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Course Title: **INFO 579 SQL/NoSQL Databases**
Term name and year: **Fall 2025**
Submission Week: **Week 8 Final Project Report**
Instructor's Name: **Nayem Rahman**
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Part 1: Problem Statement & Data

Problem Statement

A hospital is seeking to implement a database system to improve the way it manages essential aspects of patient care and clinical operations. The system must store and organize information about patients, doctors, treatments, medications, and hospital departments in a structured and reliable way. Each patient may undergo multiple treatments, but only under one doctor. Departments can have many doctors, but each doctor only belongs to one department. Doctors may perform many treatments, but only within their department. By centralizing this data, the hospital can ensure accurate record keeping, streamline communication among staff, and reduce the risk of errors.

In addition to treatments, the hospital must also track medications prescribed as part of those treatments. A treatment can involve several medications, and each medication may be used in multiple types of treatments across different patients. By building this database, the hospital will gain the ability to cross-reference patients, treatments, and medications; and efficiently, generate reports for medical and administrative purposes, and ultimately provide better, more coordinated care to patients.

Raw Data

	A	B	C	D	E	F
1	**Patients**					
2	**Patient Name**	Brad Canley		Jennifer Blake		James Nguyen
3	**DOB**	1989-10-01		1978-08-10		2002-02-13
4	**Sex**	Male		Female		Male
5	**Phone**	(934) 812-0900		(230) 865-9001		(845) 135-1500
6	**Address**	12 Pond St		342 Estate Dr		1615 Lakeside Dr
7	**Doctor**	[1] Dr. Emily Carter (Oncology)		[4] Dr. Miguel Alvarez (Physical Therapy)		[10] Dr. Benjamin Cohen (Psychiatry)
8	**Treatment**	[1] Chemotherapy, [2] Radiation Therapy		[4] Physical Therapy		[8] Cognitive Behavioral Therapy
9						
10						
11						
12		Sophia Patel		Olivia Ramirez		Daniel Kim
13		1964-03-17		1980-06-07		1969-09-15
14		Female		Female		Male
15		(518) 984-6262		(520) 830-0100		(520) 245-1619
16		130 Arizona St		1500 Grant Rd		14 McKinley St
17		[2] Dr. Rajesh Kumar (Oncology)		[6] Dr. James Whitman (Cardiology)		[9] Dr. Aisha Mahmoud (Orthopedics)
18		[1] Chemotherapy, [2] Radiation Therapy, [7] Immunotherapy		[5] Coronary Bypass Surgery		[6] Joint Replacement

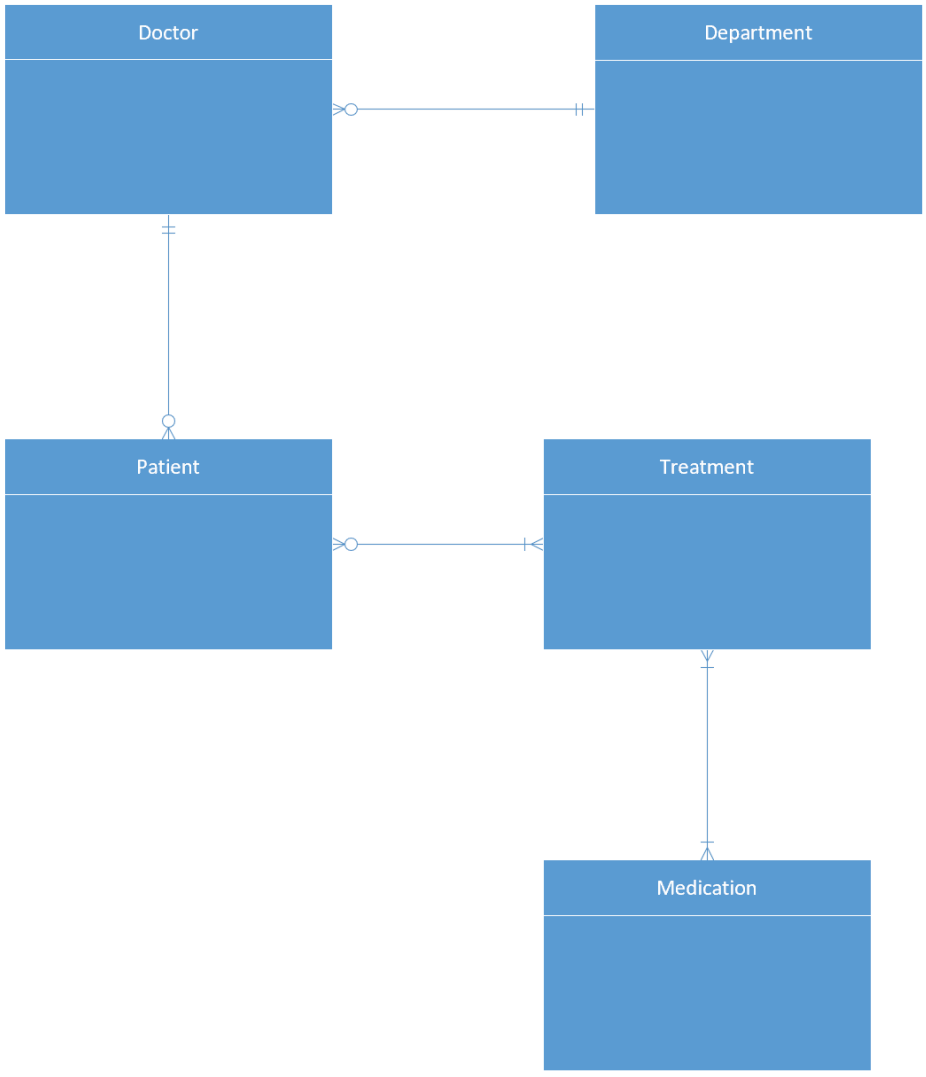
	A	B	C	D	E	F	G
1	**Doctor**		**Department**		**Treatment**		**Medication**
2	[1] Dr. Emily Carter (Oncology)		[1] Oncology (Chemotherapy, Immunotherapy, Radiation Therapy)		[1] Chemotherapy		Chemotherapy - [1] Cyclophosphamide, [2] Cisplatin, [3] Epoetin alfa, [4] Methotrexate
3	[2] Dr. Rajesh Kumar (Oncology)		[2] Dialysis Unit (Dialysis)		[2] Radiation Therapy		Radiation Therapy - [2] Cisplatin, [5] Gabapentin
4	[3] Dr. Sarah Thompson (Dialysis Unit)		[3] Physical Therapy (Physical Therapy)		[3] Dialysis		Dialysis - [3] Epoetin alfa, [6] Furosemide, [7] Heparin
5	[4] Dr. Miguel Alvarez (Physical Therapy)		[4] Cardiology (Coronary Bypass Surgery)		[4] Physical Therapy		Physical Therapy - [8] Aspirin, [9] Acetaminophen
6	[5] Dr. Hannah Lee (Physical Therapy)		[5] Orthopedics (Joint Replacement)		[5] Coronary Bypass Surgery		Coronary Bypass Surgery - [8] Aspirin, [7] Heparin, [6] Furosemide, [9] Acetaminophen
7	[6] Dr. James Whitman (Cardiology)		[6] Psychiatry (Cognitive Behavioral Therapy)		[6] Joint Replacement		Joint Replacement - [8] Aspirin, [5] Gabapentin, [9] Acetaminophen
8	[7] Dr. Olivia Rossi (Cardiology)				[7] Immunotherapy		Immunotherapy - [1] Cyclophosphamide, [4] Methotrexate
9	[8] Dr. Daniel Okafor (Cardiology)				[8] Cognitive Behavioral Therapy		Cognitive Behavioral Therapy - [10] Sertraline
10	[9] Dr. Aisha Mahmoud (Orthopedics)						
11	[10] Dr. Benjamin Cohen (Psychiatry)						
12							
13							
14			Note 1 - Each patient has only one doctor				
15			Note 2 - Doctors belong to one department, each department can have many doctors				
16			Note 3 - Each patient can receive multiple treatments, but only if they are from the same department				

