CIS-9340 (URA)
Principles of Database Management Systems
GROUP 14

Project:
Family Doctor Office Database Management

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Business Scenario:

Doctor's Offices are typically very traditional and old fashioned. The logistics are often maintained by physical files and require a secretary for appointment booking. This is mainly caused by the fact that (due to lengthy academical programs) the average age of doctors is significantly higher than other professions. The average age of actively licensed physicians is now 51, according to the 2016 United States Census. This sector is amongst the last to join the digitalization era.

We developed a database for a primary doctors' office to keep track of patients' visits and their billing record.

Our primary care doctor's office has multiple doctors, nurses, and secretaries. The doctors provide consultation, prescribe medicine, and refer patients to specialty doctors for specific medical testing. The nurses assist doctors with routine tasks, such as drawing blood for laboratories, injecting vaccines, and performing physical examinations. Secretaries manage patient appointments and keep track of billing records.

Services provided include consultation, annual checkup, vaccine injection, etc. Each service provided is subject to charge. Service invoices are billed to the insurance company or the patients or both depending on the patients' insurance policy.

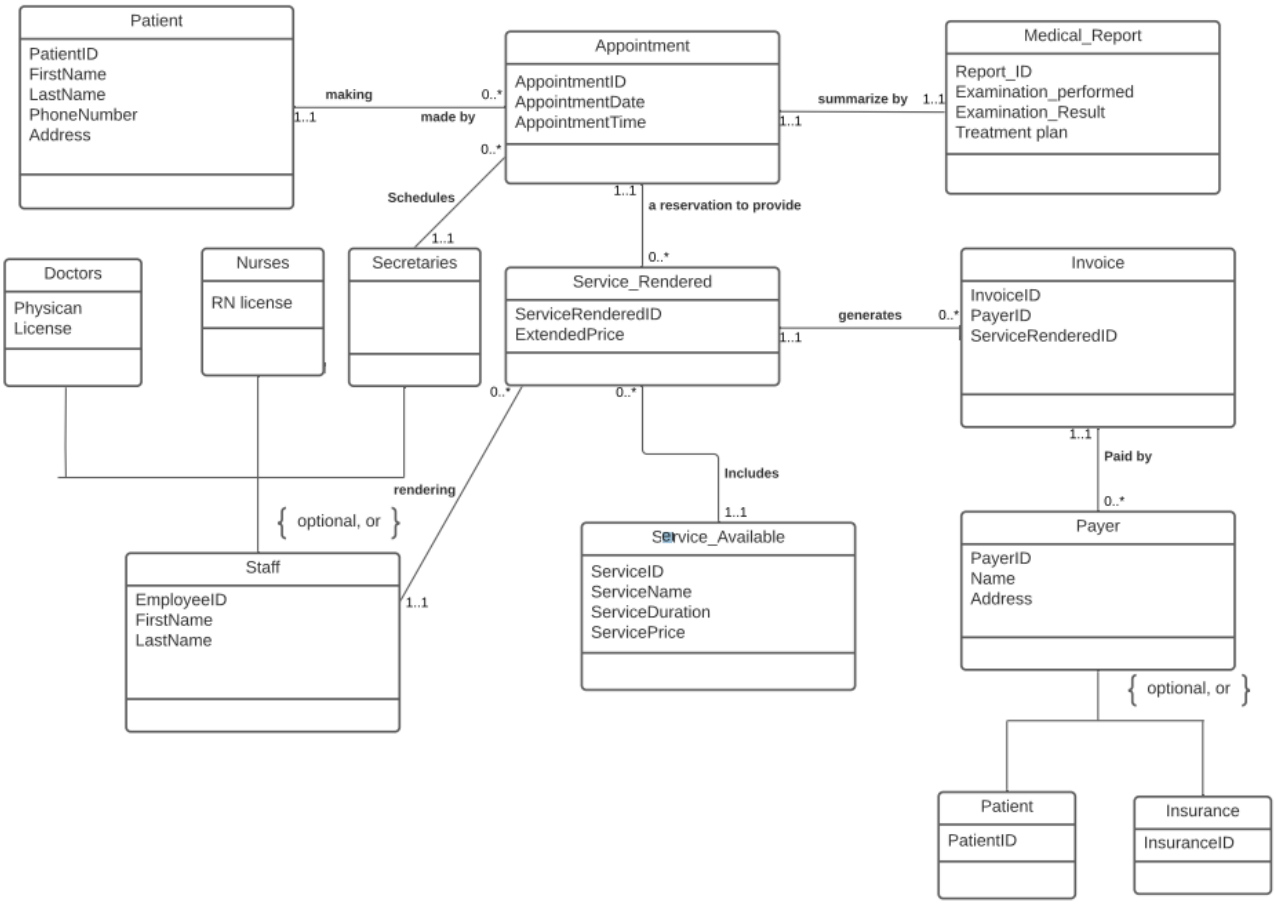
Each patient is assigned to one primary doctor and appointment is required for an office visit. Patients can schedule one or more services in one appointment. If patients are calling for a first time, a new patient file would need to be created. A patient file typically contains information such as name, address, email, date of birth, pharmacy, appointments (past and future), medical test results and previous doctor's notes. Each appointment will involve one or more staff (secretaries for check-in, doctors for consultation, nurses for performing routine tasks).

