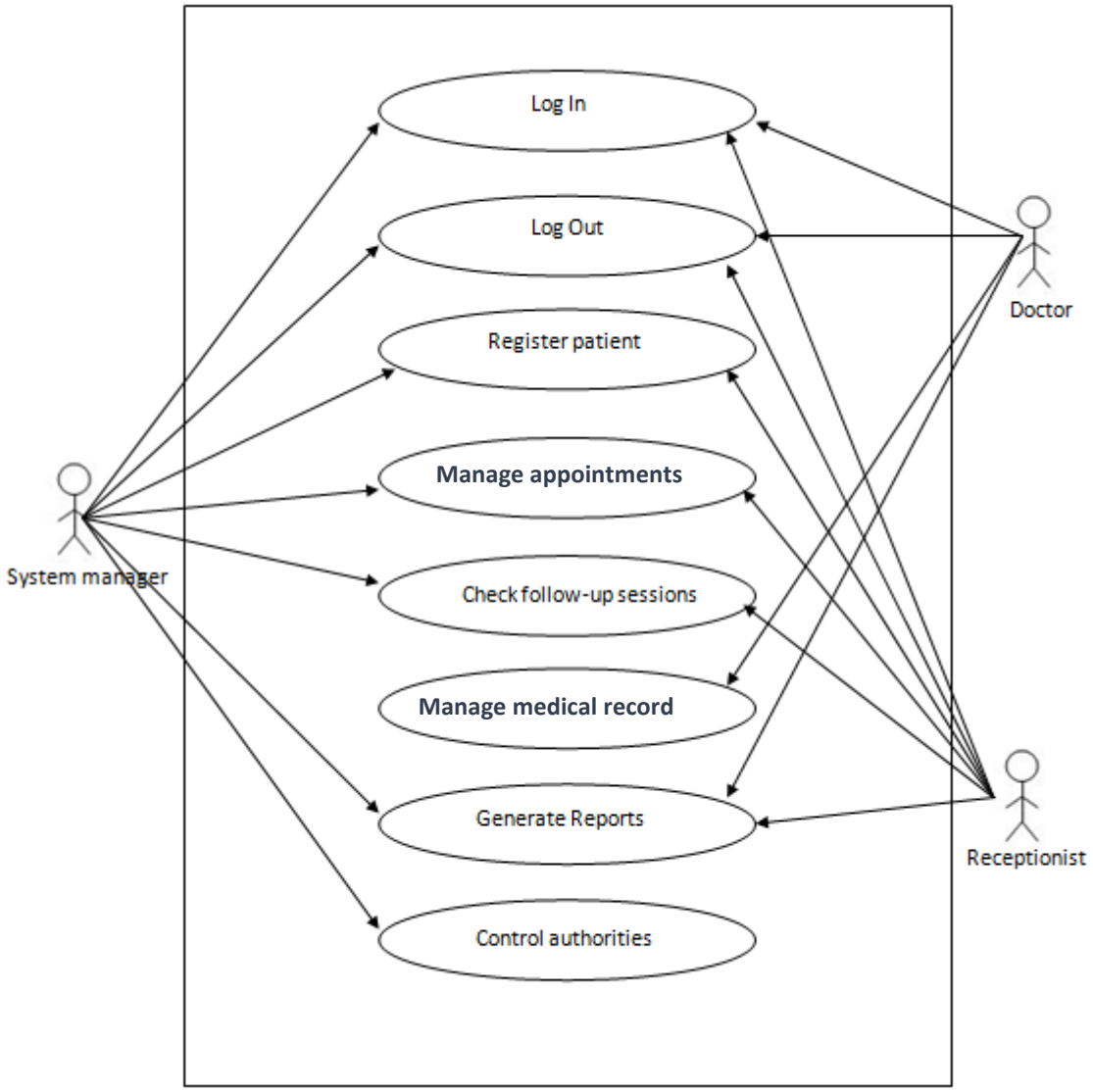


Figure (3.1) Describes the Use case diagram of the system

3.5.2 Use case Description

Use case name	Log In
Actor(s)	System manager(Admin), Doctor and receptionist(Users)

Target description: Admin and users logging in to the system
Main scenario: 1- Insert Username and password. 2- The system checks the log in data. **3-** Log in to the system according to the given authorization.
Previous statues: There is no previous statues
Following statues(if the main scenario succeeded): Log in to the system according to the given authorization
Alternative scenario: if any errors occur during the log in process or data an error message will appear and the system will not be able to log in
Priority : 3

Table (3.4) Log In Use case

Use case name	Register Patient
Actor(s)	System manager(Admin) and receptionist(Users)
Target description: saving the patient registration data	
Main scenario: 1- Log in to the system. 2- Select the patient registration interface. **3-** Add an identification number (ID) number for the patient, the system check if the ID does not exist then a new record can be added.	
Previous statues: The user and admin have to be logged in to the system	
Following statues(if the main scenario succeeded): gets an appointment or a follow-up session.	
Alternative scenario: if the patient already exists the system will notify the user and the patient data will not be saved twice.	
Priority : 3	

Table (3.5) Register Patient

Use case name	Check follow-up session
Actor(s)	System manager(Admin) and receptionist(Users)
Target description: the user will enter the patient ID to set a follow-up session	

Main scenario: 1- Log in to the system. 2- Select the patient registration interface. **3-** Add an identification number (ID) number for the patient, the system check if the ID does not exist then a new record can be added.
Previous statues: there will be no follow-up/medical session if the patient was not registered
Following statues(if the main scenario succeeded): -
Alternative scenario: if the patient ID does not exists the system will notify the user and the process will not be completed
Priority : 2

Table (3.6) check follow-up/medical session

Use case name	manage appointments
Actor(s)	System manager(Admin) and receptionist(Users)
Target description: the user reserve an appointment to the patient	
Main scenario: 1- Log in to the system. 2- Select the appointments interface. **3-** Insert the (ID) number of the patient, the system check if the ID exists then the user can book an appointment **4-** If the appointment is available the user insert the data needed then gives the patient a confirmation receipt .	
Previous statues: there will be no follow-up/medical session if the patient was not registered	
Following statues(if the main scenario succeeded): a confirmation message will appear	
Alternative scenario: if the patient ID does not exists the system will notify the user and the process will not be completed	
Priority : 3	

Table (3.7) Manage appointments

Use case name	Manage medical record
Actor(s)	Doctor (Users)
Target description: the user will document the delivery of the health service	

Main scenario: 1- Log in to the system. 2- Select the patient medical record interface. **3-** Insert the (ID) number of the patient, the system check if the ID exists then the user can diagnose/treat the case and add the session medical data
Previous statues: the user can not add data if the patient was not registered
Following statues(if the main scenario succeeded): -
Alternative scenario: : if the patient ID does not exists the system will notify the user and the process will not be completed
Priority : 3

Table (3.8) Manage medical record

Use case name	Generate report
Actor(s)	System manager(Admin), Doctor and receptionist(Users)
Target description: the users will be able to generate reports	
Main scenario: 1- Log in to the system. 2- Select the report generation interface. **3-** Insert the report query, if the data is available then the report will be displayed.	
Previous statues: the users can not generate reports unless they were logged in	
Following statues(if the main scenario succeeded): report display	
Alternative scenario: : if there is no data available a message will notify the users that there is no data to display	
Priority : 2	

Table (3.9) Generate Report

3.6 Activity diagram

The activity diagram is one of the (UML) diagrams/charts, more likely as a flowchart, represent a graphical demonstration to describe a certain function workflow or use cases.

Description	Symbol
Initiation State	 Initial state

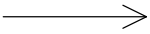
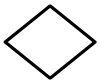
Action state	ActionState1 Action state
Control Flow	 Control flow
Decision box (If condition)	 Decision box
Transferring from one state to another	Transition(fork,join)
Final state	 Final state

Table (3.10) description of symbols used in the activity diagram.