This hypothetical data was produced mostly by me, with the list of patient names, doctor names, and medications generated by ChatGPT.

*Note that this data is hypothetical and not accurate. The data was purely generated for the purpose of practice with the various database related topics present in this report.

Part 2: Normalization, Conceptual & Logical Models

Conceptual Model



Normalization

0NF - Not Normalized

0NF - Not Normalized

PatientID	FirstNm	LastNm	DOB	Sex	Phone	Address	Doctor	Department	Treatment	Medication
1	Brad	Canley	1989-10-01	Male	(934) 812-0900	12 Pond St	[1] Emily Carter	[1] Oncology	[1] Chemotherapy, [2] Radiation Therapy	[1] Cyclophosphamide, [2] Cisplatin, [3] Epoetin alfa, [4] Methotrexate, [5] Gabapentin
2	Jennifer	Blake	1978-08-10	Female	(230) 865-9001	342 Estate Dr	[4] Dr. Miguel Alvarez	[3] Physical Therapy	[4] Physical Therapy	[8] Aspirin, [9] Acetaminophen
3	James	Nguyen	2002-02-13	Male	(845) 135-1500	1615 Lakeside Dr	[10] Dr. Benjamin Cohen	[5] Psychiatry	[8] Cognitive Behavioral Therapy	[12] Sertraline
4	Sophia	Patel	1964-03-17	Female	(518) 984-6262	130 Arizona St	[2] Dr. Rajesh Kumar	[1] Oncology	[1] Chemotherapy, [2] Radiation Therapy, [7] Immunotherapy	[1] Cyclophosphamide, [2] Cisplatin, [3] Epoetin alfa, [4] Methotrexate, [5] Gabapentin
5	Olivia	Ramirez	1980-06-07	Female	(520) 830-0100	1500 Grant Rd	[6] Dr. James Whitman	[3] Cardiology	[5] Coronary Bypass Surgery	[8] Aspirin, [7] Heparin, [6] Furosemide, [9] Acetaminophen
6	Daneil	Kim	1969-09-15	Male	(520) 245-1619	14 McKinley St	[9] Dr. Aisha Mahmoud	[4] Orthopedics	[6] Joint Replacement	[8] Aspirin, [5] Gabapentin, [9] Acetaminophen

1NF - No Repeating Groups

1NF - No Repeating Groups

PatientID	FirstNm	LastNm	DOB	Sex	Phone	Address	DoctorID	Doctor	DepartmentID	Department	TreatmentID	Treatment	MedicationID	Medication
1	Brad	Canley	1989-10-01	Male	(934) 812-0900	12 Pond St	1	Emily Carter	1	Oncology	1	Chemotherapy	1	Cyclophosphamide
1	Brad	Canley	1989-10-01	Male	(934) 812-0900	12 Pond St	1	Emily Carter	1	Oncology	2	Radiation Therapy	2	Cisplatin
1	Brad	Canley	1989-10-01	Male	(934) 812-0900	12 Pond St	1	Emily Carter	1	Oncology			3	Epoetin alfa
1	Brad	Canley	1989-10-01	Male	(934) 812-0900	12 Pond St	1	Emily Carter	1	Oncology			4	Methotrexate
1	Brad	Canley	1989-10-01	Male	(934) 812-0900	12 Pond St	1	Emily Carter	1	Oncology			5	Gabapentin
2	Jennifer	Blake	1978-08-10	Female	(230) 865-9001	342 Estate Dr	4	Dr. Miguel Alvarez	3	Physical Therapy	4	Physical Therapy	8	Aspirin
2	Jennifer	Blake	1978-08-11	Female	(230) 865-9002	343 Estate Dr	4	Dr. Miguel Alvarez	3	Physical Therapy			9	Acetaminophen
3	James	Nguyen	2002-02-13	Male	(845) 135-1500	1615 Lakeside Dr	10	Dr. Benjamin Cohen	5	Psychiatry	8	Cognitive Behavioral Therapy	12	Sertraline
4	Sophia	Patel	1964-03-17	Female	(518) 984-6262	130 Arizona St	2	Dr. Rajesh Kumar	1	Oncology	1	Chemotherapy	1	Cyclophosphamide
4	Sophia	Patel	1964-03-18	Female	(518) 984-6263	131 Arizona St	2	Dr. Rajesh Kumar	1	Oncology	2	Radiation Therapy	2	Cisplatin
4	Sophia	Patel	1964-03-19	Female	(518) 984-6264	132 Arizona St	2	Dr. Rajesh Kumar	1	Oncology	3	Immunotherapy	3	Epoetin alfa
4	Sophia	Patel	1964-03-20	Female	(518) 984-6265	133 Arizona St	2	Dr. Rajesh Kumar	1	Oncology			4	Methotrexate
4	Sophia	Patel	1964-03-21	Female	(518) 984-6266	134 Arizona St	2	Dr. Rajesh Kumar	1	Oncology			5	Gabapentin
5	Olivia	Ramirez	1980-06-07	Female	(520) 830-0100	1500 Grant Rd	6	Dr. James Whitman	4	Cardiology	5	Coronary Bypass Surgery	8	Aspirin
5	Olivia	Ramirez	1980-06-08	Female	(520) 830-0101	1501 Grant Rd	6	Dr. James Whitman	4	Cardiology			7	Heparin
5	Olivia	Ramirez	1980-06-09	Female	(520) 830-0102	1502 Grant Rd	6	Dr. James Whitman	4	Cardiology			6	Furosemide
5	Olivia	Ramirez	1980-06-10	Female	(520) 830-0103	1503 Grant Rd	6	Dr. James Whitman	4	Cardiology			9	Acetaminophen
6	Daniel	Kim	1969-09-15	Male	(520) 245-1619	14 McKinley St	9	Dr. Aisha Mahmoud	5	Orthopedics	6	Joint Replacement	8	Aspirin
6	Daniel	Kim	1969-09-15	Male	(520) 245-1619	14 McKinley St	9	Dr. Aisha Mahmoud	5	Orthopedics			5	Gabapentin
6	Daniel	Kim	1969-09-15	Male	(520) 245-1619	14 McKinley St	9	Dr. Aisha Mahmoud	5	Orthopedics			9	Acetaminophen