For each appointment, the doctor will write a medical report to summarize the examination performed, results and treatment plans.

The entities would contain:

- Staff (Doctors, Nurses, and Secretaries)
- Appointments
- Services_Rendered
- Services_Available
- Patients
- Payer
- Medical_Report
- Invoice

Entity Relationship Model Diagram:



Relationship sentences:

Conversion of the E-R model into a relational model:

- Patient (PatientNumber, FirstName, LastName, PhoneNumber, Address)
- Appointment (AppointmentID, AppointmentDate, AppointmentTime, PatientID(fk), EmployeeID(fk))
- Medical_Report(ReportID, Examination_performed, Examination_Result, Treatment_plan)
- Staff (EmployeeID, FirstName, LastName, Physician_License, RN_License)
- Service_Rendered (ServiceRenderedID, ExtendedPrice, AppointmentID(fk), ServiceID(fk), EmployeeID(fk))
- Service_Rendered (ServiceID, ServiceName, ServiceDuration, ServicePrice)
- Invoice (InvoiceID, PayerID(fk), ServiceRenderedID(fk), InvoiceDate)
- Payer (PayerID, PatientID(fk), InsuranceID, Name, Address)

Normalized the relationship diagram:

1. Patient table:
   Patient (PatientNumber, FirstName, LastName, PhoneNumber, Address)
   a) Key: PatientNumber
   b) Functional dependency:
      FD1: PatientNumber -> FirstName, LastName, PhoneNumber, Address
   c) Having keys? Yes, it's in INF
   d) Any partial dependency? No, it's in 2NF
   e) Any transitive dependency? No, it's 3NF
   f) Any determinants are not candidate keys? No, it's in BCNF

   Summary: R1(PatientNumber, FirstName, LastName, PhoneNumber, Address)

2. Appointment table:
   Appointment (AppointmentID, AppointmentDate, AppointmentTime)

a) Key: AppointmentID
b) Functional dependency:
   FD1: AppointmentID -> AppointmentDate, AppointmentTime
c) Having keys? Yes, it's in INF
d) Any partial dependency? No, it's in 2NF
e) Any transitive dependency? No, it's 3NF
f) Any determinants are not candidate keys? No, it's in BCNF

Summary: R1(AppointmentID, AppointmentDate, AppointmentTime)

3. Medical_Report table:
   Medical_Report(ReportID, Examination_performed, Examination_Result, Treatment_plan)
   a) Key: ReportID
   b) Functional dependency:
      FD1: ReportID -> Examination_performed, Examination_Result, Treatment_plan
      FD2: Examination_Result -> Examination_performed
   c) Having keys? Yes, it's in INF
   d) Any partial dependency? No, it's in 2NF
   e) Any transitive dependency? Yes, Examination_Result -> Examination_performed
      R1(Examination_Result, Examination_performed)
      R2(ReportID, Examination_Result, Treatment_plan)
      Check if any transitive dependency in both tables, no more. it's in 3NF.
   f) Any determinants are not candidate keys? No, it's in BCNF

   Summary:R1(Examination_Result, Examination_performed)o
   R2(ReportID, Examination_Result, Treatment_plan)

4. Staff table:
   Staff (EmployeeID, FirstName, LastName, Physician_License, RN_License)
   a) Key: EmployeeID
   b) Functional dependency:
      FD1: EmployeeID ->FirstName, LastName
   c) Having keys? Yes, it's in INF
   d) Any partial dependency? No, it's in 2NF
   e) Any transitive dependency? No, it's in 3NF
   f) Any determinants are not candidate keys?
      Yes: Physician_License > EmployeeID
      RN_License >EmployeeID
      R1 (Physician_License , EmployeeID)
      R2 (RN_License, EmployeeID)

R3 (EmployeeID, FirstName, LastName)
Check if determinants are not candidate keys, no more, it's in BCNF.