The following are the activity diagrams of the main functions of the system:

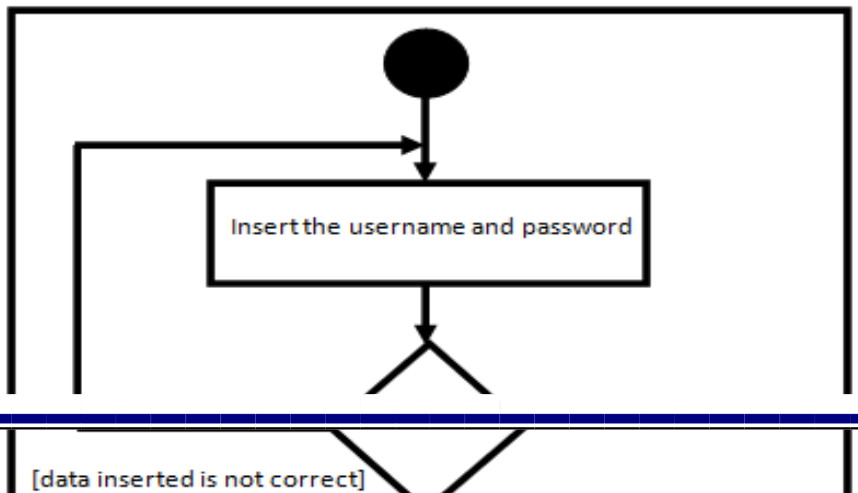


Figure (3.2) Log In Activity Diagram

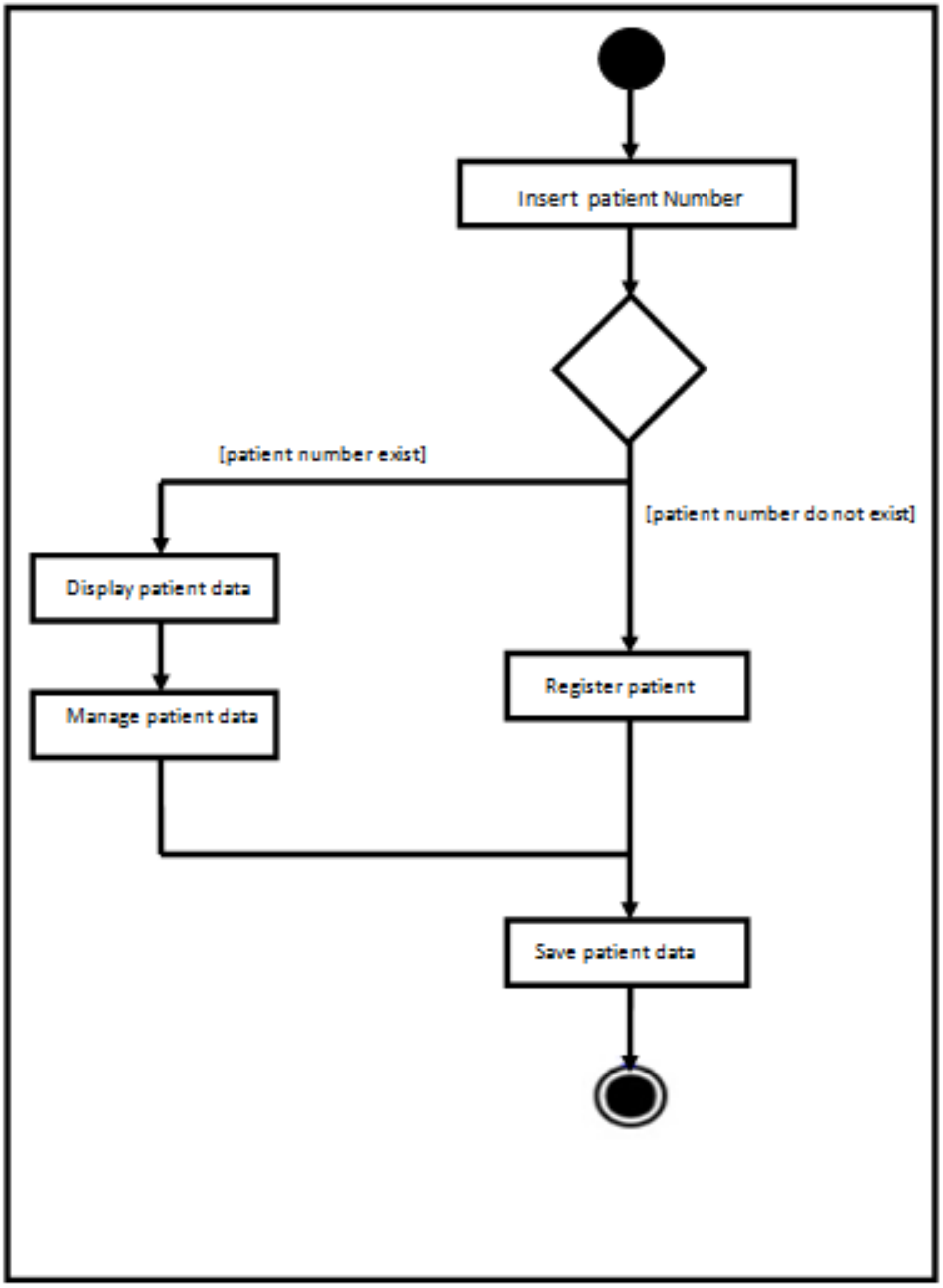


Figure (3.3) patient registration Activity Diagram

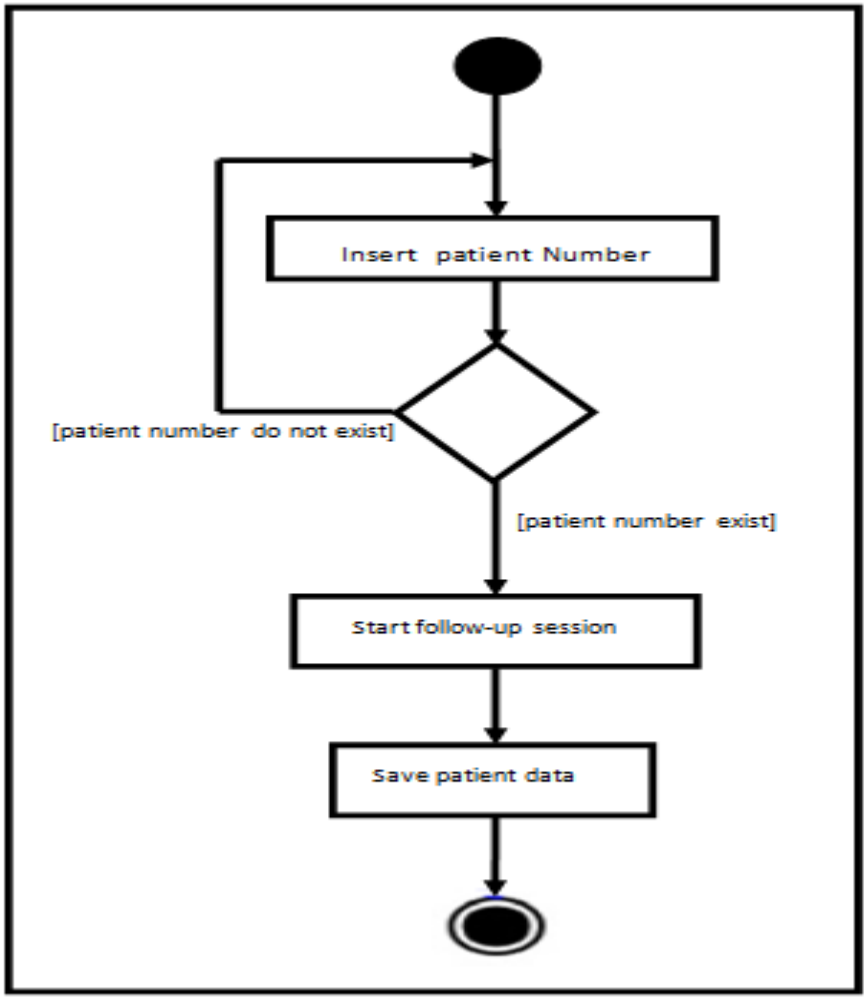


Figure (3.3) follow-up session Activity Diagram

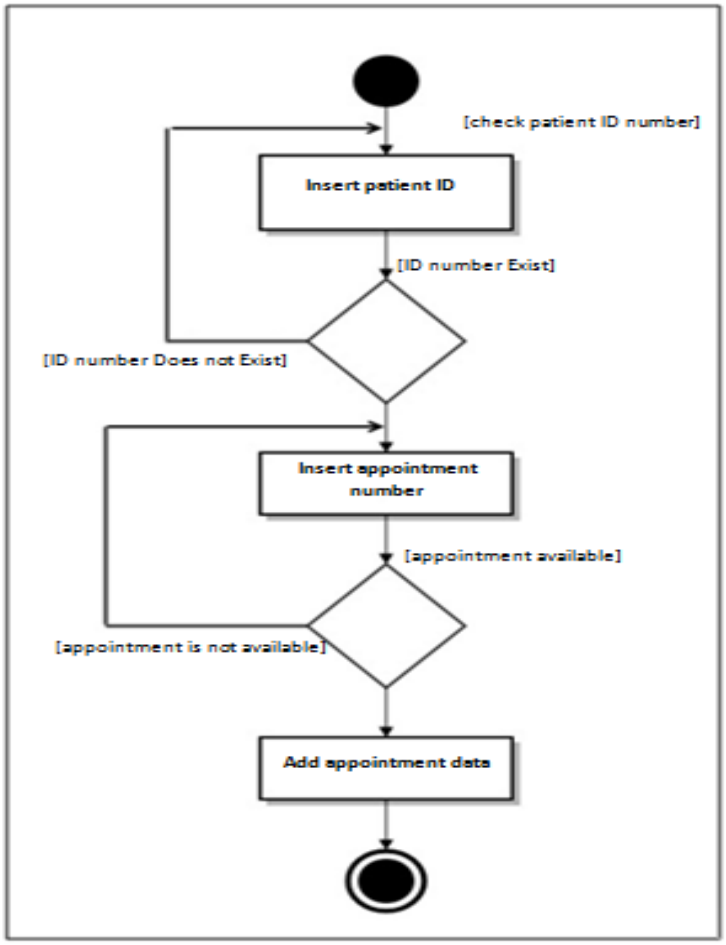