2NF - Eliminate Redundant Data

2NF - Eliminate Redundant Data

Treatment — No Transitive Dependencies

TreatmentID	TreatmentNm
1	Chemotherapy
2	Radiation Therapy
3	Dialysis
4	Physical Therapy
5	Coronary Bypass Surgery
6	Joint Replacement
7	Immunotherapy
8	Cognitive Behavioral Therapy

Medication — No Transitive Dependencies

MedicationID	MedicationNm	Price/Unit
1	Cyclophosphamide	110
2	Cisplatin	940
3	Epoetin alfa	1300
4	Methotrexate	28
5	Gabapentin	110
6	Furosemide	8
7	Heparin	190
8	Aspirin	6
9	Acetaminophen	5
10	Sertraline	26

Patient — Patient -> DoctorID -> Doc attributes; Patient -> DepartmentID -> Dept attributes

PatientID	FirstNm	LastNm	DOB	Sex	Phone	Address	DoctorID	Doctor	DepartmentID	Department
1	Brad	Canley	1989-10-01	Male	(934) 812-0900	12 Pond St	1	Emily Carter	1	Oncology
2	Jennifer	Blake	1978-08-10	Female	(230) 865-9001	342 Estate Dr	4	Dr. Miguel Alvarez	3	Physical Therapy
3	James	Nguyen	2002-02-13	Male	(845) 135-1500	1615 Lakeside Dr	10	Dr. Benjamin Cohen	6	Psychiatry
4	Sophia	Patel	1964-03-17	Female	(518) 984-6262	130 Arizona St	2	Dr. Rajesh Kumar	1	Oncology
5	Olivia	Ramirez	1980-06-07	Female	(520) 830-0100	1500 Grant Rd	6	Dr. James Whitman	4	Cardiology
6	Daniel	Kim	1969-09-15	Male	(520) 245-1619	14 McKinley St	9	Dr. Aisha Mahmoud	5	Orthopedics

TreatmentMedication — No Transitive Dependencies

TreatmentID	MedicationID
1	1
1	2
1	3
1	4
2	2
2	5
3	3
3	6
3	7
4	8
4	9
5	6
5	7
5	8
5	9
6	5
6	8
6	9
7	1
7	4
8	10

PatientTreatment — No Transitive Dependencies

PatientID	TreatmentID
1	1
1	2
2	4
3	8
4	1
4	2
4	7
5	5
6	6

3NF - Eliminate Transitive Dependency

3NF - Eliminate Transitive Dependency

Doctor

DoctorID (PK)	DepartmentID (FK)	DoctorFirstNm	DoctorLastNm
1	1	Emily	Carter
2	1	Rajesh	Kumar
3	2	Sarah	Thompson
4	3	Miguel	Alvarez
5	3	Hannah	Lee
6	4	James	Whitman
7	4	Olivia	Rossi
8	4	Daniel	Okafor
9	5	Aisha	Mahmoud
10	6	Benjamin	Cohen

Department

DepartmentID (PK)	DepartmentNm
1	Oncology
2	Dialysis Unit
3	Physical Therapy
4	Cardiology
5	Orthopedics
6	Psychiatry

Treatment

TreatmentID (PK)	TreatmentNm
1	Chemotherapy
2	Radiation Therapy
3	Dialysis
4	Physical Therapy
5	Coronary Bypass Surgery
6	Joint Replacement
7	Immunotherapy
8	Cognitive Behavioral Therapy

Medication

MedicationID (PK)	MedicationNm	Price/Unit
1	Cyclophosphamide	110
2	Cisplatin	940
3	Epoetin alfa	1300
4	Methotrexate	28
5	Gabapentin	110
6	Furosemide	8
7	Heparin	190
8	Aspirin	6
9	Acetaminophen	5
10	Sertraline	26

Patient

PatientID (PK)	FirstNm	LastNm	DOB	Sex	Phone	Address	DoctorID (FK)
1	Brad	Canley	1989-10-01	Male	(934) 812-0900	12 Pond St	1
2	Jennifer	Blake	1978-08-10	Female	(230) 865-9001	342 Estate Dr	4
3	James	Nguyen	2002-02-13	Male	(845) 135-1500	1615 Lakeside Dr	10
4	Sophia	Patel	1964-03-17	Female	(518) 984-6262	130 Arizona St	2
5	Olivia	Ramirez	1980-06-07	Female	(520) 830-0100	1500 Grant Rd	6
6	Daniel	Kim	1969-09-15	Male	(520) 245-1619	14 McKinley St	9

TreatmentMedication

TreatmentID (PK, FK)	MedicationID (PK, FK)
1	1
1	2
1	3
1	4
2	2
2	5
3	3
3	6
3	7
4	8
4	9
5	6
5	7
5	8
5	9
6	5
6	8
6	9
7	1
7	4
8	10

PatientTreatment

PatientID (PK, FK)	TreatmentID (PK, FK)
1	1
1	2
2	4
3	8
4	1
4	2
4	7
5	5
6	6

Many-to-Many Relationships

1	**Patients**			
2	**Patient Name**	Brad Canley	Jennifer Blake	James Nguyen
3	**DOB**	1989-10-01	1978-08-10	2002-02-13
4	**Sex**	Male	Female	Male
5	**Phone**	(934) 812-0900	(230) 865-9001	(845) 135-1500
6	**Address**	12 Pond St	342 Estate Dr	1615 Lakeside Dr
7	**Doctor**	[1] Dr. Emily Carter (Oncology)	[4] Dr. Miguel Alvarez (Physical Therapy)	[10] Dr. Benjamin Cohen (Psychiatry)
8	**Treatment**	[1] Chemotherapy, [2] Radiation Therapy	[4] Physical Therapy	[8] Cognitive Behavioral Therapy
9				
10				
11				
12		Sophia Patel	Olivia Ramirez	Daniel Kim
13		1964-03-17	1980-06-07	1969-09-15
14		Female	Female	Male
15		(518) 984-6262	(520) 830-0100	(520) 245-1619
16		130 Arizona St	1500 Grant Rd	14 McKinley St
17		[2] Dr. Rajesh Kumar (Oncology)	[6] Dr. James Whitman (Cardiology)	[9] Dr. Aisha Mahmoud (Orthopedics)
18		[1] Chemotherapy, [2] Radiation Therapy, [7] Immunotherapy	[5] Coronary Bypass Surgery	[6] Joint Replacement

