Integrated Regulatory Approach to Database Design, Development, and Optimization

By:

Adedayo Kukoyi

DEPARTMENT OF INFORMATION TECHNOLOGY,
PURDUE UNIVERSITY GLOBAL

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Universal Health Database **Design.**

PART 1. DATABASE DEFINITION

INTRODUCTION

The capstone project is being carried out to develop a healthcare database for a client named Universal Health. The database would be implemented to meet the client's data requirements. The database will include entities like Patient, Appointment, Insurance, Medical History, Physician, Consent, and Procedures.

PURPOSE

The project's purpose is to create an affordable healthcare database for small or mid-size healthcare organizations. The aim is to design and develop a cost-effective relational database that efficiently stores and retrieves electronic health data generated by a healthcare facility. The stored data includes patient information, medical history, physician details, diagnoses, procedures, admission records, and medications. This database ensures easy access to patient medical records while maintaining data integrity and consistency. Healthcare facilities are mandated by law (e.g, HIPAA) to secure patient health records in ways that do not compromise the patient's sensitive records. A health facility that fails to implement a secure database management system in managing protected health records may be exposed to regulatory risk and attract a stiff penalty.

PART 2. DATABASE DESIGN

List of Tables (Entity Types):
The Universal Health database is designed to include the tables listed below.

1. **Patient:** Contains patient demographics information.
2. **Physician**: Contains personal information of Physicians hired by the Universal Health Facility.
3. **Insurance:** Contains insurance information for the patient.
4. **Emergency Contact:** Contains personal information for emergency contact for patients.
5. **Appointment:** Contains patient appointment details.
6. **Prescription:** Contains information about prescriptions generated.
7. **Medication:** Contain information about medications.
8. **Medical History:** Contains the patient's medical history.
9. **Procedure:** Contain information about procedures.

10. **Consent:** Contains information about every consent issued by the patient.

Universal Health Business Rules

The table below contains the database entities, Entity Pair, Cardinality, and the Entity Business Rule.

Entity	Entity Pair	Cardinality	Entity Business Rules
Patient	Emergency Contact	One-to-Many	The patient must have at least one emergency contact.
Patient	Insurance	One-to-Many	The patient must have primary insurance on file.
Patient	Appointment	One-to-Many	A patient can have multiple appointments. Appointments cannot overlap.
Patient	Prescription	One-to-Many	A patient may have prescriptions that are linked to an appointment.
Patient	Medical History	One-to-One	A patient must have a medical history.
Patient	Consent	One-to-many	A patient must have at least one consent on file. A patient can have many contents. Examples include consent for treatment, consent for procedure, etc.
Appointment	Physician	Many-to-One	A physician or a nurse can be assigned to many appointments. Appointments cannot overlap.
Prescription	Physician	Many-to-One	A physician can create many prescriptions.
Prescription	Medication	Many-to-One	A medication needs at least one prescription. Many prescriptions can be generated for one medication.
Procedure	Physician	One-to-One	At least one physician must perform a procedure.
Procedure	Consent	One-to-One	Consent must be in place for every procedure.

Figure 2.0: Business Rule Table.

Entity Structure and Attributes.

The table below lists the entities in the universal health database and their different attributes.

Entity Name, Attributes, Primary and Secondary Keys.		
Patient • PatientID **(PK)** • FirstName • LastName • DOB (Date of Birth) • Gender • Phone • Email • Address • City	**Insurance** • InsuranceID (PK) • ProviderName • PolicyNumber • GroupNumber • CoverageType • PatientID (FK)	**Prescription** • PrescriptionID (PK) • DatePrescribed • DosageInstruction • PatientID (FK) • PhysicianID (FK) • MedicationID (FK)

• State • ZipCode • SSN • InsuranceID FK • EmergencyContactID FK		
EmergencyContact • EmergencyContactID (PK) • FirstName • LastName • Relationship • Phone • Email • PatientID (FK)	**Medication** • MedicationID (PK) • Name • Dosage • Description	**MedicalHistory** • RecordID (PK) • Diagnosis • TreatmentPlan • RecordDate • PatientID (FK)
Appointment • AppointmentID (PK) • AppointmentDate • Status • Reason • PatientID (FK) • PhysicianID (FK)	**Procedures** • ProcedureID (PK) • Name • Description • Cost • RecordID (FK)	**Physician** • PhysicianID (PK) • FirstName • LastName • Specialty • Email • Phone
Consent • ConsentID (PK) • ConsentType • ConsentDate • ExpirationDate • PatientID (FK)		

Figure 2.1: Entities Structure and Attributes.