figure (3.5) listing of appointments

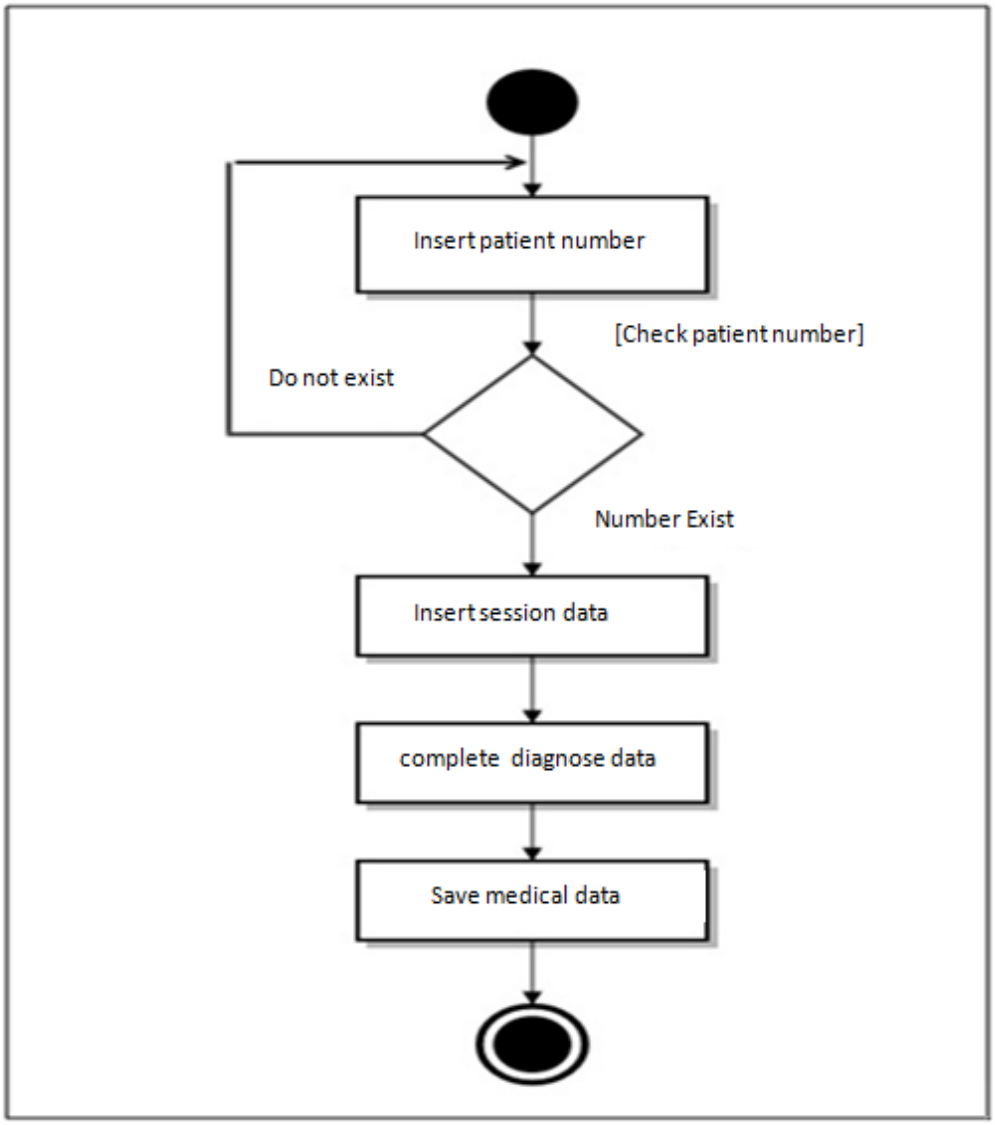


figure (3.6) patient medical record

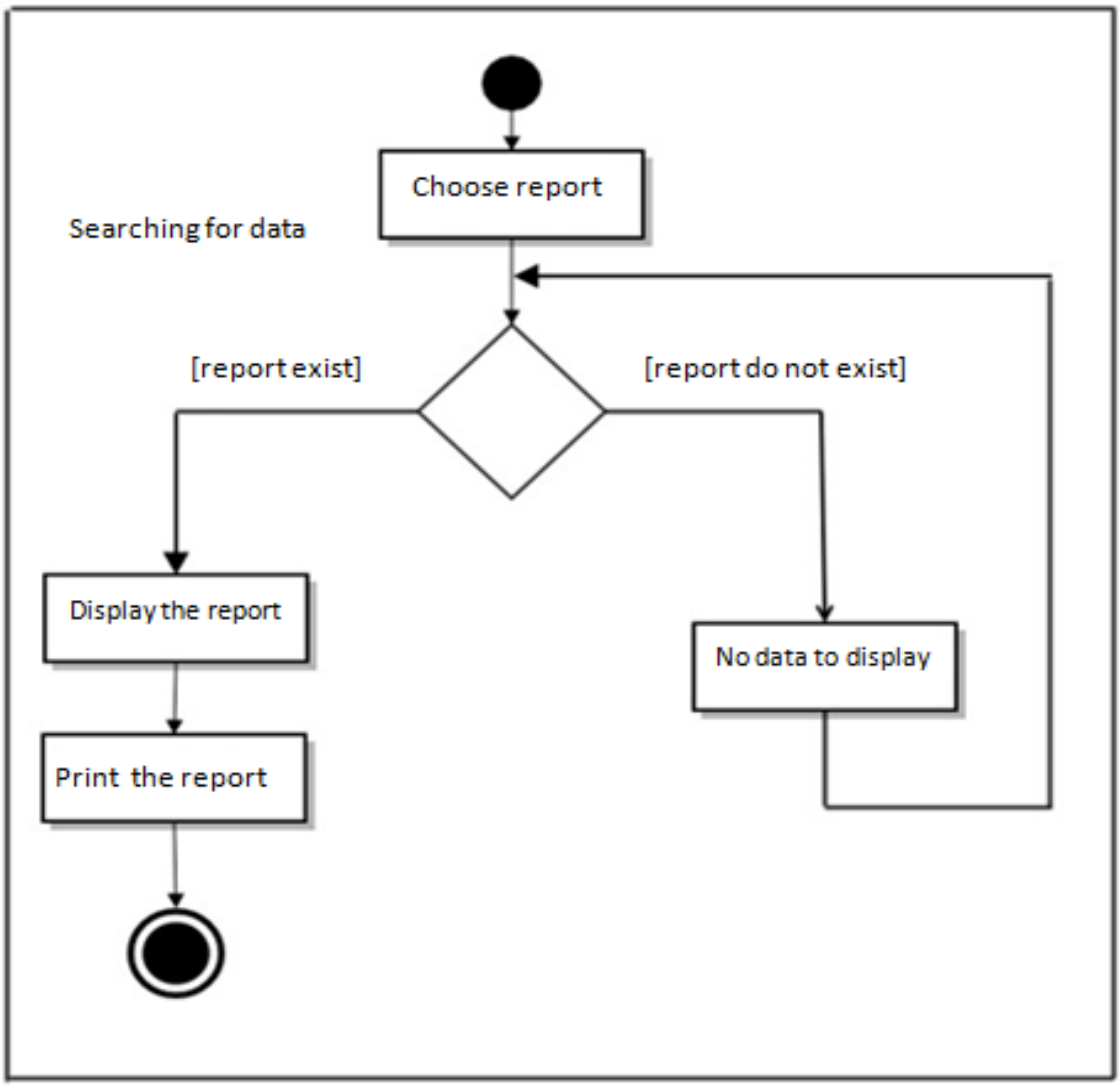


figure (3.7) Generate Report

CHAPTER IV : DESIGN

4.1 Class Diagram

This chart describes the class object that the system contains also the relation between them, where the objects described in attributes form and the attributes behavior in a methods form.