Summary: R1 (Physician_License , EmployeeID)
R2 (RN_License, EmployeeID)
R3 (EmployeeID, FirstName, LastName)

5. Service_Rendered table:
   Service_Rendered (ServiceRenderedID, ExtendedPrice)
   a) Key: ServiceRenderedID
   b) Functional dependency:
      FD1: ServiceRenderedID-> ExtendedPrice
   c) Having keys? Yes, it's in INF
   d) Any partial dependency? No, it's in 2NF
   e) Any transitive dependency? No, it's in 3NF

   Summary: R1(ServiceRenderedID, ExtendedPrice)

6. Service_Available table:
   Service_Rendered (ServiceID, ServiceName, ServiceDuration, ServicePrice)
   a) Key: ServiceID
   b) Functional dependency:
      FD1: ServiceRenderedID -> ServiceName, ServiceDuration, ServicePrice
   c) Having keys? Yes, it's in INF
   d) Any partial dependency? No, it's in 2NF
   e) Any transitive dependency? No, it's in 3NF

   Summary: R1(ServiceID, ServiceName, ServiceDuration, ServicePrice)

7. Invoice table:
   Invoice (InvoiceID, InvoiceDate)
   a) Key: InvoiceID
   b) Functional dependency:
      FD1: Invoice (InvoiceID, InvoiceDate)
   c) Having keys? Yes, it's in INF
   d) Any partial dependency? No, it's in 2NF
   e) Any transitive dependency? No, it's in 3NF

   Summary: R1(InvoiceID, InvoiceDate)

8. Payer table:
   Payer (PayerID, Name, Address)

a) Key: PayerID
b) Functional dependency:
   FD1: PatientID -> Name, Address
c) Having keys? Yes, it's in INF
d) Any partial dependency? No, it's in 2NF
e) Any transitive dependency? No, it's in 3NF

Summary: R1(PayerID, Name, Address)

SQL CREATE TABLE statements:

```
CREATE TABLE Patient (
PatientID NUMBER NOT NULL,
FirstName Varchar(20),
LastName Varchar(20),
PhoneNumber Varchar(20),
Address Varchar(100),
CONSTRAINT pk_patient PRIMARY KEY (PatientID)
);

CREATE TABLE Appointment (
AppointmentID NUMBER NOT NULL,
AppointmentDate DATE NOT NULL,
AppointmentTime TIME NOT NULL,
PatientID NUMBER NOT NULL,
EmployeeID VARCHAR(20) NOT NULL,
CONSTRAINT pk_appointment PRIMARY KEY (AppointmentID),
CONSTRAINT fk_appointment_Patient FOREIGN KEY (PatientID) REFERENCES Patient,
CONSTRAINT fk_appointment_Employee FOREIGN KEY (EmployeeID) REFERENCES Staff
);

CREATE TABLE Medical_Report (
ReportID VARCHAR(20) NOT NULL,
Examination_performed VARCHAR(20),
Examination_Result VARCHAR(20),
Treatment_plan VARCHAR(20),
AppointmentID NUMBER NOT NULL,
CONSTRAINT pk_medicalreport PRIMARY KEY (ReportID),
CONSTRAINT fk_appointment_Medical_Report FOREIGN KEY (AppointmentID ) REFERENCES
Appointment

);
```

```
CREATE TABLE Staff (
EmployeeID VARCHAR(20) NOT NULL,
FirstName VARCHAR(20),
LastName VARCHAR(20),
Physician_License VARCHAR(50),
RN_License VARCHAR(50),
CONSTRAINT pk_staff PRIMARY KEY (EmployeeID)
);

CREATE TABLE Service_Rendered (
ServiceRenderedID VARCHAR(20) NOT NULL,
ExtendedPrice FLOAT,
AppointmentID NUMBER NOT NULL,
PatientID NUMBER NOT NULL,
ServiceID VARCHAR(20) NOT NULL,
EmployeeID VARCHAR(20) NOT NULL,
CONSTRAINT pk_servicerendered PRIMARY KEY (ServiceRenderedID),
CONSTRAINT fk_servicerendered FOREIGN KEY (AppointmentID) REFERENCES Appointment,
CONSTRAINT fk2_servicerendered FOREIGN KEY (ServiceID) REFERENCES Service,
CONSTRAINT fk3_servicerendered FOREIGN KEY (EmployeeID) REFERENCES Staff,
CONSTRAINT fk4_servicerendered FOREIGN KEY (PatientID) REFERENCES Patient
);


CREATE TABLE Service (
ServiceID VARCHAR(20) NOT NULL,
ServiceName VARCHAR(20),
ServiceDuration NUMBER,
ServicePrice FLOAT,
CONSTRAINT pk_servicerendered PRIMARY KEY (ServiceID)
);

CREATE TABLE Invoice (
InvoiceID VARCHAR(20) NOT NULL,
PayerID VARCHAR(20) NOT NULL,
ServiceRenderedID Varchar(20) NOT NULL,
InvoiceDate DATE,
CONSTRAINT pk_invoice PRIMARY KEY (InvoiceID),
CONSTRAINT fk_invoice FOREIGN KEY (PayerID) REFERENCES Payer,
CONSTRAINT fk2_invoice FOREIGN KEY (ServiceRenderedID) REFERENCES Service_Rendered
);

CREATE TABLE Payer (
PayerID VARCHAR(20) NOT NULL,
```

```
PatientID NUMBER NOT NULL,
InsuranceID VARCHAR(20) NOT NULL,
FirstName VARCHAR(20),
LastName VARCHAR(20),
Address VARCHAR(100),
CONSTRAINT pk_payer PRIMARY KEY (PayerID),
CONSTRAINT fk_payer FOREIGN KEY (PatientID) REFERENCES Patient
);
```