PART 3: ERD SCHEMA DIAGRAM

ERD DIAGRAM

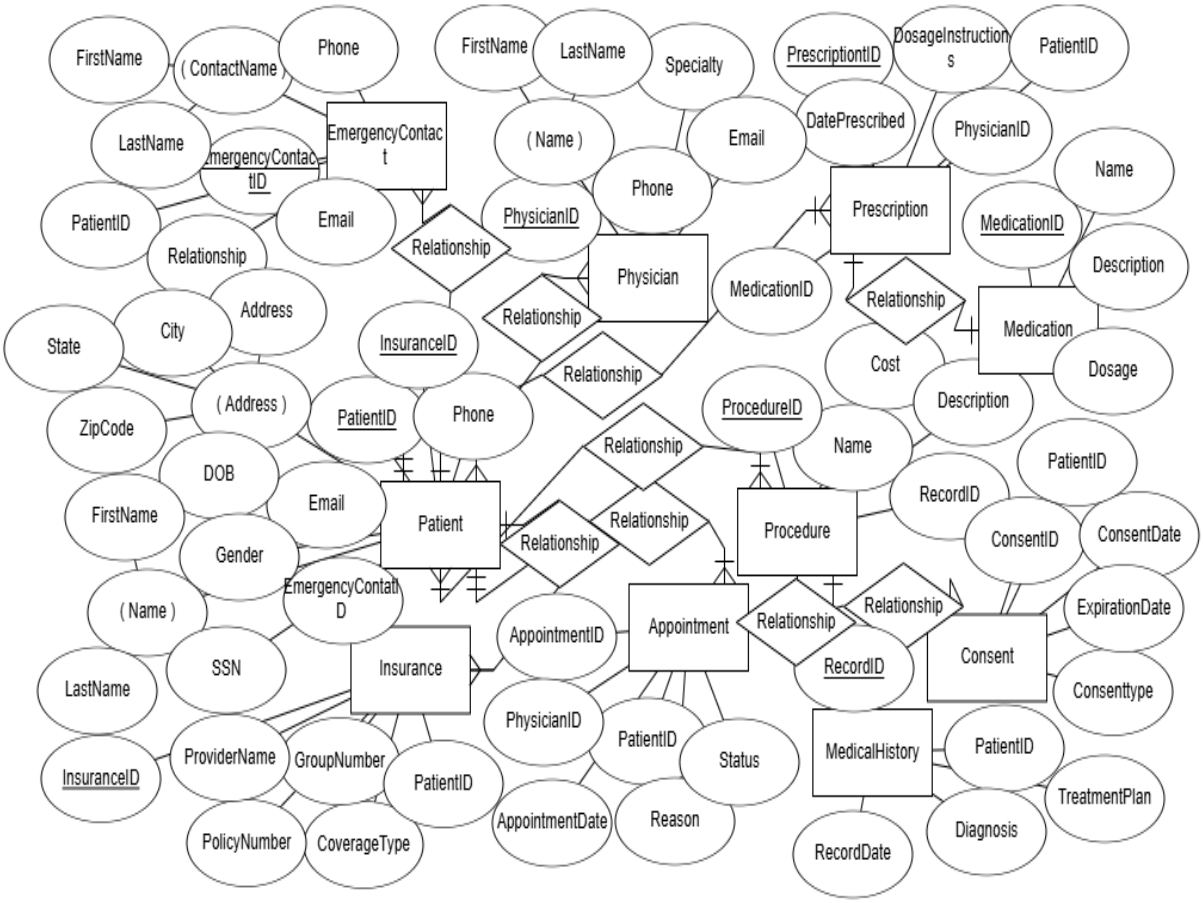


Figure 3.0 Entity Relationship Diagram.