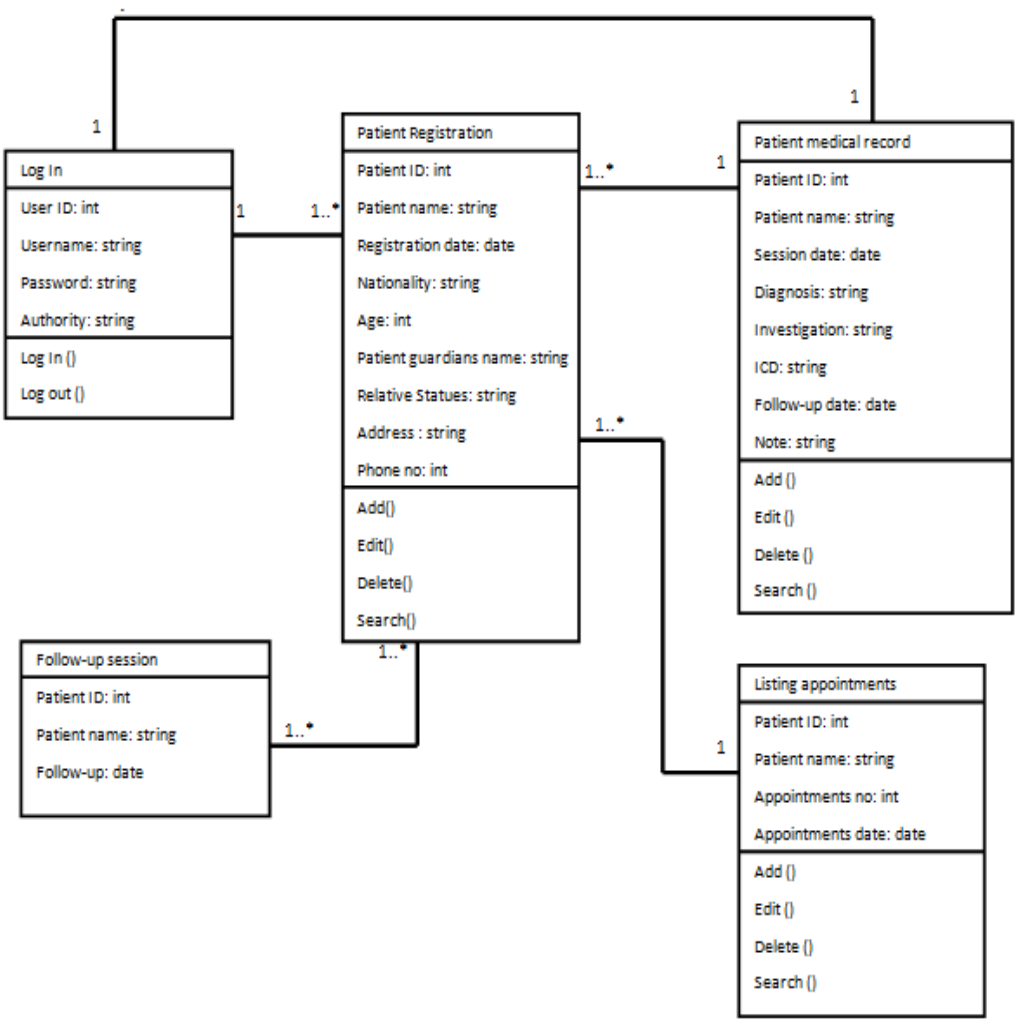


Figure (4.1) class diagram

4.2 Sequence Diagram

The sequence diagram defines the interaction between the system, the user and the parts of the system, displaying the flow of messages between the interfaces and other parts of the system. Basically it's the dynamic behavior of the system specially that is focusing on timing. The figures below will display the key interactions and its sequence diagram:

Description	Symbol
Dual classification of the time sequence by sending and receiving messages	
The object life cycle during the time sequence of the process	……..
Marks the object who send and receives messages	
The messages and data flow from one object to another	Send Message ——→ return Message - - - - - - - - →

Table (4.1) the symbols used in the sequence diagram

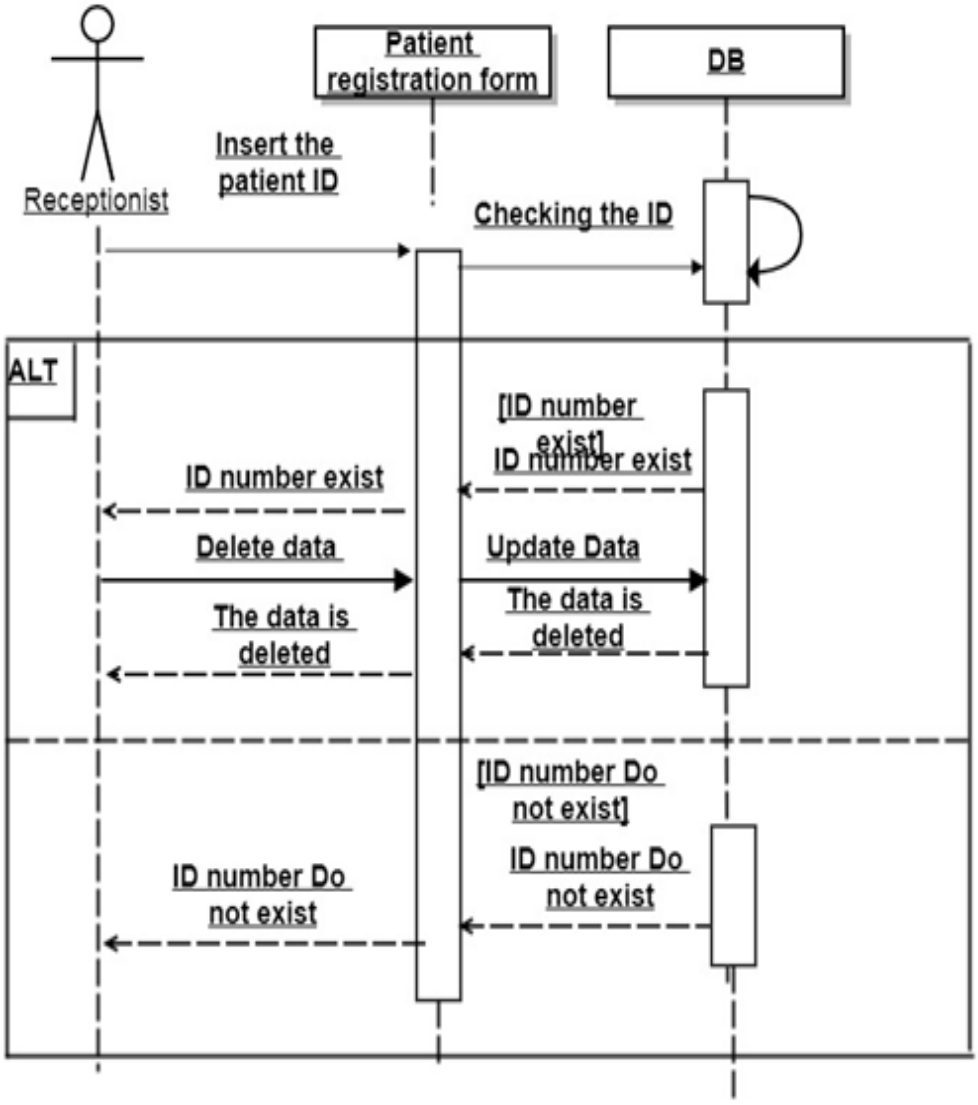


Figure (4.2) Patient registration sequence diagram.