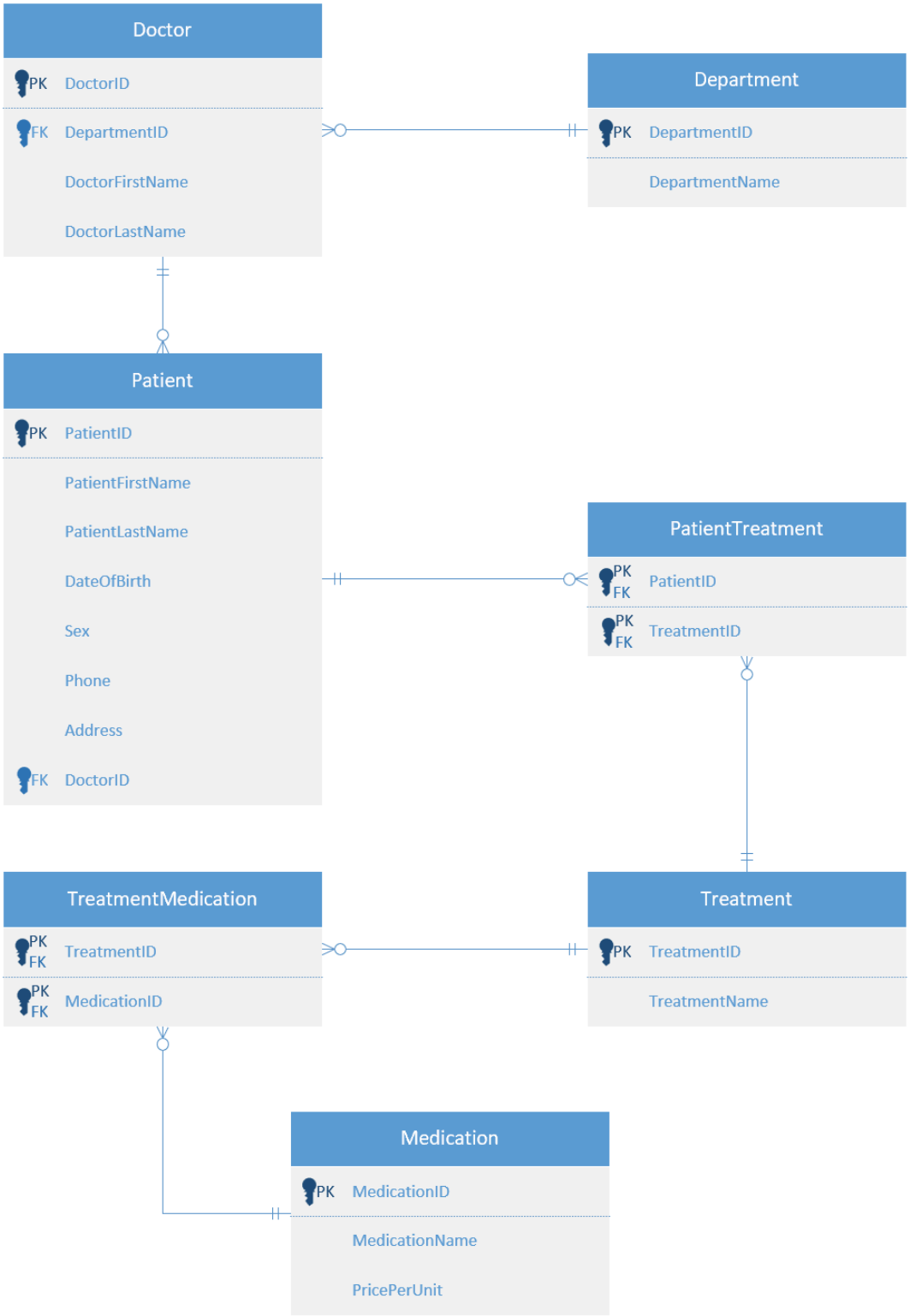
There is a many-to-many relationship between Patient and Treatment because one patient can receive many treatments, and one treatment can be received by many patients.

Treatment	Medication
[1] Chemotherapy	Chemotherapy - [1] Cyclophosphamide, [2] Cisplatin, [3] Epoetin alfa, [4] Methotrexate
[2] Radiation Therapy	Radiation Therapy - [2] Cisplatin, [5] Gabapentin
[3] Dialysis	Dialysis - [3] Epoetin alfa, [6] Furosemide, [7] Heparin
[4] Physical Therapy	Physical Therapy - [8] Aspirin, [9] Acetaminophen
[5] Coronary Bypass Surgery	Coronary Bypass Surgery - [8] Aspirin, [7] Heparin, [6] Furosemide, [9] Acetaminophen
[6] Joint Replacement	Joint Replacement - [8] Aspirin, [5] Gabapentin, [9] Acetaminophen
[7] Immunotherapy	Immunotherapy - [1] Cyclophosphamide, [4] Methotrexate
[8] Cognitive Behavioral Therapy	Cognitive Behavioral Therapy - [10] Sertraline

There is a many-to-many relationship between Treatment and Medication because one treatment can require many medications, and one medication can be used in many treatments.

For proper usage within a database, these many-to-many relationships must be resolved using junction tables, as shown in the following logical model.