ERD SCHEMA DIAGRAM

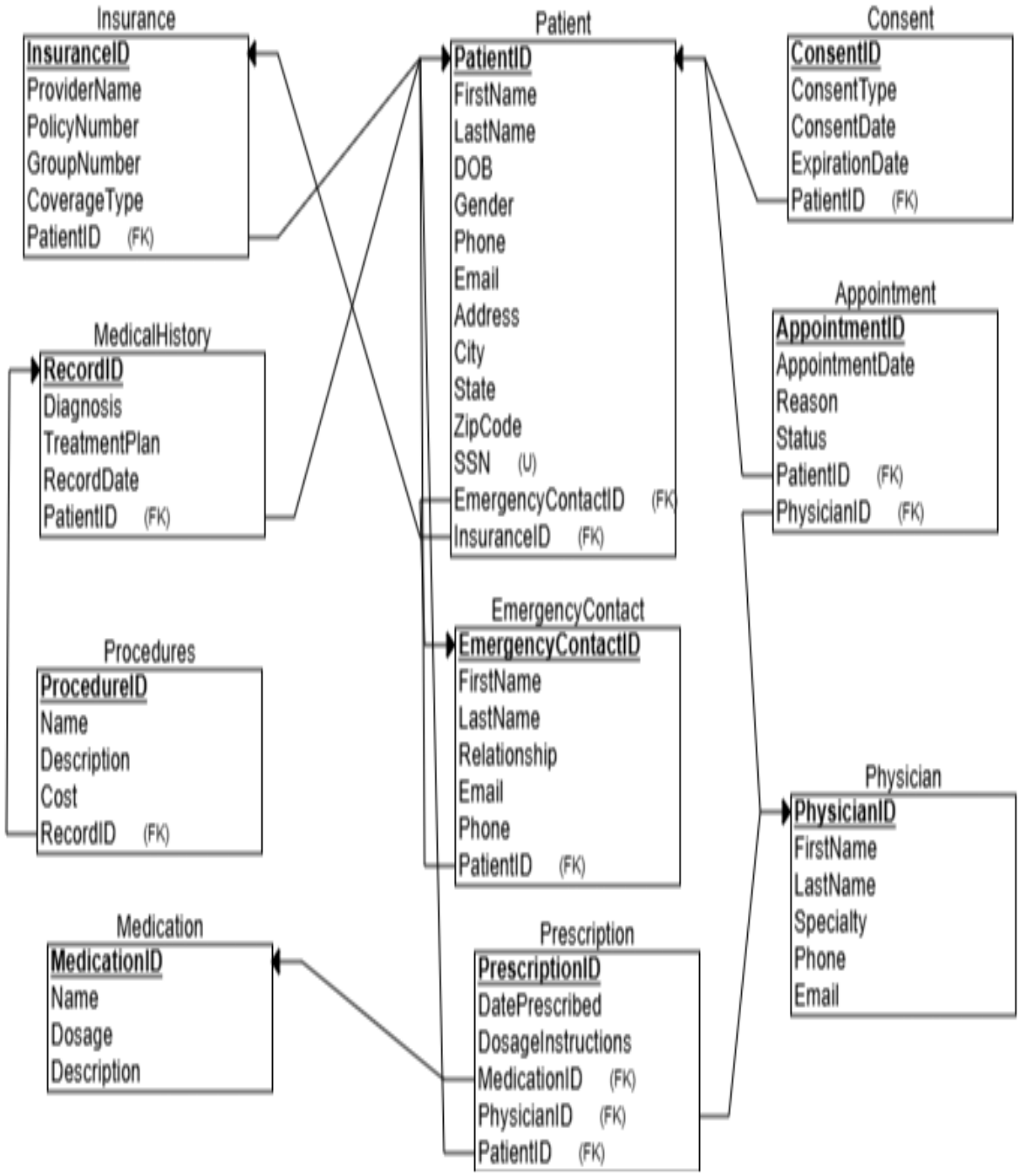


Figure 3.1 Entity Relationship Schema Diagram.

ENTITIES, STRUCTURES & RELATIONSHIP DIAGRAM

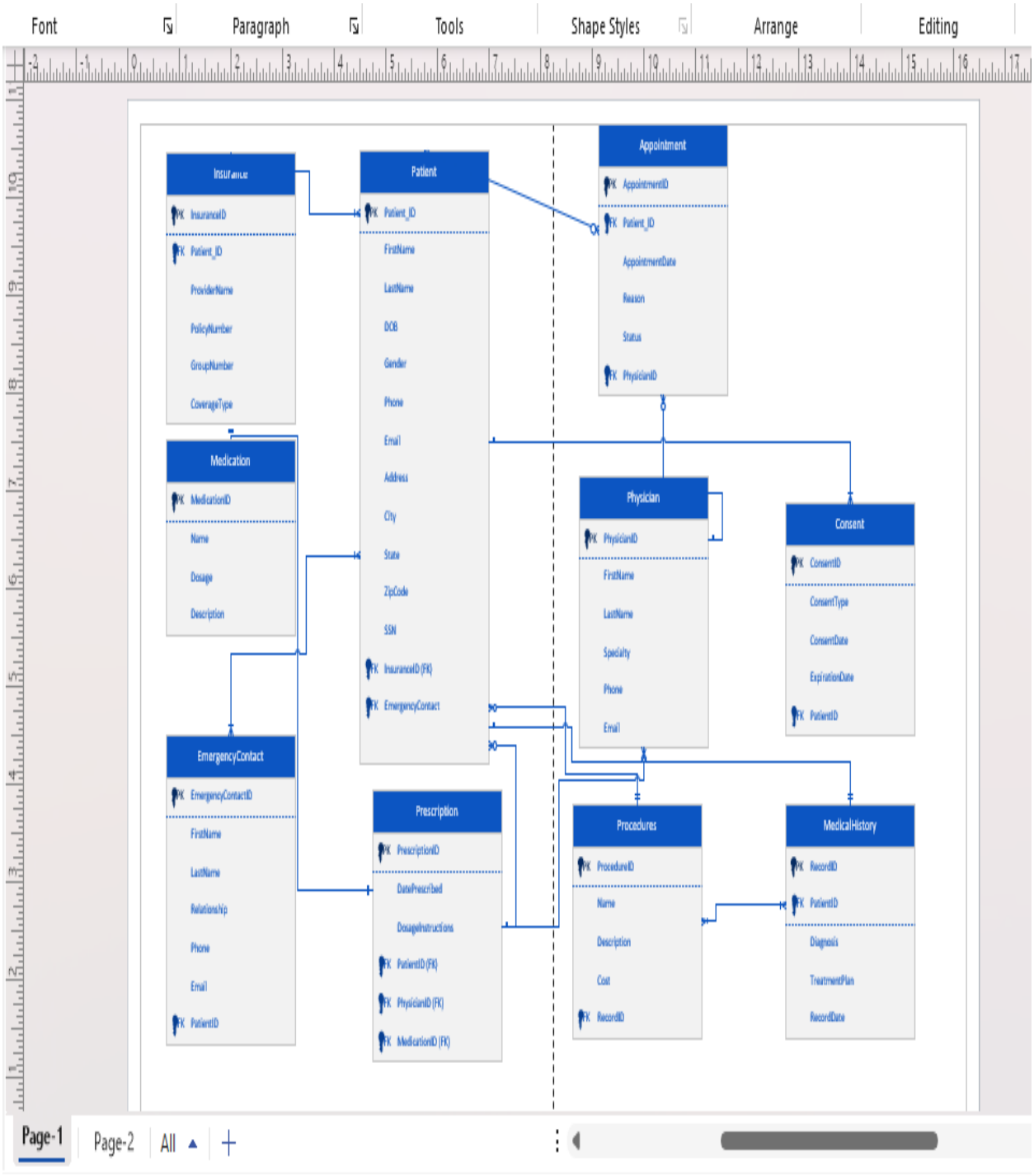


Figure 3.2: Entity Structure & Relationship Diagram.

PART 4: DATABASE DESIGN AND NORMALIZATION ASSERTION.

The Insurance-Patient entity pair below explains how the database was normalized.

Table 4.0 Normalization Example: using the insurance and patient pair.