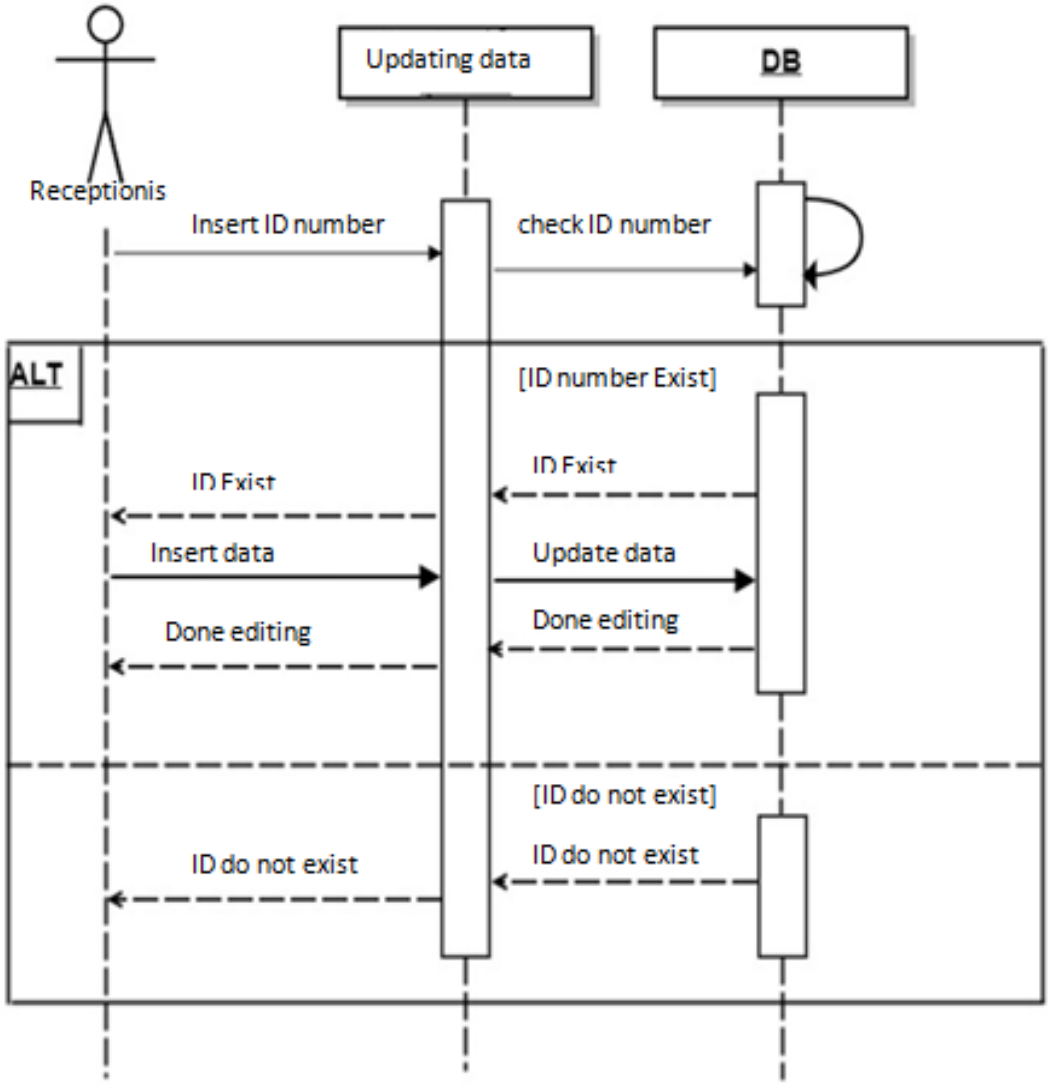


Figure (4.3) updating patient data sequence diagram

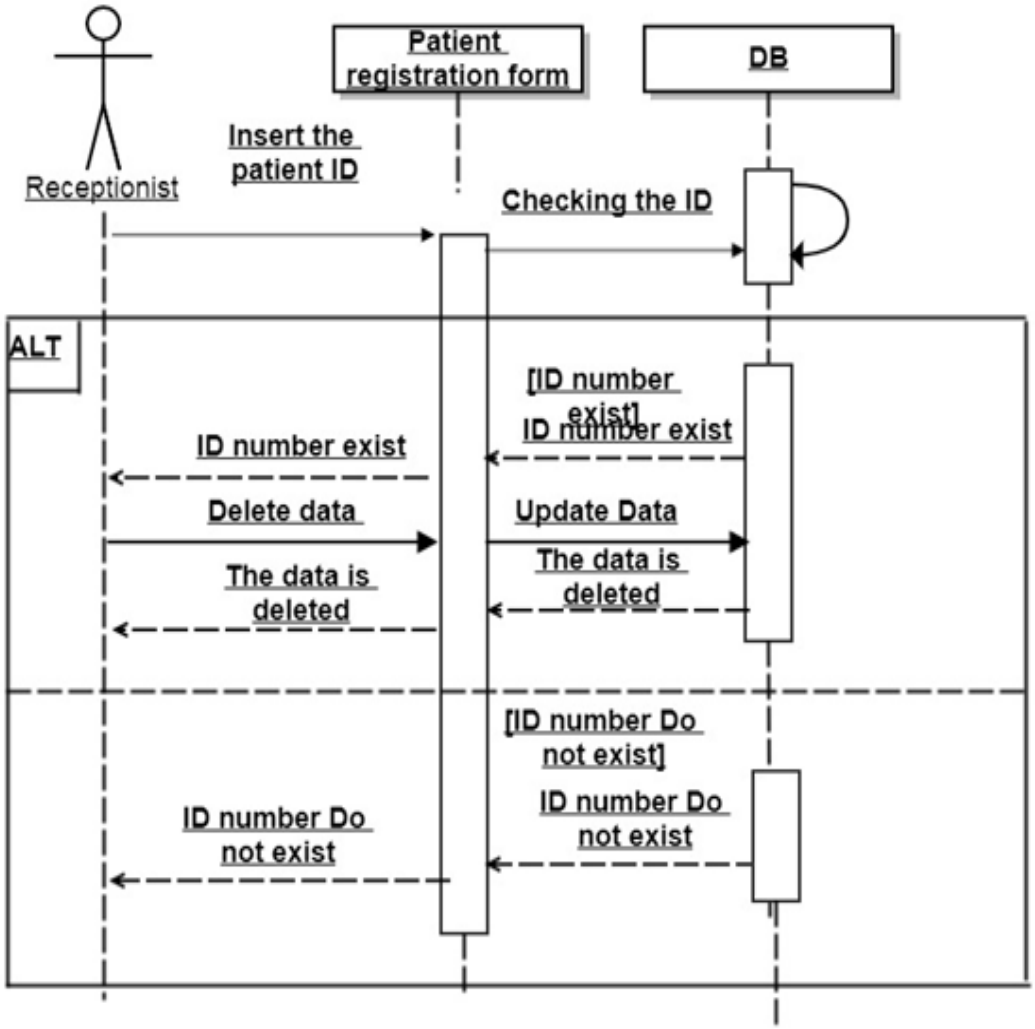


Figure (4.4) Deleting patient data sequence diagram.

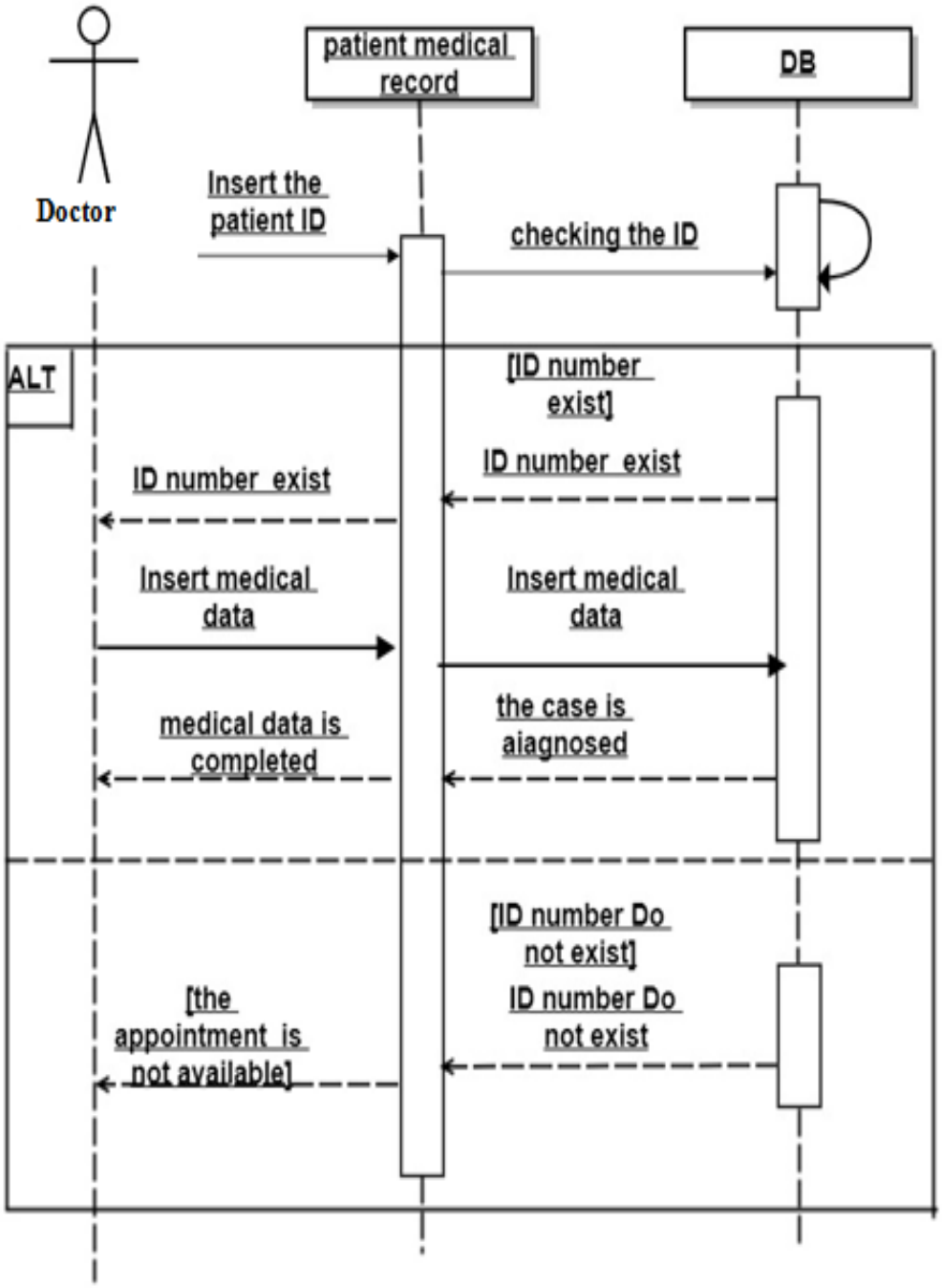


Figure (4.5) Patient medical record sequence diagram.