SQL INSERT statements:

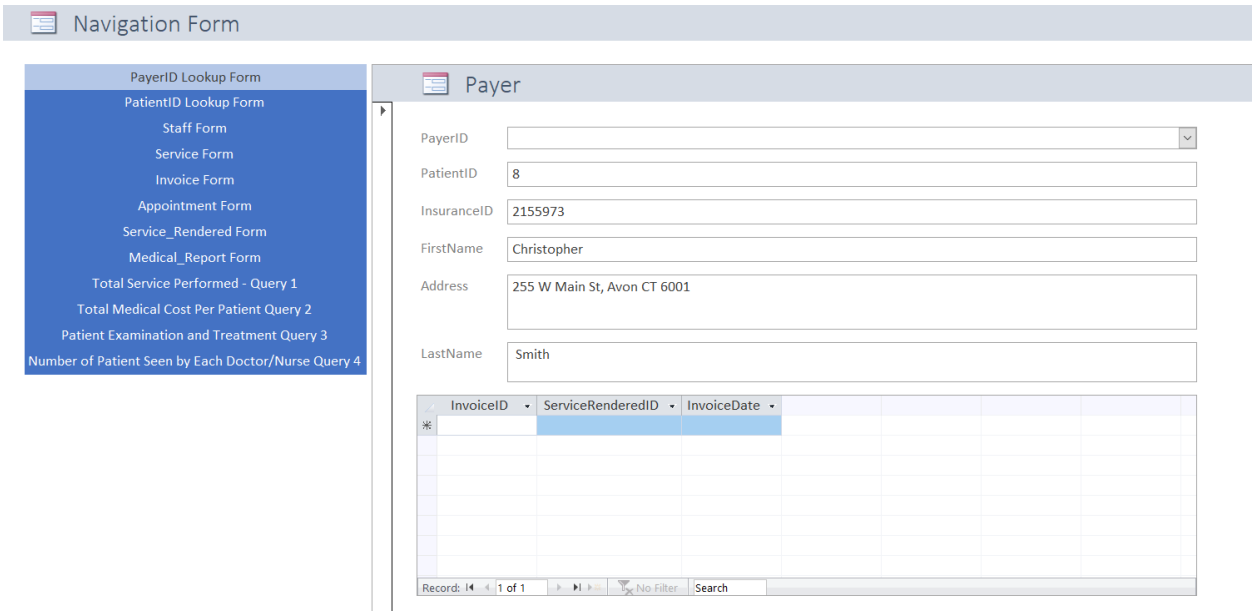
```
INSERT INTO Payer(PayerID, PatientID, InsuranceID, FirstName, LastName, Address)
VALUES (1 , 8, '2155973', 'Christopher', 'Smith', '255 W Main St, Avon CT 6001')
INSERT INTO Payer(PayerID, PatientID, InsuranceID, FirstName, LastName, Address)
VALUES (2 , 9, '1311781', 'Daniel', 'Johnson', '120 Commercial Parkway, Branford CT 6405')

INSERT INTO Patient ( PatientID, FirstName, LastName, PhoneNumber, Address )
VALUES(1, 'Christopher', 'Smith' , '+1 364-555-5812' , '777 Brockton Avenue, Abington MA 2351'
)
INSERT INTO Patient ( PatientID, FirstName, LastName, PhoneNumber, Address )
VALUES(2, 'Daniel', 'Johnson' , '+1 203-912-9983' , '30 Memorial Drive, Avon MA 2322' )


INSERT INTO Staff ( EmployeeID, FirstName ,LastName, RN_License )
VALUES ('1', 'James',  'Martinez','R5988061N')
INSERT INTO Staff ( EmployeeID, FirstName ,LastName, Physician_License)
VALUES ('2', 'John',  'Hernandez','D7731477OC')

INSERT INTO Service (ServiceID, ServiceName, ServiceDuration,ServicePrice )
VALUES ('1', 'Flu shots', 15, 50)
INSERT INTO Service (ServiceID, ServiceName, ServiceDuration,ServicePrice )
VALUES ('2', 'Laboratory testing', 20, 150)

INSERT INTO Invoice  (InvoiceID, PayerID, ServiceRenderedID, InvoiceDate )
VALUES('1', '64', '17', '12/18/2017')
INSERT INTO Invoice  (InvoiceID, PayerID, ServiceRenderedID, InvoiceDate )
VALUES('2', '43', '2', '12/28/2017')
```