InsuranceID	Provider Name	Policy Number	Group Number	Coverage Type	PatientID	PatientName (First & Last)	DOB	Email

- InsuranceID and PatientID are the Primary keys for the Insurance table and Patient table, respectively.
- Non-key attributes with different data were separated into fields.
- The insurance table non-key attribute depends on the InsuranceID.
- Please note that the PatientID is a foreign key in the Insurance table; hence, the non-key attributes of the insurance table depend on the InsuranceID key.
- Please note that the InsuranceID is a foreign key in the Patient table, hence the non-key attributes of the patient table depend on the patientID key.

The resulting tables are below:

Table 4.1 Insurance Schema

InsuranceID	PatientID	ProviderName	PolicyNumber	GroupNumber	CoverageType

Table 4.2 Patient schema

PatientID	InsuranceID	PatientFirstname	PatientLastname	DOB	Email	Address

Normalization:

The normalization table above explains how form attributes were normalized based on 1NF, 2NF, and 3NF, respectively.

- 1NF – YES <Repeat group was removed from the table column> For example, Insurance policy number and policy name were separated into different columns to eliminate redundancy.

- 2NF – YES <All partial dependency was removed, reorganized, and placed in a separate table> See the Normalization example using the Insurance: Patient pair.
- 3NF – YES <Ensure that all non-key attributes depend on a primary key> See the Normalization example using the insurance: patient entity pair.

(Kendall and Kendall, 2020).

PART 5: DATABASE DOCUMENTATION

Universal Health Data Dictionary

The tables below show the characteristics of each table and a brief description of the purpose of the table in the database.

Table 5.0 Schema Name: Appointment

Purpose: The table's purpose is to store patient appointment information for universal health.

Field	Description	Data Type	Allow Null	Key
AppointmentID	Appointment table primary key.	Integer	No	Primary Key
PatientID	Appointment table foreign key.	Integer	No	Foreign Key
PhysicianID	Appointment table foreign key.	Integer	No	Foreign Key
AppoinmentDate	Patient appointment date	DateTime	No	Not a Key
Reason	Reason for hospital visit	Text	No	Not a Key
Status	Patient arrival status	Varchar (20)	No	Not a Key

Table 5.1 Schema Name: Consent

Purpose: The table's purpose is to store the patient's consent information.

Field	Description	Data Type	Allow Null	Key
ConsentID	Consent table primary key.	Integer	No	Primary Key
PatientID	Consent table foreign key.	Integer	No	Foreign Key

ConsentType	Type of consent collected from the patient.	Varchar (100)	No	Not a Key
ConsentDate	Date & time the patient issued consent	DateTime	No	Not a Key
ExpirationDate	Consent expiration date & time.	DateTime	No	Not a Key

Table 5.2 Schema Name: EmergencyContact

Purpose: The table's purpose is to store the patient's emergency contact information.

Field	Description	Data Type	Allow Null	Key
EmergencyContactID	Emergency Contact table primary key.	Integer	No	Primary Key
PatientID	Emergency Contact table foreign key.	Integer	No	Foreign Key
FirstName	Patient's emergency contact's first name.	Varchar (20)	No	Not a Key
LastName	Patient's emergency contact's last name.	Varchar (20)	No	Not a Key
Relationship	Emergency contact relationship to the patient.	Varchar (20)	No	Not a Key
Phone	Emergency contact phone number.	Varchar (15)	No	Not a Key
Email	Emergency contact email address.	Varchar (50)	No	Not a Key

Table 5.3 Schema Name: Insurance

Purpose: The table's purpose is to store the patient's insurance information.

Field	Description	Data Type	Allow Null	Key
InsuranceID	Insurance table primary key.	Integer	No	Primary Key
PatientID	Insurance table foreign key.	Integer	No	Foreign Key
ProviderName	The name of the Patient's insurance provider	Varchar (20)	No	Not a Key
PolicyNumber	Patient insurance policy number.	Varchar (20)	No	Not a Key

GroupNumber	Patient insurance group number.	Varchar (20)	No	Not a Key
CoverageType	Patient insurance coverage type.	Varchar (20)	No	Not a Key

Table 5.4 Schema Name: Medical History

Purpose: The table's purpose is to store the patient's medical history.

Field	Description	Data Type	Allow Null	Key
RecordID	The medical history table's primary key.	Integer	No	Primary Key
PatientID	The medical history table foreign key.	Integer	No	Foreign Key
Diagnosis	This is a record of the patient's diagnosis.	Varchar (225)	No	Not a Key
TreatnmentPlan	This is the patient's treatment plan.	Nvarchar (200)	No	Not a Key
RecordDate	Date & time the record was generated.	DateTime	No	Not a Key

Table 5.5 Schema Name: Medication

Purpose: The table's purpose is to store the patient's medication information.

Field	Description	Data Type	Allow Null	Key
MedicationID	The medication table's primary key.	Integer	No	Primary Key
Name	Name of medication.	Varchar (20)	No	Not a Key
Dosage	Prescribed dosage.	Varchar (50)	No	Not a Key
Description	Description of medication.	Text	No	Not a Key

Table 5.5 Schema Name: Patient

Purpose: The table's purpose is to store the patient's information.

