Research Article
Designing and implementing of electronic health record system in KSA using SQL & ASP.NET

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Abstract

Electronic health record (EHR) rapid progress for reporting electronic data storage that employs uniform data standards will enable health care organizations to respond more quickly to federal state, and private reporting requirements, including those that support patient safety and disease surveillance. An examination of many hospitals that recently implemented in King Saudi Arabia (KSA). A little of electronic health record (EHR) system finds that clinical and administrative leaders built EHR adoption into their strategic plans to integrate, inpatient and outpatient care system and a provide continuum of coordinated services. Using Relational Data Base Management Systems (RDBMS) with eXtend Marker Language (XML) Systems and ASP.NET as web based system. Successful implementation depended on: strong leadership, full involvement of clinical staff in design and implementation, mandatory staff training, and strict adherence to timeline and budget. The EHR systems facilitate patient safety and quality development through; use of checklists, alerts, and predictive tools embedded clinical guidelines that promote standardized, evidence-based practices electronic prescribing and test-ordering that reduces errors and redundancy and discrete data fields that foster use of performance dashboards and compliance reports. The proposed system will be developed using ASP.NET as a technology of web based system. In this paper; most of the services, enjoyed on the internet are provided by web database applications and using .net technology. Such as, Web-based email, online shopping, forums and bulletin boards, corporate web sites, and sports and news portals are all database-driven. The main goals in this work, building a modern web site of electronic health record system in KSA hospitals.

Introduction

Saudi Arabia with an area of 2.15 million km^2 and populations about of 29.5 Million peoples. The kingdom of Saudi Arabia (KSA) have a number of 256 hospitals with 49 000 beds in government hospital and 14000 in the private hospitals [1]. A terms used in the field include electronic medical record (EMR), electronic patient record (EPR), electronic health record (EHR), computer-based patient record (CPR). These terms can be used interchangeably or generically but some specific differences have been identified. Such as, an Electronic Patient Record has been defined as encapsulating a record of care provided by a single site, in contrast to an Electronic Health Record which provides a longitudinal

record of a patient's care carried out across different institutions and sectors. But such differentiations are not consistently observed. Geographical Information System (GIS) was used to locate the administrative areas and the places of hospitals [2].

A. Review of the Health Record in KSA & Health Care Planning in Saudi Arabia

Health care planning system in Saudi Arabia has different agencies that play important roles in providing health care to residents. These agencies are The Ministry of Health, The