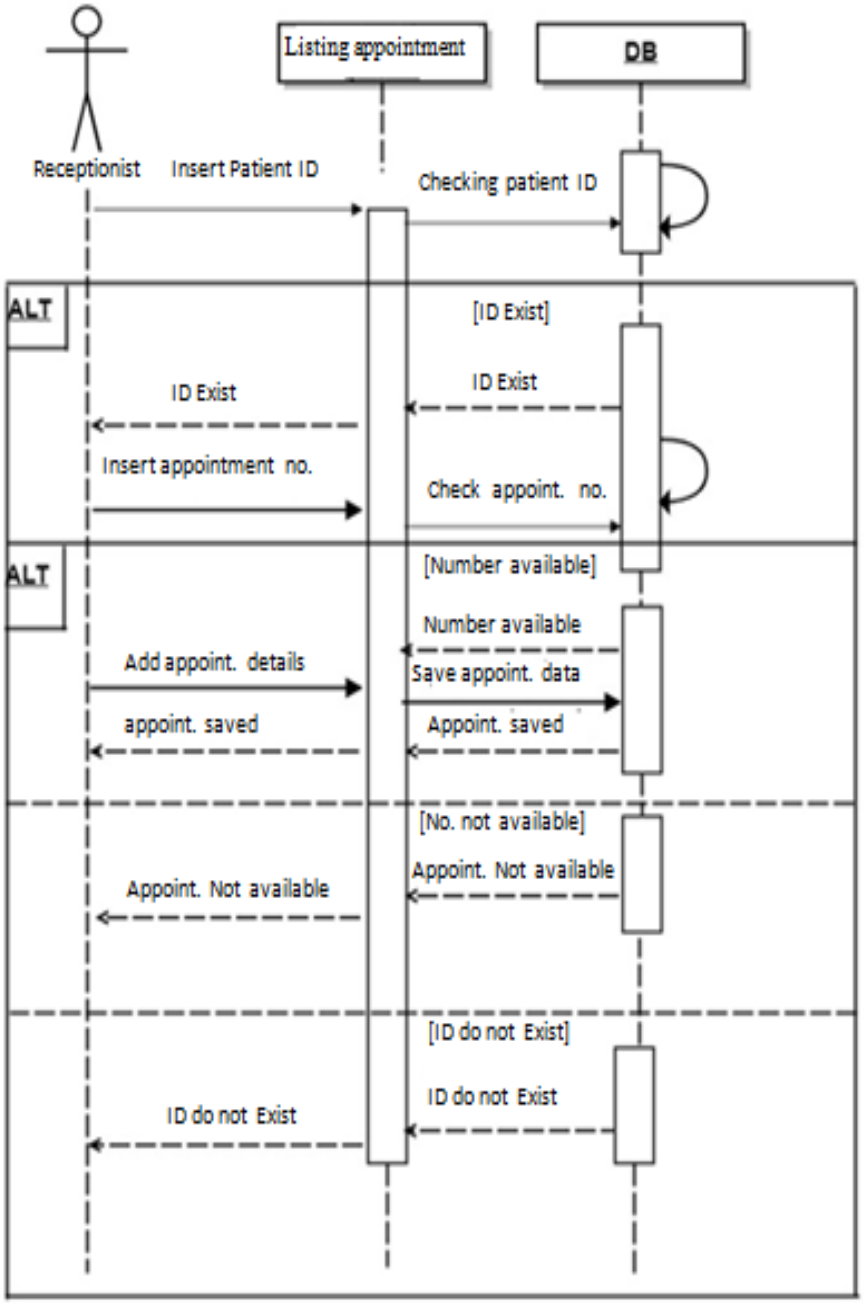


Figure (4.6) Listing appointments sequence diagram.

CHAPTER V : DEVELOPMENT AND TESTING

5.1 Database creation

The system database is developed and coded on Microsoft access environment, although it s quite uncommon to use it nowadays but it stills the easy to manage and adopt database, always making chances to update and upgrade the database, following are some of the tables design from the database (the un-listed tables are still being modified):

PTN

اسم الحقل	نوع البيانات	الوصف
PNO	رقم	patient number
PFname	نص	patient first name
PMname	نص	patient Middle nale
PLname	نص	patient Last name
Nat	نص	Patient Nationality
DateOfBirth	تاريخ/وقت	Patient Date of Birth
Gender	نعم/لا	Patient Gender
Address	مذكرة	Patient Address
PGFname	نص	Patient guardian first name
PGMname	نص	Patient guardian middle name
PGLname	نص	Patient guardian last name
Relative	نص	Relative Statues
Tel	نص	Guardian phone number