Field	**Description**	**Data Type**	**Allow Nulls**	**Key**
PatientID	Patient table primary key.	Integer	No	Primary Key
FirstName	Patient's first name.	Varchar (20)	No	Not a Key
LastName	Patient's last name.	Varchar (20)	No	Not a Key
DOB	Patient's date of birth	Date	No	Not a Key

Gender	Patient's Gender	Char (1)	No	Not a Key
Phone	Phone number of the patient.	Varchar (15)	Yes	Not a Key
Email	Email of the patient.	Varchar (50)	Yes	Not a Key
Address	Residential & mailing address of the patient.	Varchar (100)	No	Not a Key
City	Patient City name.	Varchar (15)	No	Not a Key
State	Patient state name	Varchar (10)	No	Not a Key
ZipCode	Address Zip Code for the customer.	Varchar (5)	No	Not a Key
SSN	Patient's social security number.	Char (11)	Yes	Not a Key
InsuranceID	Patient's table foreign key.	Integer	No	Not a Key
EmergencyContactID	Patient's table foreign key.	Integer	No	Not a Key

Table 5.6 Schema Name: Physician

Purpose: The table's purpose is to store personal information about the physician.

Field	**Description**	**Data Type**	**Allow Nulls**	**Key**
PhysicianID	Physician table primary key.	Integer	No	Primary Key
FirstName	Physician's first name.	Varchar (20)	No	Not a Key
LastName	Physician's last name.	Varchar (20)	No	Not a Key
Specialty	Physician's area of specialization.	Varchar (20)	No	Not a Key
Phone	Physician phone number.	Varchar (15)	No	Not a Key
Email	Physician's email address.	Varchar(50)	No	Not a Key

Table 5.7 Schema Name: Prescription

Purpose: The table's purpose is to store information about the patient's prescription.

Field	**Description**	**Data Type**	**Allow Nulls**	**Key**

PrescriptionID	Prescription table primary key.	Integer	No	Primary Key
PatientID	Prescription table Foreign Key.	Integer	No	Foreign Key
PhysicianID	Prescription table Foreign Key.	Integer	No	Foreign Key
MedicationID	Prescription table Foreign Key.	Integer	No	Foreign Key
DatePrescribed	Prescription date.	Date	No	Not a Key
DosageInstructions	Dosage instructions.	Text	No	Not a Key

Table 5.8 Schema Name: Procedures.

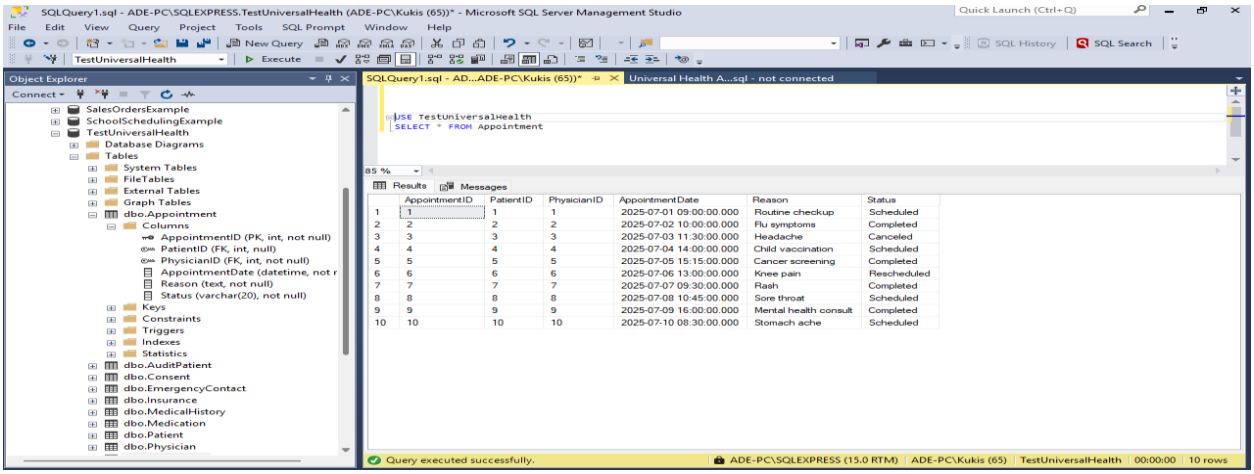
Purpose: The table's purpose is to store information about the patient's procedures.

Field	Description	Data Type	Allow Nulls	Key
ProcedureID	Procedures table primary key.	Integer	No	Primary Key
RecordID	Procedures table Foreign Key.	Integer	No	Foreign Key
Name	The name of the procedure.	Varchar (20)	No	Not a Key
Description	Description of the procedure.	Text	No	Not a Key
Cost	Cost of Procedure.	Decimal (10, 2)	No	Not a Key

PART 6: SCHEMAS WITH SAMPLE DATA.

The Figure below shows the efficiency of the database in patient data retrieval with sample data.

Figure 6.0 - Appointment Schema with Sample Data.



The image above shows the Appointment test data retrieval. The query was executed in less than 1 second.

Figure 6.1 - Consent Schema with Sample Data.