National Guard, The Ministry of Defense and Aviation, and The Ministry of Interior [3]. In addition to these agencies there are specialist hospitals in Saudi Arabia that provide health care to specialist health cases. These agencies provide health care services on the basis of exclusive free health care to all citizens. In addition, the private sector in Saudi Arabia plays an increasingly significant role in the Kingdom and coordinates with the referral network and the regulatory requirements of health sector as a whole [4-9]. The Ministry of health in Saudi Arabia has seen that the primary objective of both the public and private health sector is to improve the health conditions of all citizens through the provision of comprehensive preventive and curative health services throughout the Kingdom, with particular emphasis on equitable and efficient primary health care (ibid) [5].
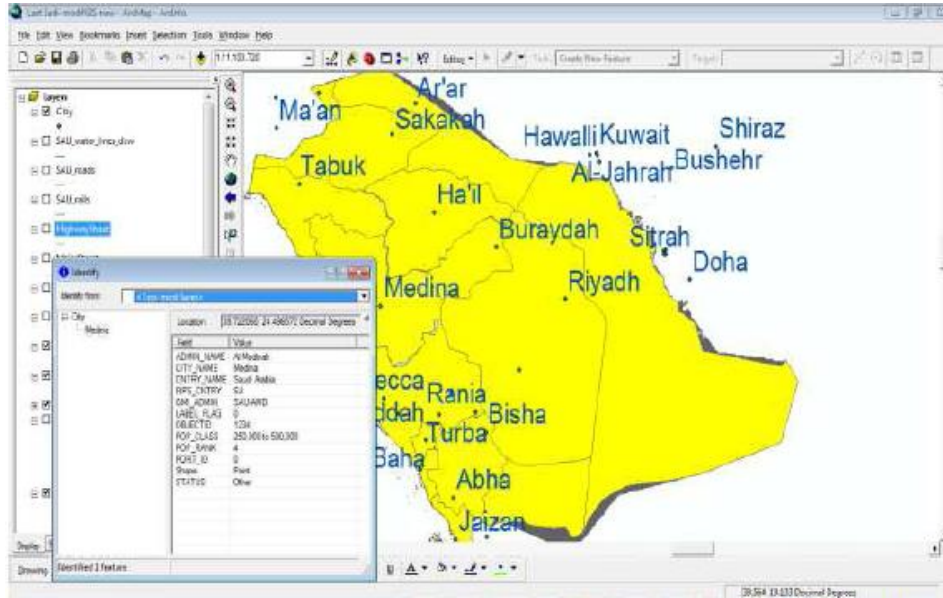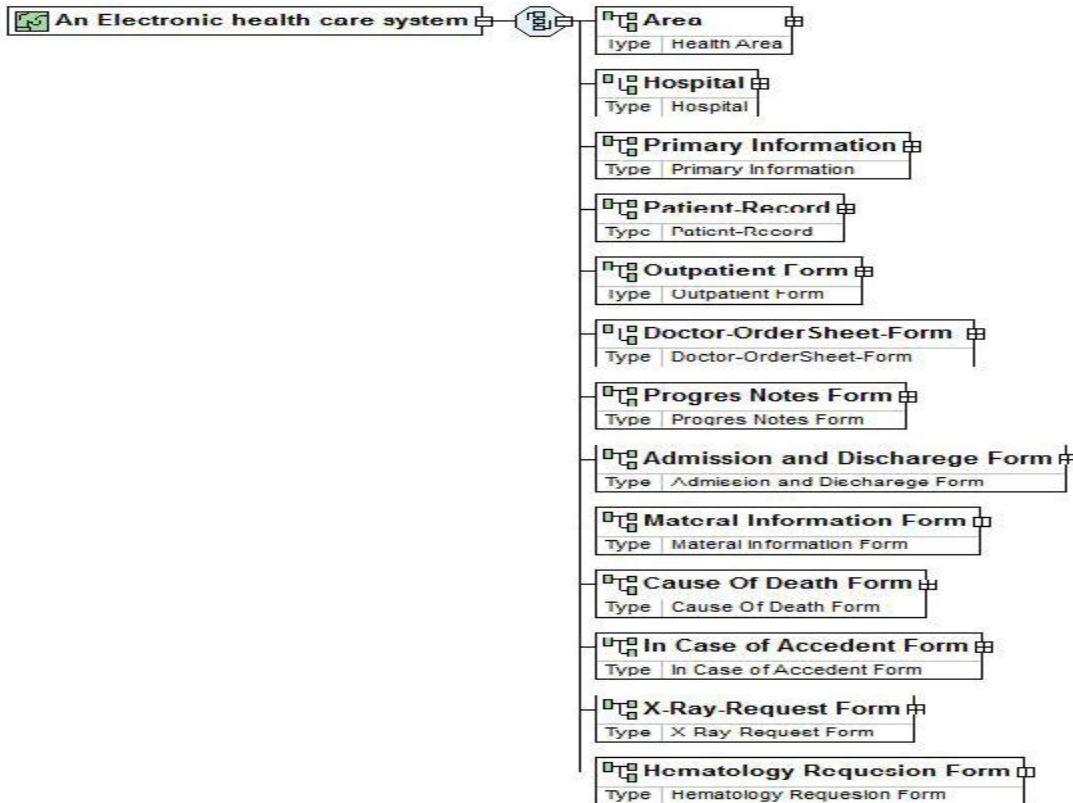

Figure 1: shows the map of Saudi Arabia Subareas

B-XML Instance Representation of the whole EHR system code

<Area> Health Area </Area> [1]

<Hospital> Hospital </Hospital> [1]

<Primary Information> Primary Information </Primary Information> [1]

<Patient-Record> Patient-Record </Patient-Record> [1]

<Outpatient Form> Outpatient Form </Outpatient Form> [1]