INSERT INTO Appointment (AppointmentID, AppointmentDate, AppointmentTime, PatientID, EmployeeID)
VALUES (1, '12/14/2017', ‘9:00', 95, '17')
INSERT INTO Appointment (AppointmentID, AppointmentDate, AppointmentTime, PatientID, EmployeeID)
VALUES (2, '12/18/2017', ‘11:00', 92, '5')

INSERT INTO Service_Rendered (ServiceRenderedID, ExtendedPrice, AppointmentID, PatientID, ServiceID, EmployeeID)
VALUES ('1',   67, 27, 14, '7' , '11')
INSERT INTO Service_Rendered (ServiceRenderedID, ExtendedPrice, AppointmentID, PatientID, ServiceID, EmployeeID)
VALUES ('2', 50, 23, 56, '10' , '12')

INSERT INTO Medical_Report(ReportID, Examination_performed, Examination_Result, Treatment_Plan, AppointmentID)
VALUES ('1', 'XRAY','Medium', 'Medication',21)
INSERT INTO Medical_Report(ReportID, Examination_performed, Examination_Result, Treatment_Plan, AppointmentID)
VALUES ('2', 'Physical','Good', 'Specialist',6)

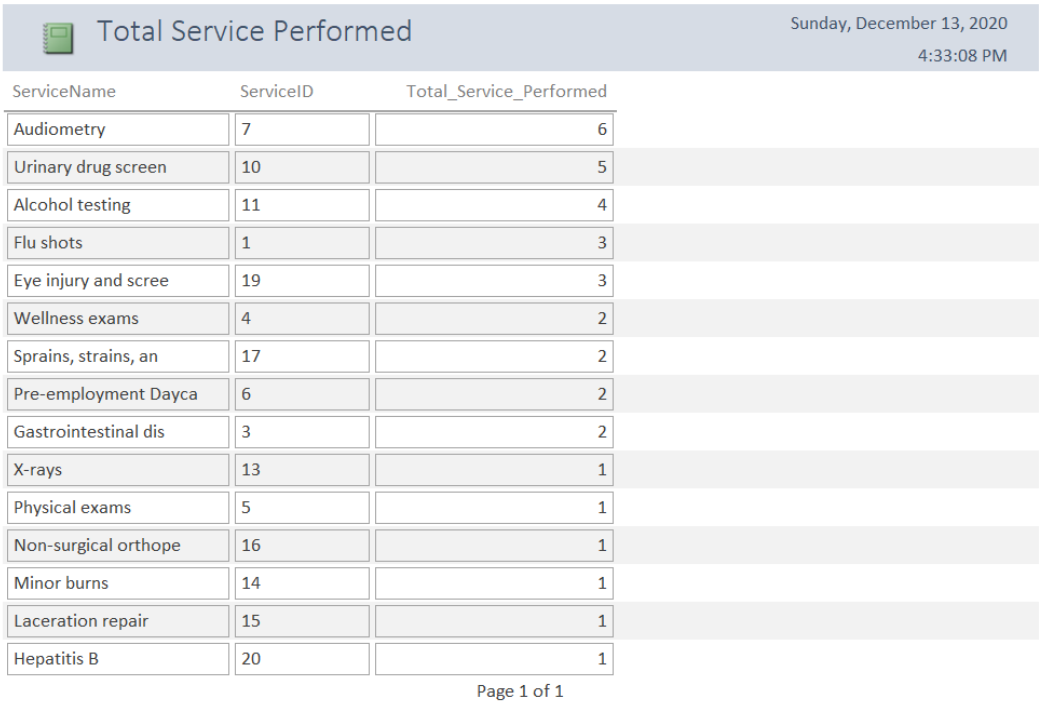
Navigation Form:



Queries and Reports:

1.Find the service that was performed the most at the doctor office

```
SELECT ServiceName, sr.ServiceID, COUNT(sr.ServiceID) AS
Total_Service_Performed
FROM service_rendered AS sr, service AS s
WHERE sr.serviceid =  s.serviceid
GROUP BY ServiceName, sr.ServiceID
ORDER BY COUNT(sr.ServiceID) DESC;
```



Total Service Performed

Sunday, December 13, 2020
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ServiceName	ServiceID	Total_Service_Performed
Audiometry	7	6
Urinary drug screen	10	5
Alcohol testing	11	4
Flu shots	1	3
Eye injury and scree	19	3
Wellness exams	4	2
Sprains, strains, an	17	2
Pre-employment Dayca	6	2
Gastrointestinal dis	3	2
X-rays	13	1
Physical exams	5	1
Non-surgical orthope	16	1
Minor burns	14	1
Laceration repair	15	1
Hepatitis B	20	1

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2.Find the total medical cost of each patient and display their address

```
SELECT p.firstname, p.lastname, p.address, s.extendedprice AS Total_medical_cost
FROM patient AS p, service_rendered AS s, invoice AS i
WHERE s.ServiceRenderedID = i.ServiceRenderedID AND p.PatientID = S.PatientID
GROUP BY p.firstname, p.lastname, p.address, s.extendedprice;
```

Total Medical Cost Per Patient

Sunday, December 13, 2020
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firstname	lastname	address	Total_medical_cost
Lawrence	Anderson	6438 Basile Rowe, East Syracuse NY 13057	100
Carol	Baker	750 Middle Country Road, Middle Island NY 11953	133
Jerry	Flores	550 Providence Hwy, Walpole MA 2081	133
Keith	Garcia	100 Thruway Plaza, Cheektowaga NY 14225	50
Austin	Gonzalez	279 Troy Road, East Greenbush NY 12061	33
Sean	Hernandez	85 Crooked Hill Road, Commack NY 11725	50
Dorothy	Hill	7155 State Rt 12 S, Lowville NY 13367	67
Kenneth	Martinez	374 William S Canning Blvd, Fall River MA 2721	150
Paul	Miller	55 Brooksby Village Way, Danvers MA 1923	67
Stephanie	Mitchell	41 Anawana Lake Road, Monticello NY 12701	100
Gary	Perez	830 Curran Memorial Hwy, North Adams MA 1247	100
Laura	Roberts	1201 Rt 300, Newburgh NY 12550	67
Stephen	Sanchez	72 Main St, North Reading MA 1864	67
Timothy	Taylor	20 Soojian Dr, Leicester MA 1524	50
Nicholas	Thompson	1470 S Washington St, North Attleboro MA 2760	100
Patrick	Torres	100 Charlton Road, Sturbridge MA 1566	117
Sandra	Torres	579 Troy-Schenectady Road, Latham NY 12110	17
George	Wilson	295 Plymouth Street, Halifax MA 2338	67