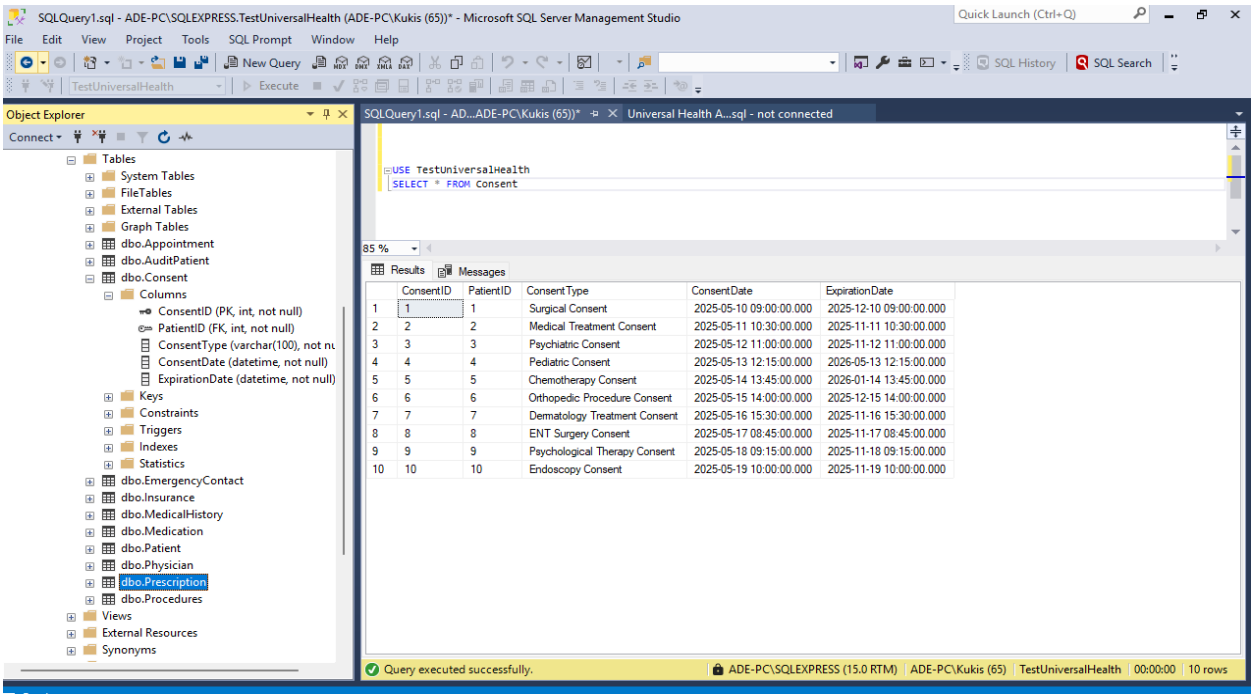


Figure 6.2 - EmergencyContact Schema with Sample Data.

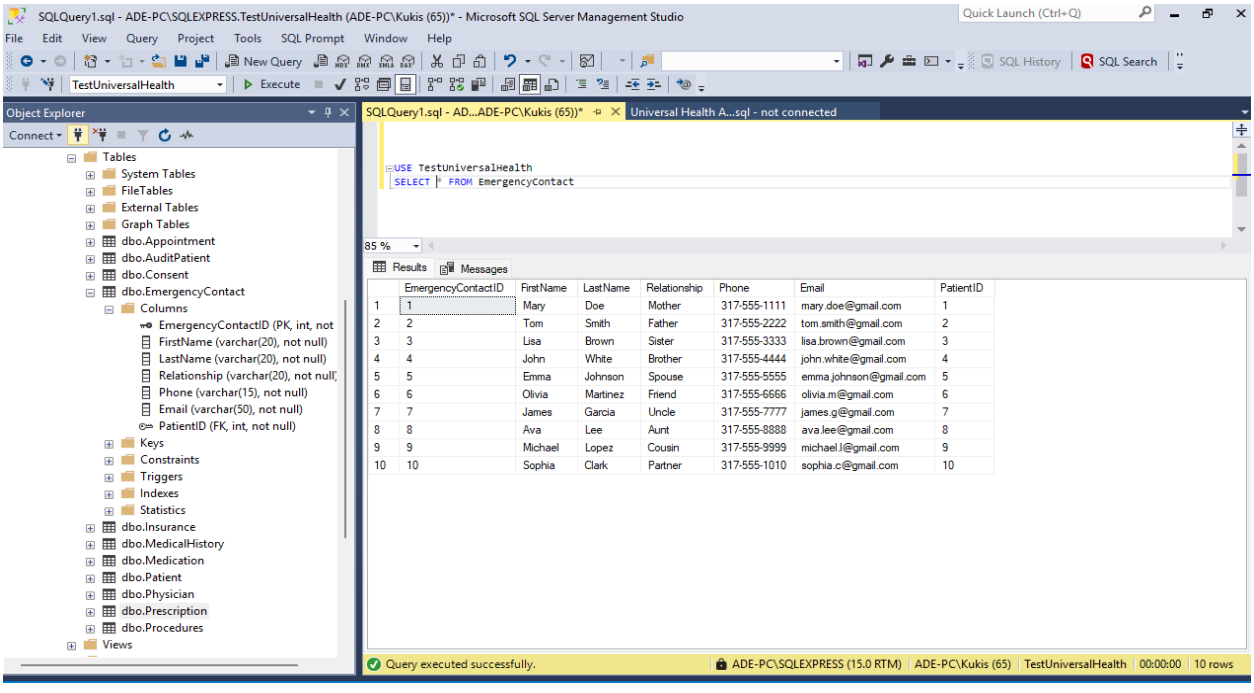


Figure 6.3 - Insurance Schema with Sample Data.