<Doctor-OrderSheet-Form > Doctor-OrderSheet-Form </Doctor-OrderSheet-Form >

<Progres Notes Form> Progres Notes Form </Progres Notes Form> [1]
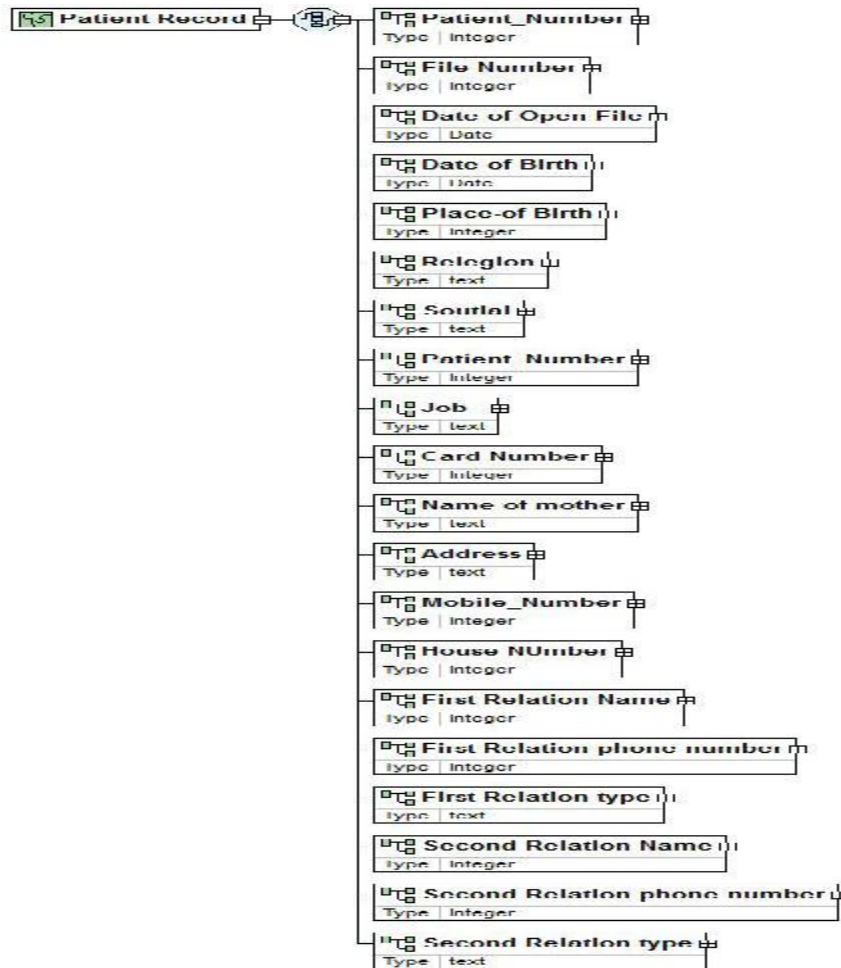
<Admission and Discharege Form> Admission and Discharege Form </Admission and Discharege Form>

Figure 2: Shows the **XML Instance Representation of the whole EHR system**

C- Creation of Rational Data base system and Tables

A Relations between tables was established and generated figure 3, forms was build of the patient data entry ,consists of :

- Hospital manpower basic information
- Patients basic information
- Outpatient transaction record
- The clinical system
- In case of accident
- X_ray
- 7-Microbilogy requesting form.

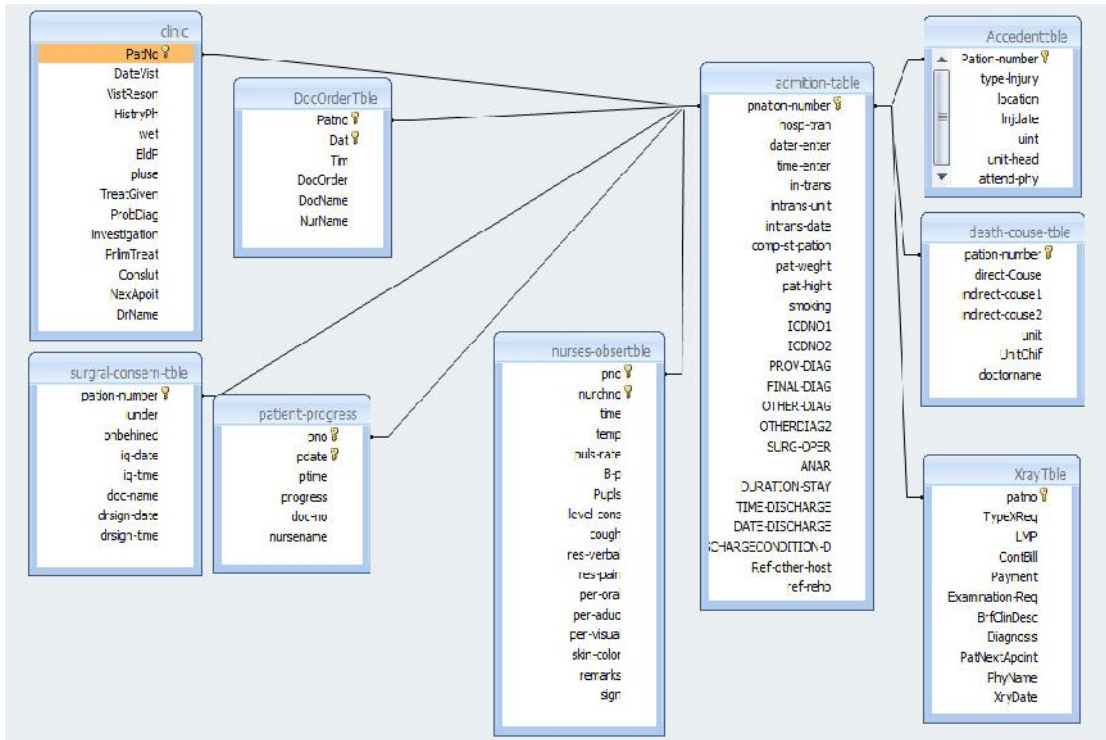Then a relation between tables was established and generated as shown in figure 3.