Logical Model



Part 3: Physical Model & MySQL

Physical Model

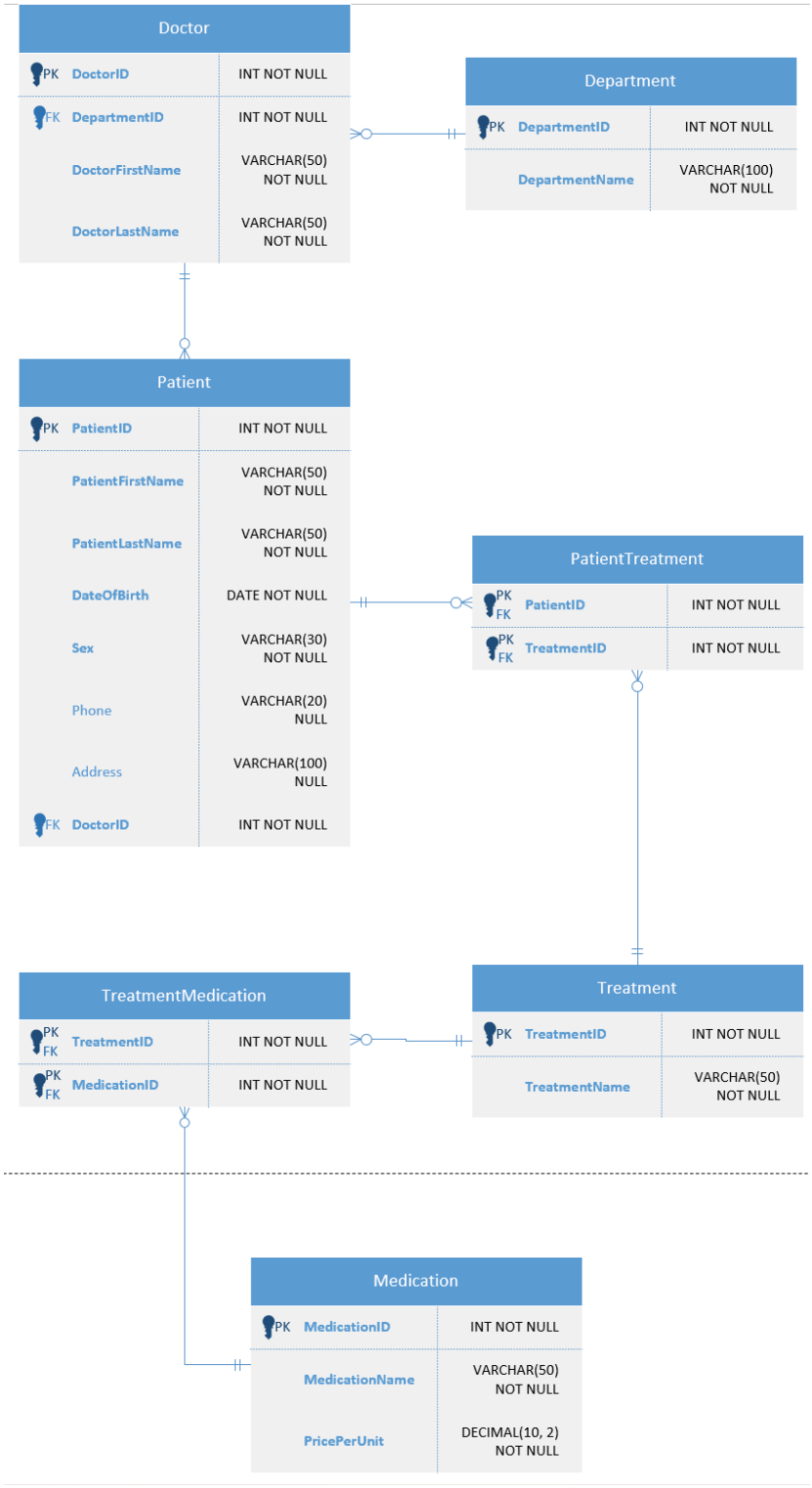


Table Creation and Data Insertion

New Hospital Database

```
1  CREATE DATABASE Hospital;
2  USE Hospital;
```

Department Table

```
CREATE TABLE Hospital.Department
(
DepartmentID INT NOT NULL,
DepartmentName VARCHAR(100) NOT NULL,
PRIMARY KEY (DepartmentID)
);

INSERT INTO Hospital.Department (DepartmentID, DepartmentName) VALUES(1, "Oncology");
INSERT INTO Hospital.Department (DepartmentID, DepartmentName) VALUES(2, "Dialysis Unit");
INSERT INTO Hospital.Department (DepartmentID, DepartmentName) VALUES(3, "Physical Therapy");
INSERT INTO Hospital.Department (DepartmentID, DepartmentName) VALUES(4, "Cardiology");
INSERT INTO Hospital.Department (DepartmentID, DepartmentName) VALUES(5, "Orthopedics");
INSERT INTO Hospital.Department (DepartmentID, DepartmentName) VALUES(6, "Psychiatry");
```

Doctor Table

```
CREATE TABLE Hospital.Doctor
(
DoctorID INT NOT NULL,
DepartmentID INT NOT NULL,
DoctorFirstName VARCHAR(50) NOT NULL,
DoctorLastName VARCHAR(50) NOT NULL,
PRIMARY KEY (DoctorID),
FOREIGN KEY (DepartmentID) REFERENCES Hospital.Department(DepartmentID)
);

INSERT INTO Hospital.Doctor (DoctorID, DepartmentID, DoctorFirstName, DoctorLastName) VALUES(1, 1, "Emily", "Carter");
INSERT INTO Hospital.Doctor (DoctorID, DepartmentID, DoctorFirstName, DoctorLastName) VALUES(2, 1, "Rajesh", "Kumar");
INSERT INTO Hospital.Doctor (DoctorID, DepartmentID, DoctorFirstName, DoctorLastName) VALUES(3, 2, "Sarah", "Thompson");
INSERT INTO Hospital.Doctor (DoctorID, DepartmentID, DoctorFirstName, DoctorLastName) VALUES(4, 3, "Miguel", "Alvarez");
INSERT INTO Hospital.Doctor (DoctorID, DepartmentID, DoctorFirstName, DoctorLastName) VALUES(5, 3, "Hannah", "Lee");
INSERT INTO Hospital.Doctor (DoctorID, DepartmentID, DoctorFirstName, DoctorLastName) VALUES(6, 4, "James", "Whitman");
INSERT INTO Hospital.Doctor (DoctorID, DepartmentID, DoctorFirstName, DoctorLastName) VALUES(7, 4, "Olivia", "Rossi");
INSERT INTO Hospital.Doctor (DoctorID, DepartmentID, DoctorFirstName, DoctorLastName) VALUES(8, 4, "Daniel", "Okafor");
INSERT INTO Hospital.Doctor (DoctorID, DepartmentID, DoctorFirstName, DoctorLastName) VALUES(9, 5, "Aisha", "Mahmoud");
INSERT INTO Hospital.Doctor (DoctorID, DepartmentID, DoctorFirstName, DoctorLastName) VALUES(10, 6, "Benjamin", "Cohen");
```