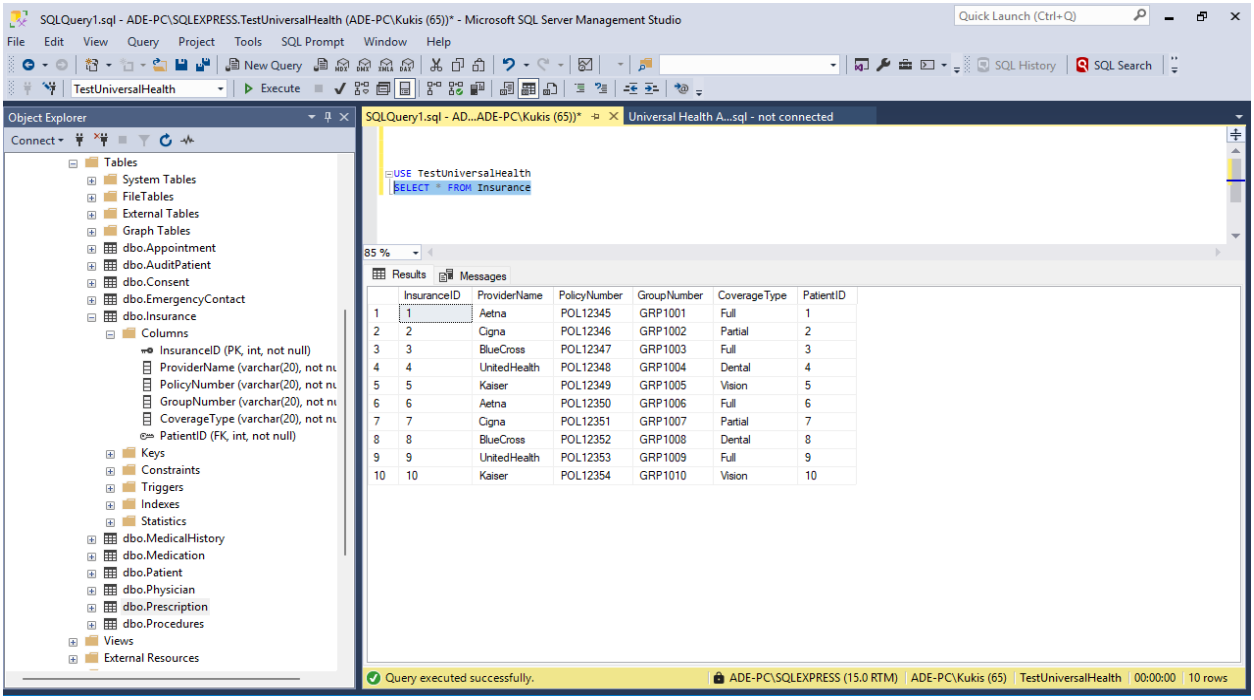


Figure 6.4 - MedicalHistory Schema with Sample Data

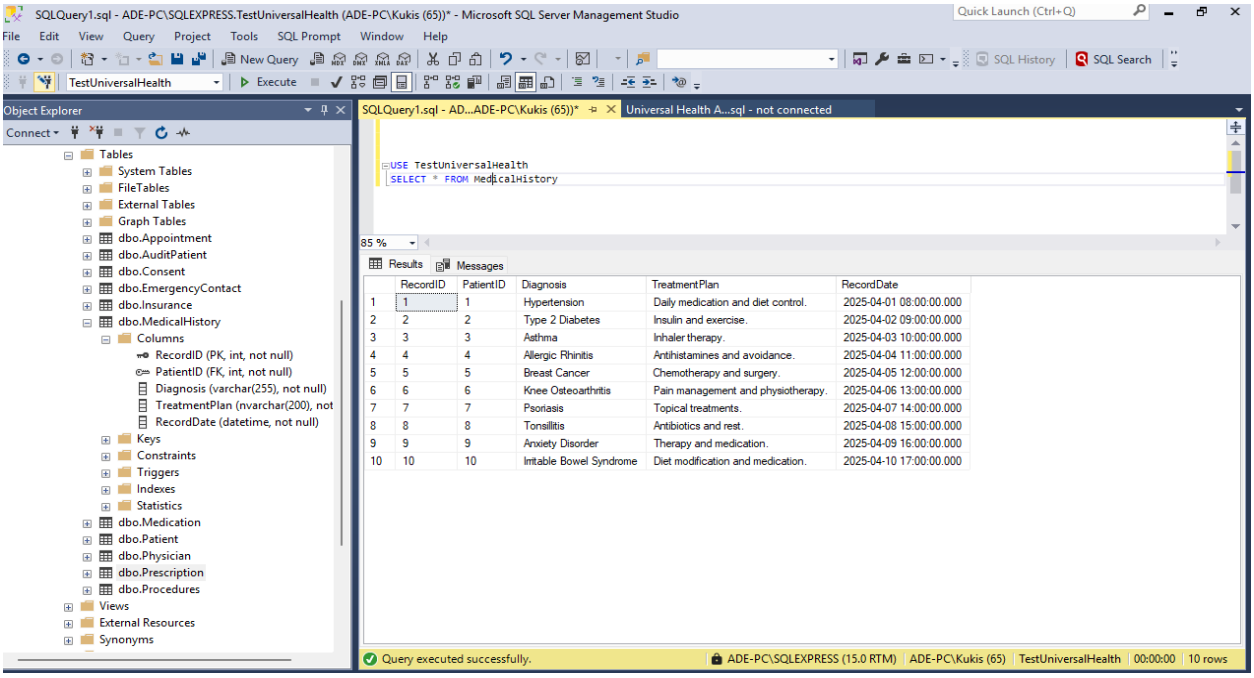


Figure 6.5 - Medication Schema with Sample Data