Figure 3: The relations between tables of the system

II. DESIGNING AND IMPLEMENTING AN EHR SYSTEM

EHR rapid progress for reporting electronic data storage that employs uniform data standards will enable health care organizations to respond more quickly to federal state, and private reporting requirements, including those that support patient safety and disease surveillance [10-12].

A. Designing and implementing an EHR system

- Replace paper-based medical records which can be incomplete, fragmented (different parts in different locations), hard to read and (sometimes) hard to find.
- Provide a single, shareable, up to date, accurate, rapidly retrievable source of information, potentially available anywhere e at any time. Require less space and administrative resources.
- Potential for automating, structuring and streamlining clinical workflow.
- Provide integrated support for a wide range of discrete care activities including decision support, monitoring, electronic prescribing, electronic referrals radiology laboratory ordering and results display.

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- Maintain a data and information trail that can be readily analyzed for medical audit, research and quality assurance, epidemiological monitoring, disease surveillance.
- EHR and Hospital management planning systems.

B. The outcome results of proposed EHR system

- EHR Result management improve ability for all providers participating in the care of a patient in multiple settings to quickly access new and past test results would increase patient safety and the effectiveness of care.

  - EHR provide the ability to enter and store orders for prescriptions, tests, and other services in a computer-based system should enhance legibility, reduce duplication, and improve the speed with which orders are executed.

  - EHR support decision support , using reminders, prompts, and alerts, computerized decision-support systems

  would help improve compliance with best clinical practices ensure regular screenings and other preventive practices, identify possible drug interactions, and facilitate diagnoses and treatments.

- EHR gives good communication and connectivity and support efficient, secure, and readily accessible communication among providers and patients would improve the continuity of care, increase the timeliness of diagnoses and treatments, and reduce the frequency of adverse events.
- EHR Patient support give patients access to their health records, provide interactive patient education, and help them carry out home-monitoring and self-testing can improve control of chronic conditions, such as diabetes.