Patient Table

```sql
CREATE TABLE Hospital.Patient
(
PatientID INT NOT NULL,
PatientFirstName VARCHAR(50) NOT NULL,
PatientLastName VARCHAR(50) NOT NULL,
DateOfBirth DATE NOT NULL,
Sex VARCHAR(30) NOT NULL,
Phone VARCHAR(20),
Address VARCHAR(100),
DoctorID INT NOT NULL,
PRIMARY KEY (PatientID),
FOREIGN KEY (DoctorID) REFERENCES Hospital.Doctor(DoctorID)
);

INSERT INTO Hospital.Patient (PatientID, PatientFirstName, PatientLastName, DateOfBirth, Sex, Phone, Address, DoctorID)
    VALUES(1, "Brad", "Canley", "1989-10-01", "Male", "(934) 812-0900", "12 Pond St", 1);
INSERT INTO Hospital.Patient (PatientID, PatientFirstName, PatientLastName, DateOfBirth, Sex, Phone, Address, DoctorID)
    VALUES(2, "Jennifer", "Blake", "1978-08-10", "Female", "(230) 865-9001", "342 Estate Dr", 4);
INSERT INTO Hospital.Patient (PatientID, PatientFirstName, PatientLastName, DateOfBirth, Sex, Phone, Address, DoctorID)
    VALUES(3, "James", "Nguyen", "2002-02-13", "Male", "(845) 135-1500", "1615 Lakeside Dr", 10);
INSERT INTO Hospital.Patient (PatientID, PatientFirstName, PatientLastName, DateOfBirth, Sex, Phone, Address, DoctorID)
    VALUES(4, "Sophia", "Patel", "1964-03-17", "Female", "(518) 984-6262", "130 Arizona St", 2);
INSERT INTO Hospital.Patient (PatientID, PatientFirstName, PatientLastName, DateOfBirth, Sex, Phone, Address, DoctorID)
    VALUES(5, "Olivia", "Ramirez", "1980-06-07", "Female", "(520) 830-0100", "1500 Grant Rd", 6);
INSERT INTO Hospital.Patient (PatientID, PatientFirstName, PatientLastName, DateOfBirth, Sex, Phone, Address, DoctorID)
    VALUES(6, "Daniel", "Kim", "1969-09-15", "Male", "(520) 245-1619", "14 McKinley St", 9);
```

Treatment Table

```sql
CREATE TABLE Hospital.Treatment
(
TreatmentID INT NOT NULL,
TreatmentName VARCHAR(50) NOT NULL,
PRIMARY KEY (TreatmentID)
)

INSERT INTO Hospital.Treatment (TreatmentID, TreatmentName) VALUES(1, "Chemotherapy");
INSERT INTO Hospital.Treatment (TreatmentID, TreatmentName) VALUES(2, "Radiation Therapy");
INSERT INTO Hospital.Treatment (TreatmentID, TreatmentName) VALUES(3, "Dialysis");
INSERT INTO Hospital.Treatment (TreatmentID, TreatmentName) VALUES(4, "Physical Therapy");
INSERT INTO Hospital.Treatment (TreatmentID, TreatmentName) VALUES(5, "Coronary Bypass Surgery");
INSERT INTO Hospital.Treatment (TreatmentID, TreatmentName) VALUES(6, "Joint Replacement");
INSERT INTO Hospital.Treatment (TreatmentID, TreatmentName) VALUES(7, "Immunotherapy");
INSERT INTO Hospital.Treatment (TreatmentID, TreatmentName) VALUES(8, "Cognitive Behavioral Therapy");
```

Medication Table

```
CREATE TABLE Hospital.Medication
(
MedicationID INT NOT NULL,
MedicationName VARCHAR(50) NOT NULL,
PricePerUnit DECIMAL(10,2) NOT NULL,
PRIMARY KEY (MedicationID)
);

INSERT INTO Hospital.Medication (MedicationID, MedicationName, PricePerUnit) VALUES(1, "Cyclophosphamide", 110.00);
INSERT INTO Hospital.Medication (MedicationID, MedicationName, PricePerUnit) VALUES(2, "Cisplatin", 940.00);
INSERT INTO Hospital.Medication (MedicationID, MedicationName, PricePerUnit) VALUES(3, "Epoetin alfa", 1300.00);
INSERT INTO Hospital.Medication (MedicationID, MedicationName, PricePerUnit) VALUES(4, "Methotrexate", 28.00);
INSERT INTO Hospital.Medication (MedicationID, MedicationName, PricePerUnit) VALUES(5, "Gabapentin", 110.00);
INSERT INTO Hospital.Medication (MedicationID, MedicationName, PricePerUnit) VALUES(6, "Furosemide", 8.00);
INSERT INTO Hospital.Medication (MedicationID, MedicationName, PricePerUnit) VALUES(7, "Heparin", 190.00);
INSERT INTO Hospital.Medication (MedicationID, MedicationName, PricePerUnit) VALUES(8, "Aspirin", 6.00);
INSERT INTO Hospital.Medication (MedicationID, MedicationName, PricePerUnit) VALUES(9, "Acetaminophen", 5.00);
INSERT INTO Hospital.Medication (MedicationID, MedicationName, PricePerUnit) VALUES(10, "Sertraline", 26.00);
```

PatientTreatment Junction Table

```
CREATE TABLE Hospital.PatientTreatment
(
PatientID INT NOT NULL,
TreatmentID INT NOT NULL,
PRIMARY KEY (PatientID, TreatmentID),
FOREIGN KEY (PatientID) REFERENCES Hospital.Patient (PatientID),
FOREIGN KEY (TreatmentID) REFERENCES Hospital.Treatment (TreatmentID)
);

INSERT INTO Hospital.PatientTreatment (PatientID, TreatmentID) VALUES(1, 1);
INSERT INTO Hospital.PatientTreatment (PatientID, TreatmentID) VALUES(1, 2);
INSERT INTO Hospital.PatientTreatment (PatientID, TreatmentID) VALUES(2, 4);
INSERT INTO Hospital.PatientTreatment (PatientID, TreatmentID) VALUES(3, 8);
INSERT INTO Hospital.PatientTreatment (PatientID, TreatmentID) VALUES(4, 1);
INSERT INTO Hospital.PatientTreatment (PatientID, TreatmentID) VALUES(4, 2);
INSERT INTO Hospital.PatientTreatment (PatientID, TreatmentID) VALUES(4, 7);
INSERT INTO Hospital.PatientTreatment (PatientID, TreatmentID) VALUES(5, 5);
INSERT INTO Hospital.PatientTreatment (PatientID, TreatmentID) VALUES(6, 6);
```

TreatmentMedication Junction Table

```
CREATE TABLE Hospital.TreatmentMedication
(
TreatmentID INT NOT NULL,
MedicationID INT NOT NULL,
PRIMARY KEY (TreatmentID, MedicationID),
FOREIGN KEY (TreatmentID) REFERENCES Hospital.Treatment (TreatmentID),
FOREIGN KEY (MedicationID) REFERENCES Hospital.Medication (MedicationID)
);

INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(1, 1);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(1, 2);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(1, 3);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(1, 4);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(2, 2);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(2, 5);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(3, 3);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(3, 6);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(3, 7);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(4, 8);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(4, 9);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(5, 6);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(5, 7);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(5, 8);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(5, 9);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(6, 5);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(6, 8);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(6, 9);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(7, 1);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(7, 4);
INSERT INTO Hospital.TreatmentMedication (TreatmentID, MedicationID) VALUES(8, 10);
```

SQL Queries

Prompts will be followed by images of related SQL queries and their outputs.