3. Display the appointment number, date, patient first name, doctor first name, what examination was performed and the type of treatment.

```
SELECT a.appointmentid, a.appointmentdate, p.firstname AS Patient_FirstName,
s.firstname AS Doctor_FirstName, m.Examination_performed, m.Treatment_plan
FROM medical_report AS m, appointment AS a, patient AS p, staff AS s
WHERE m.appointmentid = a.appointmentid AND a.patientid = p.patientid AND
a.employeeid = s.employeeid;
```

Patient Examination and Treatment

Sunday, December 13, 2020
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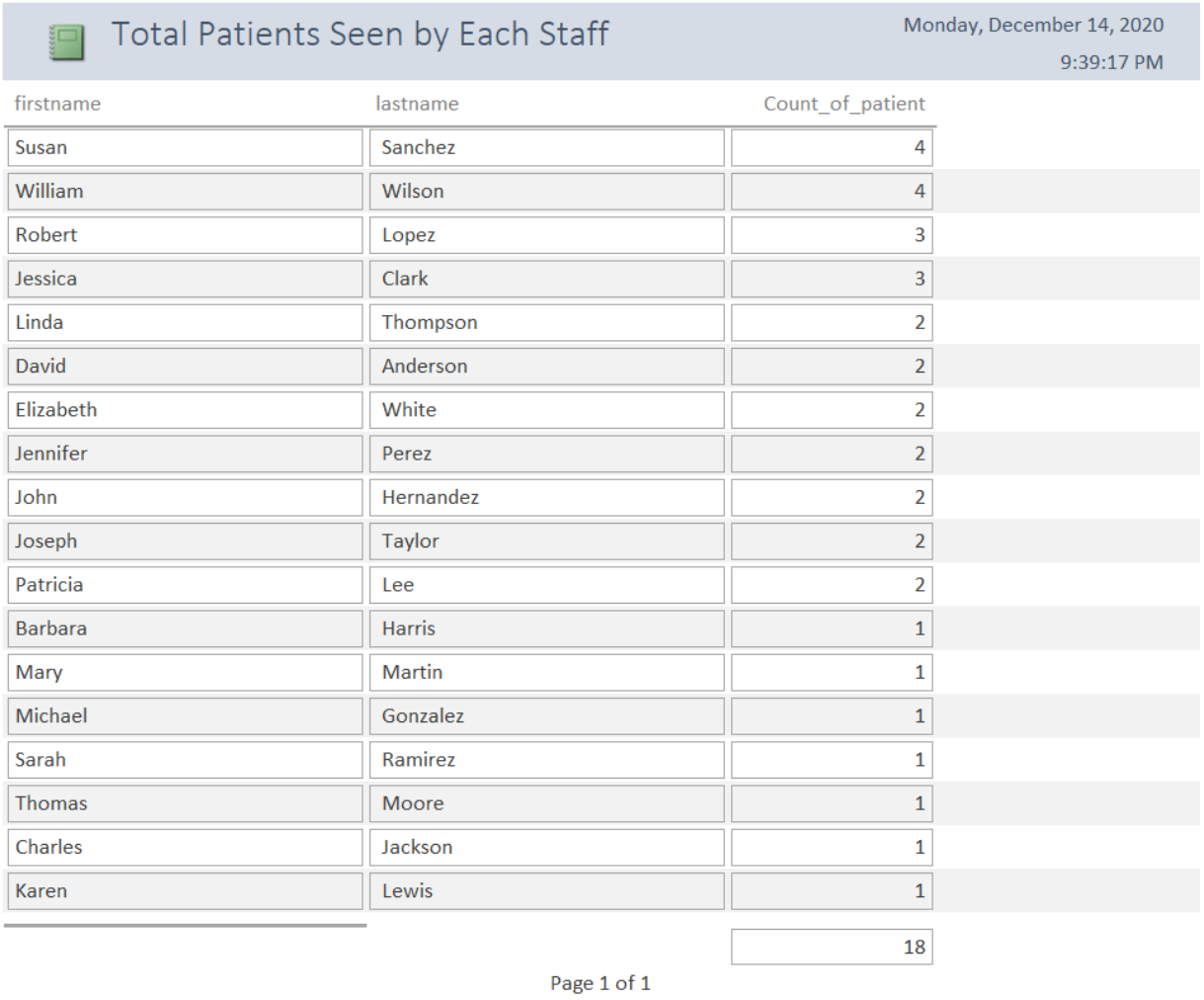
appointmentid	appointmentdate	Patient_FirstName	Doctor_FirstName	Examination_performed	Treatment_plan
1	12/14/2017	Amanda	Susan	General	Nothing
1	12/14/2017	Amanda	Susan	XRAY	Physical Therapy
3	12/22/2017	Douglas	John	XRAY	Medication
3	12/22/2017	Douglas	John	XRAY	Physical Therapy
4	12/26/2017	Juan	William	BloodTest	ER
5	12/30/2017	Bryan	Jessica	Mental	ER
6	1/3/2018	Timothy	Mary	Physical	Specialist
8	1/11/2018	Aaron	Robert	General	ER
8	1/11/2018	Aaron	Robert	Mental	Medication
9	1/15/2018	Jacob	Linda	General	Nothing
9	1/15/2018	Jacob	Linda	XRAY	Nothing
10	1/19/2018	Ashley	Jennifer	General	ER
13	1/31/2018	Alexander	Charles	General	Nothing
15	2/8/2018	Nancy	Jessica	General	ER
19	2/24/2018	Michelle	John	General	Physical Therapy
19	2/24/2018	Michelle	John	Mental	ER
19	2/24/2018	Michelle	John	BloodTest	Medication
19	2/24/2018	Michelle	John	General	Physical Therapy
21	3/4/2018	Terry	Susan	XRAY	Medication
21	3/4/2018	Terry	Susan	XRAY	Nothing
21	3/4/2018	Terry	Susan	BloodTest	ER
22	3/8/2018	Keith	Jennifer	Mental	ER
23	3/12/2018	Andrew	Jessica	XRAY	ER