- EHR gives computerized administrative tools, such as scheduling systems, would greatly improve hospitals and clinics efficiency and provide more timely service to patients.
- EHR gives a rapid progress for reporting electronic data storage that employs uniform data standards will enable health care organizations to respond more quickly to federal state, and private reporting requirements, including those that support patient safety and disease surveillance
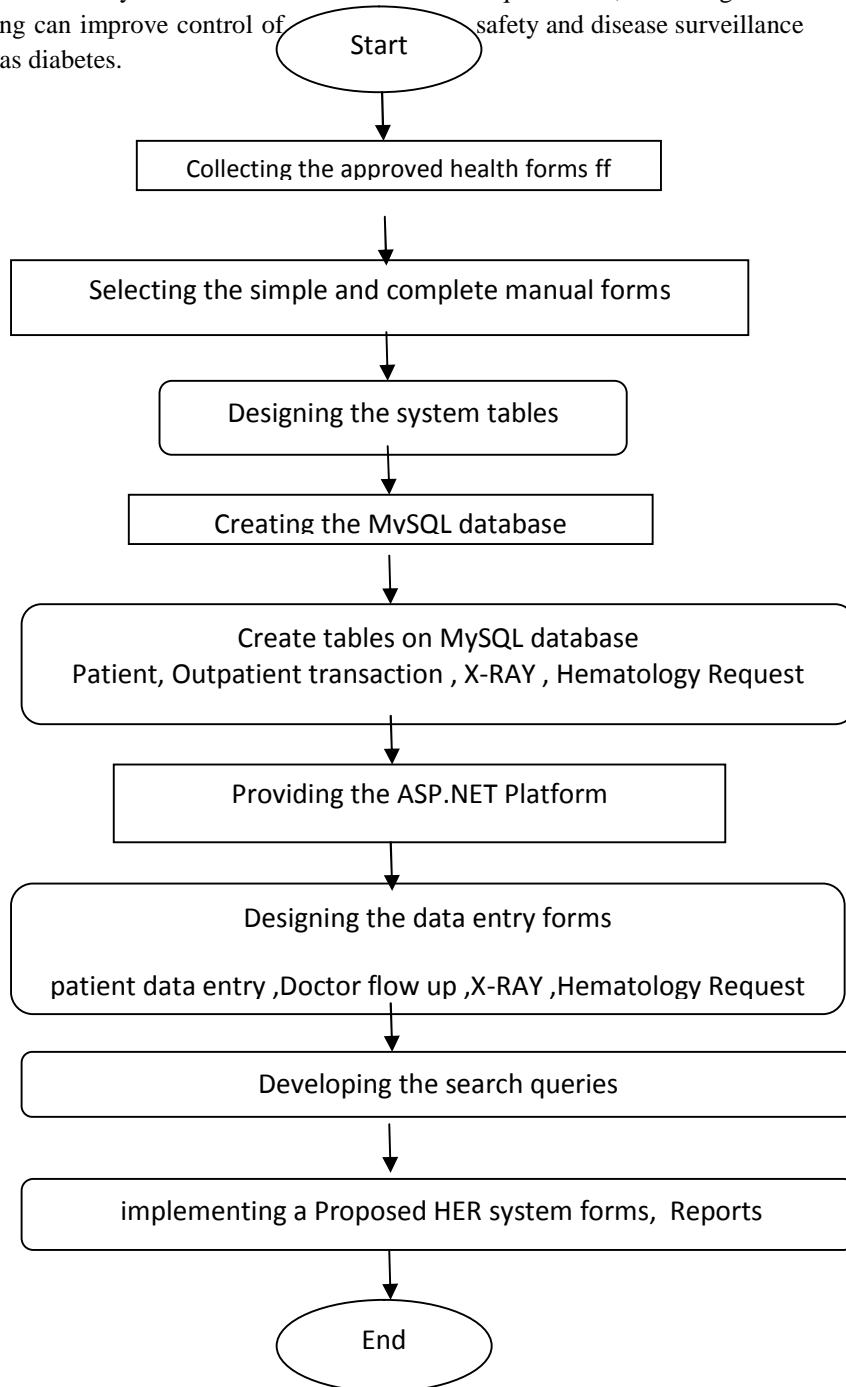
```
        ┌─────────┐
        │  Start  │
        └────┬────┘
             ▼
   ┌──────────────────────────────┐
   │ Collecting the approved      │
   │ health forms ff              │
   └──────────────┬───────────────┘
                  ▼
   ┌──────────────────────────────┐
   │ Selecting the simple and     │
   │ complete manual forms        │
   └──────────────┬───────────────┘
                  ▼
   ┌──────────────────────────────┐
   │ Designing the system tables  │
   └──────────────┬───────────────┘
                  ▼
   ┌──────────────────────────────┐
   │ Creating the MvSQL database  │
   └──────────────┬───────────────┘
                  ▼
   ┌──────────────────────────────┐
   │ Create tables on MySQL       │
   │ database                     │
   │ Patient, Outpatient          │
   │ transaction, X-RAY,          │
   │ Hematology Request           │
   └──────────────┬───────────────┘
                  ▼
   ┌──────────────────────────────┐
   │ Providing the ASP.NET        │
   │ Platform                     │
   └──────────────┬───────────────┘
                  ▼
   ┌──────────────────────────────┐
   │ Designing the data entry     │
   │ forms                        │
   │ patient data entry ,Doctor   │
   │ flow up ,X-RAY ,Hematology   │
   │ Request                      │
   └──────────────┬───────────────┘
                  ▼
   ┌──────────────────────────────┐
   │ Developing the search queries│
   └──────────────┬───────────────┘
                  ▼
   ┌──────────────────────────────┐
   │ implementing a Proposed HER  │
   │ system forms,  Reports       │
   └──────────────┬───────────────┘
                  ▼
        ┌─────────┐
        │   End   │
        └─────────┘
```

Figure 4: Shows the flow chart of proposed HER system.

III. DESIGN THE ELECTRONICS FORMS FOR DATA ENTRY

Health care planning system in Saudi Arabia has different agencies that play important roles in providing health care to residents. These agencies are The Ministry of Health, The National Guard, The Ministry of Defense and Aviation, and The Ministry of Interior [13, 21]. In addition to these agencies there are specialist hospitals in Saudi Arabia that provide health care to specialist health cases. These agencies provide health care services on the basis of exclusive free health care to all citizens. In addition, the private sector in Saudi Arabia plays an increasingly significant role in the Kingdom and coordinates with the referral network and the regulatory requirements of health sector as a whole [14-19].