1. Retrieve the data from each table by using the SELECT * statement and order by PK column(s).

Department Table

```
SELECT *
FROM Hospital.Department
ORDER BY DepartmentID;
```

DepartmentID	DepartmentNa...
1	Oncology
2	Dialysis Unit
3	Physical Therapy
4	Cardiology
5	Orthopedics
6	Psychiatry

Doctor Table

```
1 •   SELECT *
2     FROM Hospital.Doctor
3     ORDER BY DoctorID;
```

DoctorID	DepartmentID	DoctorFirstNa...	DoctorLastNa...
1	1	Emily	Carter
2	1	Rajesh	Kumar
3	2	Sarah	Thompson
4	3	Miguel	Alvarez
5	3	Hannah	Lee
6	4	James	Whitman
7	4	Olivia	Rossi
8	4	Daniel	Okafor
9	5	Aisha	Mahmoud
10	6	Benjamin	Cohen

Patient Table

```
1 •   SELECT *
2     FROM Hospital.Patient
3     ORDER BY PatientID;
```

PatientID	PatientFirstNa...	PatientLastName	DateOfBirth	Sex	Phone	Address	DoctorID
1	Brad	Canley	1989-10-01	Male	(934) 812-0900	12 Pond St	1
2	Jennifer	Blake	1978-08-10	Female	(230) 865-9001	342 Estate Dr	4
3	James	Nguyen	2002-02-13	Male	(845) 135-1500	1615 Lakeside Dr	10
4	Sophia	Patel	1964-03-17	Female	(518) 984-6262	130 Arizona St	2
5	Olivia	Ramirez	1980-06-07	Female	(520) 830-0100	1500 Grant Rd	6
6	Daniel	Kim	1969-09-15	Male	(520) 245-1619	14 McKinley St	9

Treatment Table

```
1 •   SELECT *
2     FROM Hospital.Treatment
3     ORDER BY TreatmentID;
```

TreatmentID	TreatmentName
1	Chemotherapy
2	Radiation Therapy
3	Dialysis
4	Physical Therapy
5	Coronary Bypass Surgery
6	Joint Replacement
7	Immunotherapy
8	Cognitive Behavioral Therapy

Medication Table

```
1 •   SELECT *
2     FROM Hospital.Medication
3     ORDER BY MedicationID;
```

MedicationID	MedicationName	PricePerUnit
1	Cyclophosphamide	110.00
2	Cisplatin	940.00
3	Epoetin alfa	1300.00
4	Methotrexate	28.00
5	Gabapentin	110.00
6	Furosemide	8.00
7	Heparin	190.00
8	Aspirin	6.00
9	Acetaminophen	5.00
10	Sertraline	26.00

PatientTreatment Table

```
1 •   SELECT *
2     FROM Hospital.PatientTreatment
3     ORDER BY PatientID, TreatmentID;
```

PatientID	TreatmentID
1	1
1	2
2	4
3	8
4	1
4	2
4	7
5	5
6	6

TreatmentMedication Table

```
1 •   SELECT *
2     FROM Hospital.TreatmentMedication
3     ORDER BY TreatmentID, MedicationID;
```

TreatmentID	MedicationID
1	1
1	2
1	3
1	4
2	2
2	5
3	3
3	6
3	7
4	8
4	9
5	6
5	7
5	8
5	9
6	5
6	8
6	9
7	1
7	4
8	10

2. Write an SQL involving the junction table and two other related tables. You must use the INNER JOIN to connect with all three tables.

```
1  SELECT p.PatientFirstName, p.PatientLastName, t.TreatmentName
2  FROM Hospital.Patient p
3  INNER JOIN Hospital.PatientTreatment pt ON p.PatientID = pt.PatientID
4  INNER JOIN Hospital.Treatment t ON pt.TreatmentID = t.TreatmentID
5  ORDER BY p.PatientFirstName;
```

PatientFirstNa...	PatientLastName	TreatmentName
Brad	Canley	Chemotherapy
Brad	Canley	Radiation Therapy
Daniel	Kim	Joint Replacement
James	Nguyen	Cognitive Behavioral Therapy
Jennifer	Blake	Physical Therapy
Olivia	Ramirez	Coronary Bypass Surgery
Sophia	Patel	Chemotherapy
Sophia	Patel	Radiation Therapy
Sophia	Patel	Immunotherapy

The resulting table lets us easily see which treatment(s) each patient is receiving.

3. Write an SQL statement by including two or more tables and using the LEFT OUTER JOIN. Show the results and sort the results by key field(s). Interpret the results compared to what an INNER JOIN does.

```
SELECT d.DoctorFirstName, d.DoctorLastName, p.PatientFirstName, p.PatientLastName
FROM Hospital.Doctor d
LEFT OUTER JOIN Hospital.Patient p ON d.DoctorID = p.PatientID
ORDER BY d.DoctorFirstName;
```

DoctorFirstNa...	DoctorLastNa...	PatientFirstNa...	PatientLastName
Aisha	Mahmoud	NULL	NULL
Benjamin	Cohen	NULL	NULL
Daniel	Okafor	NULL	NULL
Emily	Carter	Brad	Canley
Hannah	Lee	Olivia	Ramirez
James	Whitman	Daniel	Kim
Miguel	Alvarez	Sophia	Patel
Olivia	Rossi	NULL	NULL
Rajesh	Kumar	Jennifer	Blake
Sarah	Thompson	James	Nguyen

The resulting table lets us see which doctor is serving each patient. If an INNER JOIN were used here, the rows returning NULL in the PatientFirstName and PatientLastName columns would be omitted.