appointmentid	appointmentdate	Patient_FirstName	Doctor_FirstName	Examination_performed	Treatment_plan
24	3/16/2018	Rebecca	Barbara	BloodTest	Nothing
25	3/20/2018	Logan	Thomas	Mental	Medication
25	3/20/2018	Logan	Thomas	General	Medication
28	4/1/2018	Douglas	David	Mental	Medication
28	4/1/2018	Douglas	David	XRAY	Medication
30	4/9/2018	Bruce	Michael	General	Nothing
32	4/17/2018	Deborah	William	BloodTest	Nothing

4. Display the total number of patients seen by each Doctor/Nurse.

```
SELECT firstname, lastname, COUNT(patientid) AS Count_of_patient
FROM STAFF AS s, APPOINTMENT AS a
WHERE s.employeeID = a.employeeid
GROUP BY firstname, lastname
ORDER BY COUNT(patientid) DESC;
```



Total Patients Seen by Each Staff

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firstname	lastname	Count_of_patient
Susan	Sanchez	4
William	Wilson	4
Robert	Lopez	3
Jessica	Clark	3
Linda	Thompson	2
David	Anderson	2
Elizabeth	White	2
Jennifer	Perez	2
John	Hernandez	2
Joseph	Taylor	2
Patricia	Lee	2
Barbara	Harris	1
Mary	Martin	1
Michael	Gonzalez	1
Sarah	Ramirez	1
Thomas	Moore	1
Charles	Jackson	1
Karen	Lewis	1
		18

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Conclusion:

We encountered difficulties in the initial stage with our project proposal. It was difficult for us to come up with the entities, the attributes, and identify the relationships between them. We had to revise our proposal several times to meet the difficulty level. However, once the proposal is completed, the ERD is easy to do since we have already identified the necessary information.

We also encountered some pain points in the table creation process. The first thing we learned is that the sequence in which tables are inserted are important. We need to insert tables that have primary keys only first. If we want to insert a table that has dependencies with the use of foreign keys, we first need to make sure their corresponding parent tables are inserted before. Another point we observed is that for columns which share Primary Key - Foreign Key relationships,the data types need to be exactly the same across tables.

For data entry of our initial tables, we initially wanted to use SQL Insert statements, but unfortunately Access limits insertion to one entry per statement. As we had a few hundred rows to insert, we therefore had to configure an Excel file which we then inserted into our tables using the importer wizard which was significantly more efficient.

Compared to other parts, it was easier to write SQL create table statements. However, when we tried to write the statements in Access to see if it's working properly, small errors of SQL keywords such as misspelling some words occurred so we also had to revise them several times. Other than that, this would be one of the easiest parts of the project.

The database could be used to identify the most frequently requested services, track medical costs of each patient, lookup appointment information, and utilization rate of the doctors/nurses.