The design of electronics forms based on the existing manual forms

About 80% of the public hospitals operated by municipal entities across the nation today are said to be running deficits and do find themselves in severe situations as they must deal with cutback in medical costs, doctor shortages and other problems. The Ministry of health in Saudi Arabia has seen that the primary objective of both the public and private health sector is to improve the health conditions of all citizens through the provision of comprehensive preventive and curative health services throughout the Kingdom, with particular emphasis on equitable and efficient primary health care (ibid) [5, 20].

Figure 5: Shows Login and registering web forms

```
While read.Read()
If TextUserId.Text = read.Item("UserId").ToString And
Textpassword.Text = read.Item("UserPassword").ToString
Then Response.Redirect("Default.aspx")
Label2.Text = "login successful"
End While
Else
Label2.Text = "login UN successful"
End If
read.Close()
Catch ex As Exception
Response.Write(ex.Message())
Finally
myConnection.Close()
End Try
```

B- Improved Patient Safety

Hospitals report that EHRs have been "life savers" by preventing drug interactions, allergy conflicts, and error in ordering, filling, and administering drugs through functions that compare physicians' orders against standards and verify a patient is receiving the right medication or treatment. The Sentara health system calculated that it avoided 117,400 potential medication errors due to medication barcoding. Gunderson reports in a published study that after implementing its EHR, medication errors per 1,000 hospital days decreased from 17.9 to 15.4. The percentage of medication events (injury caused by a drug) that were medication errors decreased from 66.5 percent to 55.2 percent. [11-15]

eh

C- Defining the database connection of table Users

Figure 6: Shows the main web form of the electronics health system

```
 Dim myConnection As New SqlConnection(SqlDataSource6.ConnectionString)
 Dim myCommand As New SqlCommand("SELECT
PatientNumber,PatientName,CardNumber,Nationality,xtype,Address,
Department,PhoneNumber,age,Consaltant,jobtype,Relegion from Patients wEHR e PatientNumber=" &
TextBox1.Text, myConnection)
  Dim insertSQL As New StringBuilder
    Dim myConnection As New SqlConnection(SqlDataSource3.ConnectionString)
    insertSQL.Append("INSERT INTO PATIENTS
(PatientNumber,PatientName,CardNumber,Nationality,xtype,Address,
Department,PhoneNumber,age,Consaltant,motEHR Name,jobtype,Relegion)")
insertSQL.Append("VALUES(@PatientNumber,@PatientName,@CardNumber,
@Nationality,@xtype,@Address,@Department,@PhoneNumber,@age,
@Consaltant,@motEHR Name,@jobtype,@Relegion)")
    Dim myCommand As New SqlCommand()
    myCommand.Connection = myConnection
    myCommand.CommandText = insertSQL.ToString()
    With myCommand.Parameters
```

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Figure 7: Shows an adding new patient record web form on the local host

Figure 8: Shows a Master detail of patients and outpatients web form.

A message of "RECORD WAS ADDED SUCUSSFULLY " shown after running the patient web form on the local hot web Master detail on Searching The patient form was linked by the gird view of outpatients data see figure 9. Linking the two tables was done by the patient number using the code using vb.net language and My SQL.

Figure 9: Shows a configure of select statements of the outpatient table fields using SQL server wizard
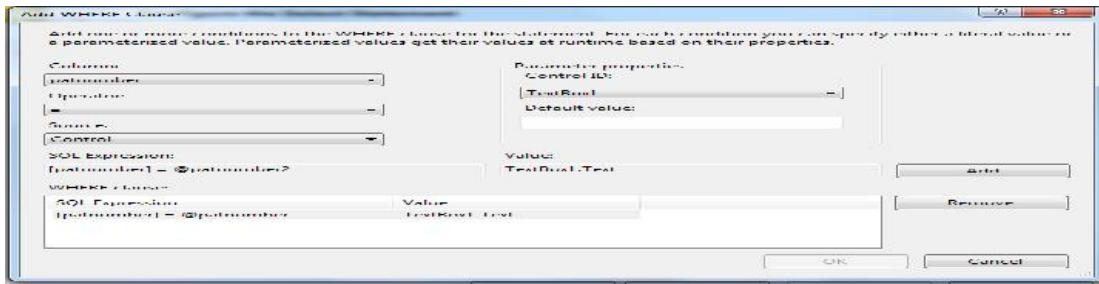
Figure 10: Shows an add a where clause Statement