Figure (5.1) patient file database table design

Figure (5.2) patient medical file database table design

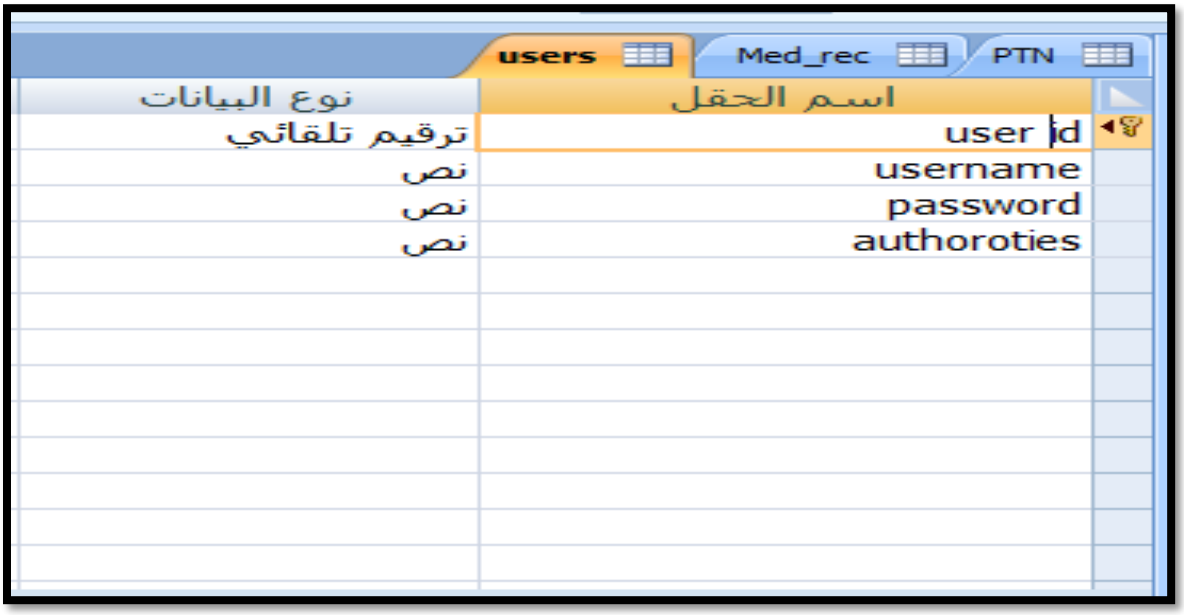


Figure (5.3) system users file database table design

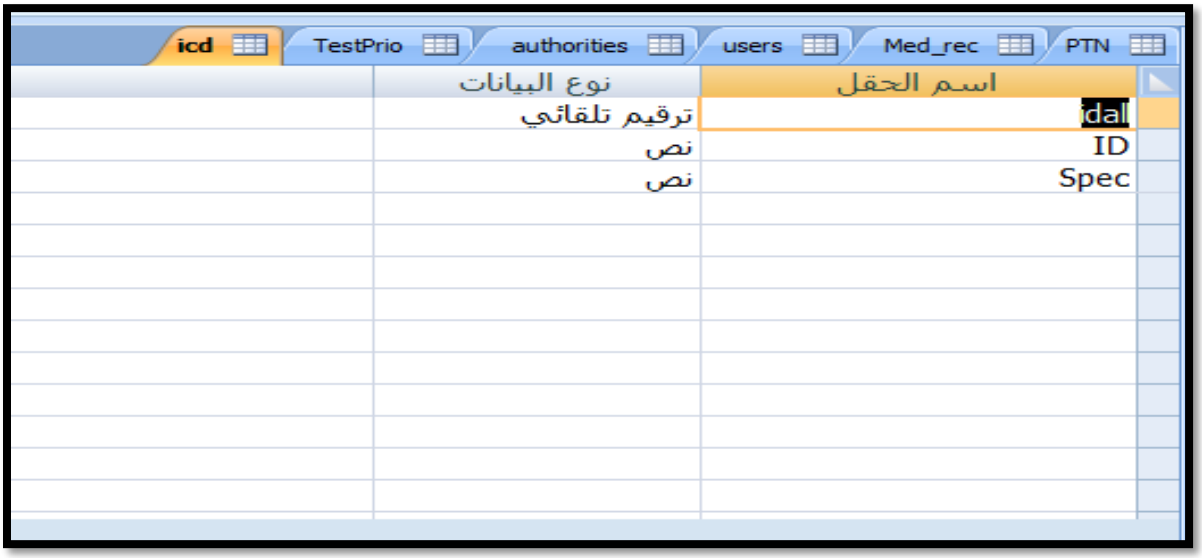


Figure (5.4) ICD-10 file database table design

icd

idall	ID	Spec
1	A000	Cholera due to Vibrio cholerae 01, biovar cholerae
2	A001	Cholera due to Vibrio cholerae 01, biovar eltor
3	A009	Cholera, unspecified
4	A0100	Typhoid fever, unspecified
5	A0101	Typhoid meningitis
6	A0102	Typhoid fever with heart involvement
7	A0103	Typhoid pneumonia
8	A0104	Typhoid arthritis
9	A0105	Typhoid osteomyelitis
10	A0109	Typhoid fever with other complications
11	A011	Paratyphoid fever A
12	A012	Paratyphoid fever B
13	A013	Paratyphoid fever C
14	A014	Paratyphoid fever, unspecified
15	A020	Salmonella enteritis
16	A021	Salmonella sepsis
17	A0220	Localized salmonella infection, unspecified
18	A0221	Salmonella meningitis
19	A0222	Salmonella pneumonia
20	A0223	Salmonella arthritis
21	A0224	Salmonella osteomyelitis
22	A0225	Salmonella pyelonephritis
23	A0229	Salmonella with other localized infection
24	A028	Other specified salmonella infections
25	A029	Salmonella infection, unspecified

Figure (5.5) ICD-10 records database table design

5.2 Testing plan.

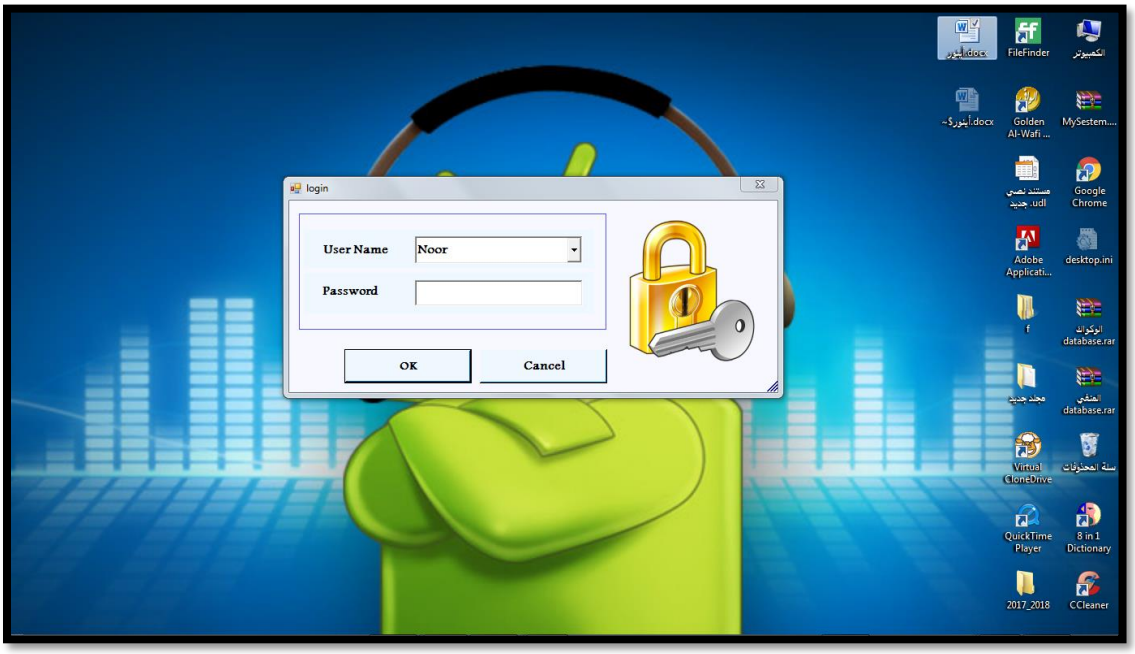
It is a part of the testing plan, where the key requirements are tested one by one, by testing the input and the output of the system using sample data. The following figures is a documentation to all the testing process for the key features of the system:

Table (5.1) Test plan scenario

Actual result	Predicted result	Test scenario	test condition
Pass	Fail	If the user log in using correct username and password the system will generate an error message	TC1
Pass	Fail	If the user is the receptionist the system will open the authorization interface	TC2
Pass	Pass	The system will not allow the user to save patient data if one of the fields is missing.	Tc3
Pass	Fail	In case of a repeated ID the system will generate an error message	Tc3
Pass	Fail	Adding a phone number that is more then 10 digits	Tc3
Pass	Pass	The system allows users to edit previously stored patient data	Tc4
Pass	Fail	The system allows booking an appointment before registration	Tc5

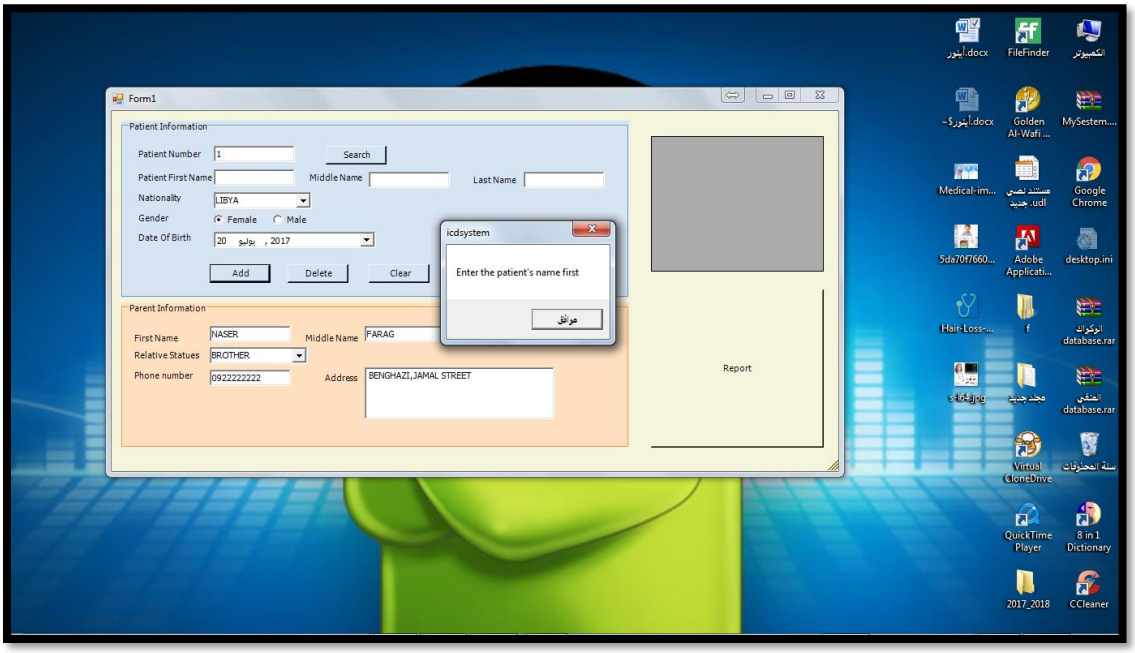
Pass	Pass	The system will not allow the doctor to add medical data unless the patient is registered	Tc6
Pass	Fail	The system allows the doctor to delete the patient record if the ID is not correct	TC6