4. Write a single-row subquery. Interpret the output.

```
SELECT *
FROM Hospital.Patient
WHERE DateOfBirth > (
    SELECT DateOfBirth
    FROM Hospital.Patient
    WHERE PatientFirstName = "Jennifer" AND PatientLastName = "Blake"
    )
ORDER BY PatientID;
```

PatientID	PatientFirstNa...	PatientLastName	DateOfBirth	Sex	Phone	Address	DoctorID
1	Brad	Canley	1989-10-01	Male	(934) 812-0900	12 Pond St	1
3	James	Nguyen	2002-02-13	Male	(845) 135-1500	1615 Lakeside Dr	10
5	Olivia	Ramirez	1980-06-07	Female	(520) 830-0100	1500 Grant Rd	6

The resulting table displays the information of each patient born after Jennifer Blake.

5. Write a multiple-row subquery. Interpret the output.

```
SELECT dr.DoctorID, dr.DoctorFirstName, dr.DoctorLastName
FROM Hospital.Doctor dr
WHERE dr.DepartmentID IN (
    SELECT d.DepartmentID
    FROM Hospital.Department d
    WHERE d.DepartmentName IN ("Oncology", "Cardiology", "Psychiatry")
    )
ORDER BY dr.DoctorID;
```

DoctorID	DoctorFirstNa...	DoctorLastNa...
1	Emily	Carter
2	Rajesh	Kumar
6	James	Whitman
7	Olivia	Rossi
8	Daniel	Okafor
10	Benjamin	Cohen

The resulting table displays the ID's and names of the doctors that operate in the Oncology, Cardiology, and Psychiatry departments.

6. Write an SQL to aggregate the results by using multiple columns in the SELECT clause. Interpret the output.

```
SELECT d.DepartmentName AS Department, p.Sex, COUNT(p.PatientID) AS NumPatients
FROM Hospital.Department d
INNER JOIN Hospital.Doctor doc ON d.DepartmentID = doc.DepartmentID
INNER JOIN Hospital.Patient p ON doc.DoctorID = p.DoctorID
GROUP BY d.DepartmentName, p.Sex
ORDER BY d.DepartmentName, p.Sex;
```

Department	Sex	NumPatients
Cardiology	Female	1
Oncology	Female	1
Oncology	Male	1
Orthopedics	Male	1
Physical Therapy	Female	1
Psychiatry	Male	1

The query aggregates the results using the Department and Sex columns and the COUNT() function. The resulting table displays the number of patients of each sex that exist in each department within the database.

7. Write a subquery using the NOT IN operator. Interpret the output.

```
SELECT DISTINCT d.DoctorID, d.DoctorFirstName, d.DoctorLastName
FROM Hospital.Doctor d
WHERE d.DoctorID NOT IN (
    SELECT p.DoctorID
    FROM Hospital.Patient p
    );
```

DoctorID	DoctorFirstNa...	DoctorLastNa...
3	Sarah	Thompson
5	Hannah	Lee
7	Olivia	Rossi
8	Daniel	Okafor

The resulting table displays the doctors in the database that are not currently assigned to a patient.

8. Write a query using a CASE statement. Interpret the output.

```
SELECT d.DoctorFirstName, d.DoctorLastName,
    CASE
        WHEN p.PatientLastName IS NULL THEN 'NO PATIENT'
        ELSE p.PatientLastName
    END AS PatientLastName
FROM Hospital.Doctor d
LEFT OUTER JOIN Hospital.Patient p ON d.DoctorID = p.PatientID
ORDER BY d.DoctorFirstName;
```

DoctorFirstNa...	DoctorLastNa...	PatientLastName
Aisha	Mahmoud	NO PATIENT
Benjamin	Cohen	NO PATIENT
Daniel	Okafor	NO PATIENT
Emily	Carter	Canley
Hannah	Lee	Ramirez
James	Whitman	Kim
Miguel	Alvarez	Patel
Olivia	Rossi	NO PATIENT
Rajesh	Kumar	Blake
Sarah	Thompson	Nguyen

The resulting table lists all doctors in the database along with their assigned patient's last name. In the event that a doctor is not assigned a patient, the CASE statement outputs "NO PATIENT" as opposed to "NULL."

9. Write a query using the NOT EXISTS operator. Interpret the output.

```
SELECT doc.DoctorID, doc.DoctorFirstName, doc.DoctorLastName, d.DepartmentName
FROM Hospital.Doctor doc
INNER JOIN Department d ON doc.DepartmentID = d.DepartmentID
WHERE NOT EXISTS (
    SELECT 1
    FROM Patient p
    WHERE p.DoctorID = doc.DoctorID
    )
ORDER BY doc.DoctorID;
```

DoctorID	DoctorFirstNa...	DoctorLastNa...	DepartmentNa...
3	Sarah	Thompson	Dialysis Unit
5	Hannah	Lee	Physical Therapy
7	Olivia	Rossi	Cardiology
8	Daniel	Okafor	Cardiology

The resulting table shows doctors, and their department, who are not currently assigned to any patient.

10. Write a subquery using the NOT NULL operator in the inner query. Interpret the output.

```
SELECT doc.DoctorID, doc.DoctorFirstName, doc.DoctorLastName
FROM Hospital.Doctor doc
WHERE doc.DoctorID IN (
    SELECT p.DoctorID
    FROM Hospital.Doctor d
    LEFT OUTER JOIN Hospital.Patient p ON d.DoctorID = p.DoctorID
    WHERE p.PatientLastName IS NOT NULL
)
ORDER BY doc.DoctorID;
```

DoctorID	DoctorFirstNa...	DoctorLastNa...
1	Emily	Carter
2	Rajesh	Kumar
4	Miguel	Alvarez
6	James	Whitman
9	Aisha	Mahmoud
10	Benjamin	Cohen

The resulting table shows only the doctors who are currently assigned to at least one patient by using NOT NULL to filter out the rows whose PatientLastName value is NULL after the Doctor table is left joined with the Patient table.

Conclusion

This report demonstrates the design and implementation of a relational database for a hypothetical hospital, applying key concepts of database normalization, modeling, and SQL querying. Beginning with the identification of essential hospital entities such as patients, doctors, treatments, medications, and departments, the database was developed to capture their relationships in a structured and consistent manner. Through the use of conceptual, logical, and physical models, many-to-many relationships were properly resolved with junction tables, ensuring referential integrity and eliminating data redundancy. A variety of SQL queries were then constructed to retrieve, join, and filter data, illustrating the application of joins, subqueries, aggregate functions, and conditional logic.

While the database schema successfully demonstrates foundational database management principles, it is important to acknowledge that it simplifies the complexities of a real-world hospital system. Certain assumptions, such as each patient being assigned to only one doctor or the absence of detailed treatment timelines, were made to focus on developing core SQL and relational modeling skills. Future improvements could involve implementing more advanced constraints and triggers, or extending the database to include scheduling, billing, and staff management. Overall, this project effectively met its educational purpose of strengthening practical skills in database design and SQL operations, providing a solid foundation for future, more sophisticated database development.