By selecting the patient number in textbox.text entered by the user Using operator control for the wEHR e clause " SELECT [patnumber], [VistDate], [ReasonOfVist], [Weight], [BludPrure], [Plus], [History], [Treatment], [NextApointment], [Ivestigatio], [Problem] FROM [Outatients] WEHR E ([patnumber] = @patnumber)"
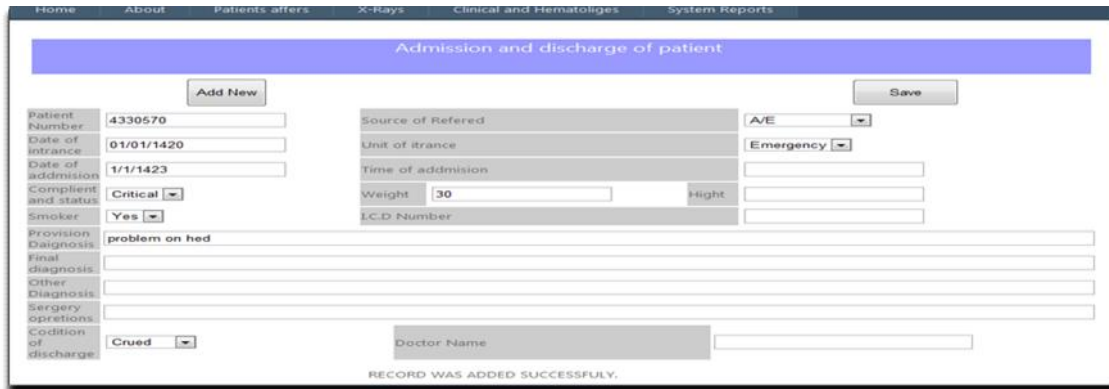

Figure 7: Shows an adding admission and discharge of patients web form

```vb
Dim insertSQL As New StringBuilder
Dim myConnection As New SqlConnection(SqlDataSource1.ConnectionString)
insertSQL.Append("INSERT INTO Outatients (patnumber, VistDate, ReasonOfVist,
Weight, BludPrure, Plus, History, Treatment,    Problem, Planing,Ivestigatio,
PrlimanaryTreatment,RfereedForConsulation, NextApointment, drName )")
insertSQL.Append("VALUES(@patnumber, @VistDate, @ReasonOfVist,@Weight,
@BludPrure, @Plus, @History, @Treatment, @Problem, @Planing,@Ivestigatio,
@PrlimanaryTreatment,@RfereedForConsulation, @NextApointment, @drName)")
Dim myCommand As New SqlCommand()
myCommand.Connection = myConnection
myCommand.CommandText = insertSQL.ToString()
With myCommand.Parameters                'Do this next
   .AddWithValue("@Patnumber", TextBox16.Text)
   .AddWithValue("@VistDate", TextBox17.Text)
   .AddWithValue("@ReasonOfVist", DropDownList1.Text)
 End With
Dim successBoolean As Boolean = True
  Try      myConnection.Open()
     successBoolean = myCommand.ExecuteNonQuery
    Label1.Text = "RECORD  WAS ADDED SUCCESSFULY."
    Label1.Visible = True
     Catch ex As Exception
       successBoolean = False
       Label1.Text = "Error inserting story. " & ex.Message
       Label1.Visible = True
    Finally          myConnection.Close()
    End Try
```
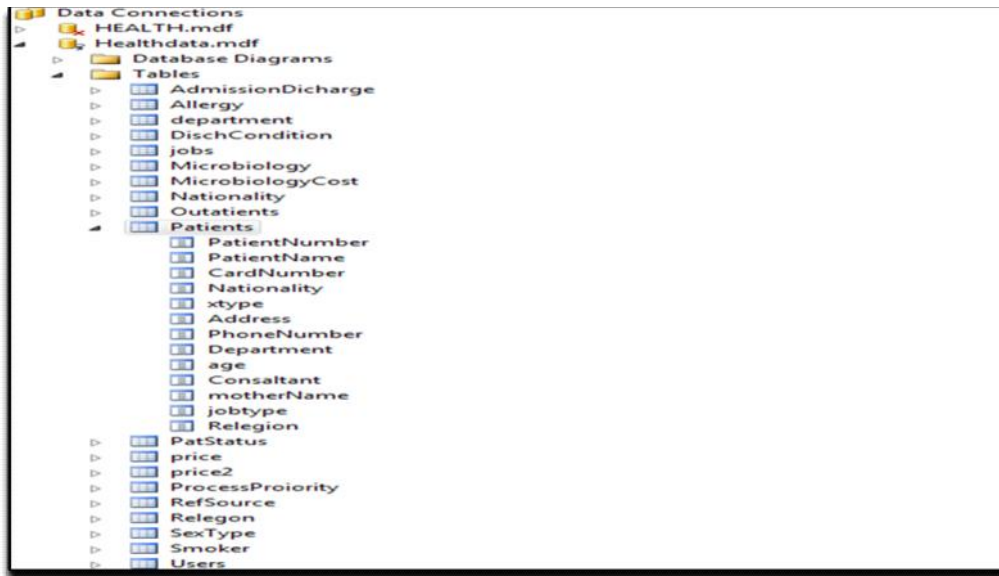
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Figure 8: Shows the electronics health record system tables in SQL Server