Testing , the log in form

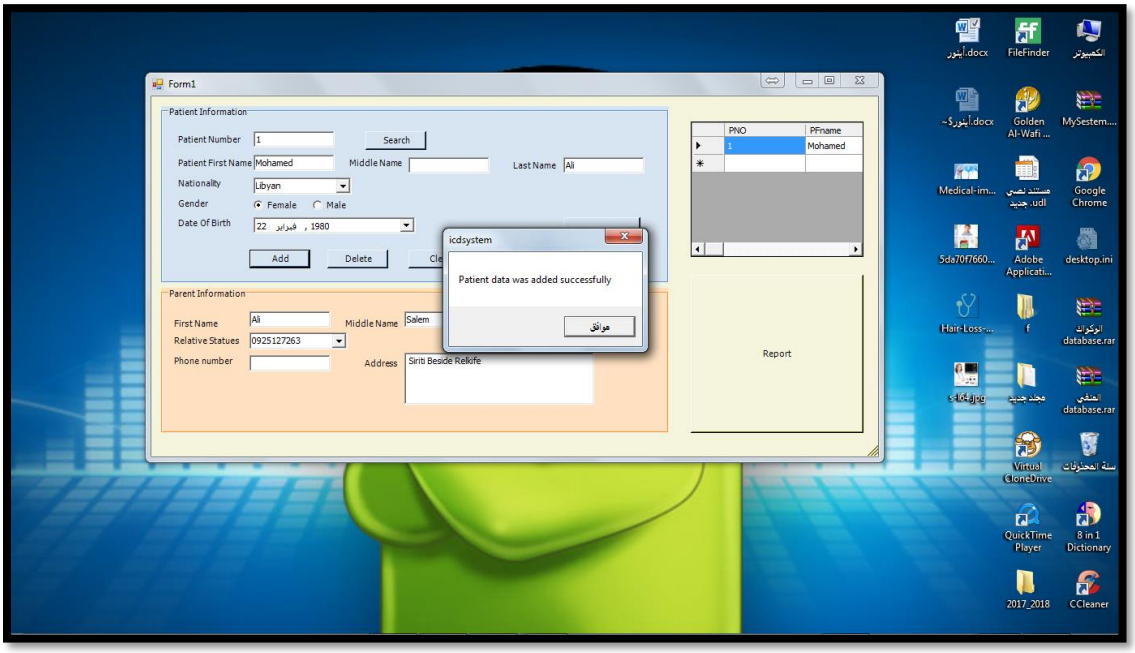


Testing , the log in form in case of a wrong password

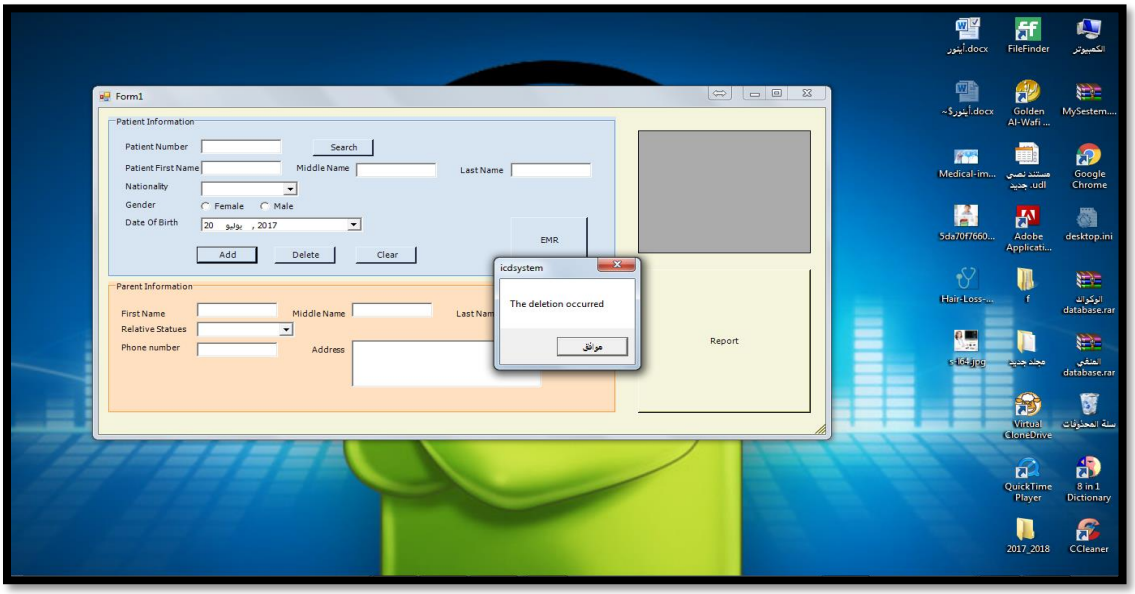
Testing, Patient registration form in case of missing fields



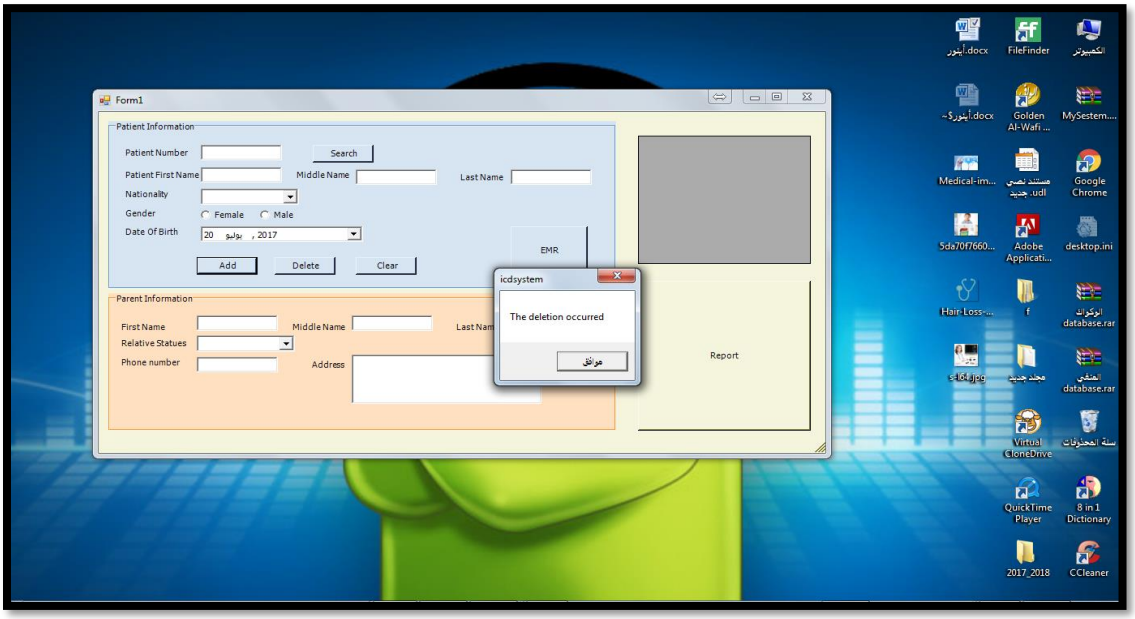
Testing, patient registration form in case of successful saving



Testing, the patient information form in case of deleting a patient record



Testing, authorization form in case of adding a user data that is previously exist


Form1
Patient Information
Patient Number
Search
Patient First Name
Middle Name
Last Name
Nationality
Gender
Female
Male
Date Of Birth
EMR
Add
Delete
Clear
Parent Information
First Name
Middle Name
Relative Statues
Phone number
Address
Report
icdsystem
The deletion occurred
موافق
الكمبيوتر
FileFinder
MySestem....
Google Chrome
desktop.ini
Adobe Applicati...
Virtual CloneDrive
QuickTime Player
8 in 1 Dictionary
CCleaner
2017_2018

CHAPTER VI : CONCLUSION

6.1 Conclusion

This project is providing the electronic data tools missing in the OPD of the BMC , the design of the requirements was based on the knowledge of a health informatics that's what led a very educate and secure medical information system. Including ICDs inside every patient record a database of ICDs is to be created for the most and frequently used to the benefit of the department reports and health quality improvement.

6.2 Suggestions

Further improvement can be held to the department procedures to adopt the ideal EMR for pediatrician including Progress note templates, Automated Growth Charts, ePrescribing, Reports and Immunization modules, Streamline clinical workflows. Integrated Practice Management System enables the front office(reception) and revenue cycle management staff to perform at their best in all administrative and financial aspects.

The ideal EMR is for doctors that would like to treat their patients as a children not as little adults, this improvements can be added only if several procedures were added to the center or department policy.

References

1- **Chaudhry B, Wang J, Wu S, et al. (16 May 2006). "Systematic review: Impact of health information technology on quality, efficiency, and costs of medical care". Annals of Internal Medicine. 144 (10): 742–52.**

2- **Kawamoto, Kensaku; Houlihan, Caitlin A; Balas, E Andrew; Lobach, David F (2 Apr 2005). "Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success". British Medical Journal. 330 (7494): 765–774. PMC 555881**

3- **"International Classification of Diseases (ICD)". *World Health Organization.* Archived *from the original on 12 February 2014.***

4- ***Ingenix Coding Lab: Implementing ICD-10*. Ingenix, Inc.: Reston, Virginia. 2002.**

5- ***Federal Register* 65, no. 160, August 17, 2000; p. 50311–50372. Available at www.access.gpo.gov/su_docs/aces/aces140.html.**

6- **"About WHO"**. ***World Health Organization.*** **Archived** ***from the original on 9 February 2014*****. Retrieved 14 March 2014.**