Figure 9: Shows a Searching and chaining data of patients web form

```
Try
    myConnection.Open()
    Dim read As SqlDataReader = myCommand.ExecuteReader()
    If read.HasRows Then
        read.Read()
        'Do this next
        TextBox1.Text = read.Item("PatientNumber").ToString
        TextBox2.Text = read.Item("PatientName").ToString
        TextBox3.Text = read.Item("CardNumber").ToString
        DropDownList4.Text = read.Item("Nationality").ToString
        DropDownList1.Text = read.Item("xtype").ToString
        TextBox4.Text = read.Item("Address").ToString
        DropDownList3.Text = read.Item("Department").ToString
        TextBox5.Text = read.Item("PhoneNumber").ToString
        TextBox8.Text = read.Item("age").ToString
        TextBox6.Text = read.Item("Consaltant").ToString
        DropDownList5.Text = read.Item("jobtype").ToString
        DropDownList6.Text = read.Item("Relegion").ToString
    End Sub
```

Figure 10: showing a web for x-rey records field component in design stage.

```
With myCommand.Parameters
'Do this next
.AddWithValue(" @PatientNumber", TextBox1.Text)
.AddWithValue(" @TypeofRequest", DropDownList1.Text)
.AddWithValue(" @Allergies", DropDownList4.Text)
.AddWithValue("  @L_M_D,Contraceptive_Pill", TextBox3.Text)
.AddWithValue(" @Pregnant", DropDownList3.Text)
.AddWithValue(" @Examinatio_Request", TextBox4.Text)
.AddWithValue(" @Brief_Clinical_Description", TextBox5.Text)
.AddWithValue(" @Diagnosis", TextBox6.Text)
.AddWithValue("@X_rayDate", TextBox7.Text)
……………..
………….
End With
```


Figure 11: Showing web for microbiology records

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```
The checkbox code system
Showing the cost of the treatment was given from the table of costing
    While read.Read()
If CheckBox26.Checked = True And read.Item("Prno").ToString = 26 Then TextBox32.Text =
read.Item("PrValue").ToString ': valuetot += read.Item("PrValue")
Calculating of the fees code
Dim TOT As Decimal = 0
    TOT = Val(TextBox32.Text) + Val(TextBox7.Text) + Val(TextBox8.Text) + Val(TextBox9.Text) +
Val(TextBox10.Text) + Val(TextBox11.Text) + Val(TextBox12.Text) +
Val(TextBox13.Text) + Val(TextBox14.Text) + TextBox30.Text = TOT
```

IV- BENEFITS OF PROPOSED EHRS

The benefits of EHRs offer far more than a paper record can. EHRs in KSA hospitals:

1- Improve quality and convenience of patient care.
2- Increase patient participation in their care.
3- Improve accuracy of diagnoses and health outcomes.
4- Improve care coordination.
5- Increase practice efficiencies and cost savings.
6- Designing the EHR system with RDBMS and XML.
7- Implementing the EHR system in the web using ASP.net and PHP programming.

V- CONCLUSION & FUTURE WORK

This research provides recommended actions to support the development of an objective EHR usability evidence base and formative policies to systematically improve the usability of EHR systems. In a companion document, Electronic Health Record Usability: Evaluation and Use Case Framework, the evolving role of EHRs and the need for a practical, common evaluation framework is discussed. Information design principles tailored to EHR, considerations along with initial approaches to heuristic usability evaluation and representative use cases are also provided. These two companion documents on EHR usability are intended to foster discussion on the importance of usability and guide federally funded research activities as well as inform policy development in this area. Through collaborative efforts between physicians, researches, and vendors these recommendations and frameworks can be further refined to promote the necessary industry focus on EHR design and its significance to consistently delivering desired improvements in care quality and efficiency. Finally, the proposed system will be developed using ASP.NET as a technology of web based system. In this paper; most of the services, enjoyed on the Web are provided by web database applications and using .net technology. Such as, Web-based email, online shopping, forums and bulletin boards, corporate web sites, and sports and news portals are all database-driven. The main goals in this work, building a modern web site of electronic health record system in KSA hospitals. In the future work the electronic health care system will be developed using Oracle Data base and PHP.

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