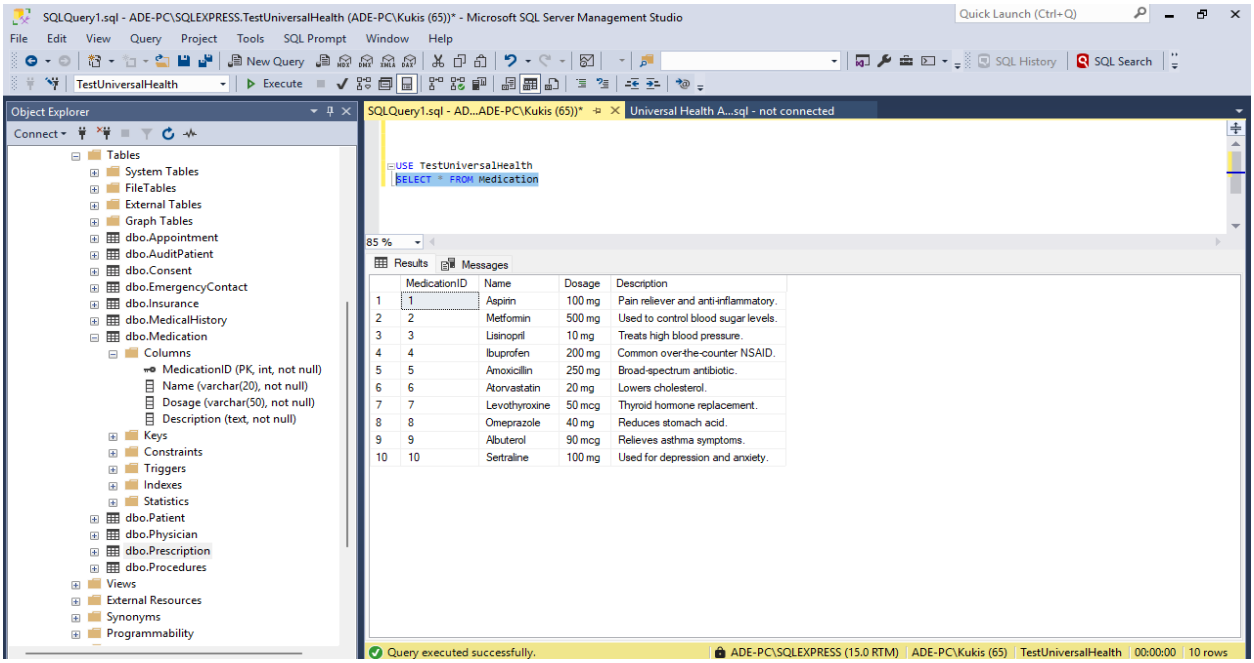


Figure 6.6 - Patient Schema with Sample Data

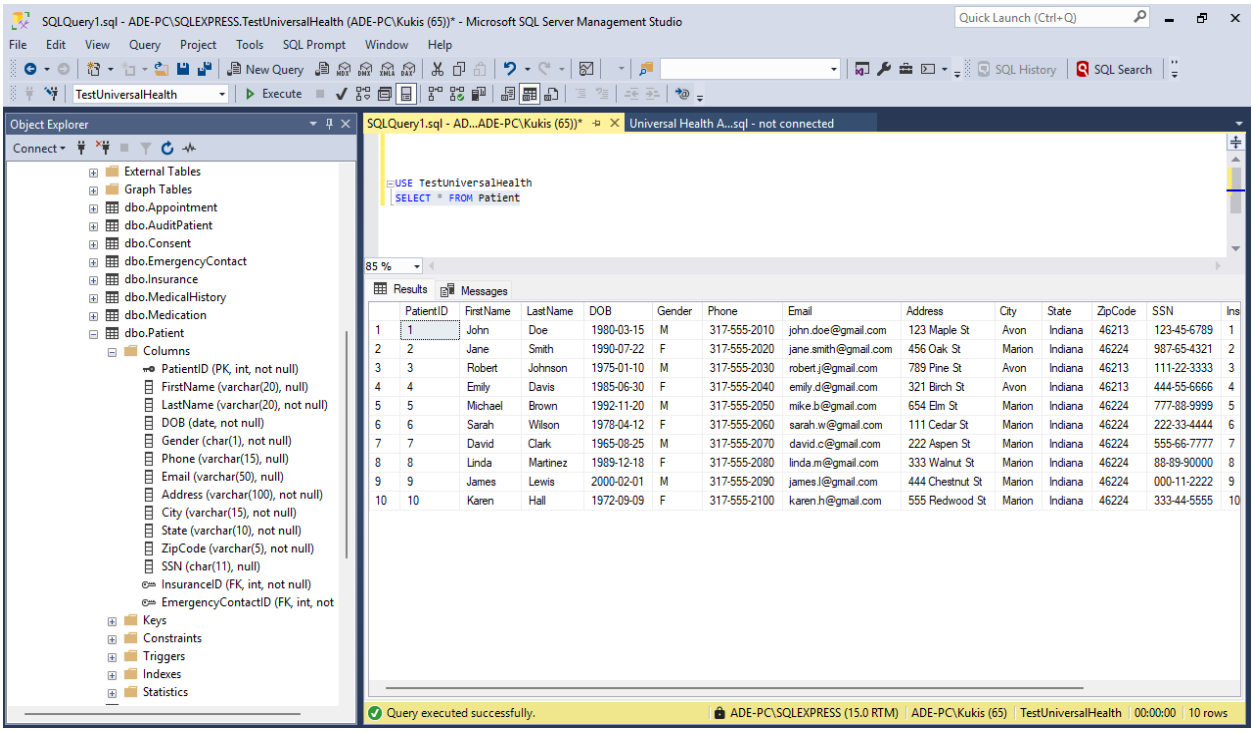


Figure 6.7 - Physician Schema with Sample Data

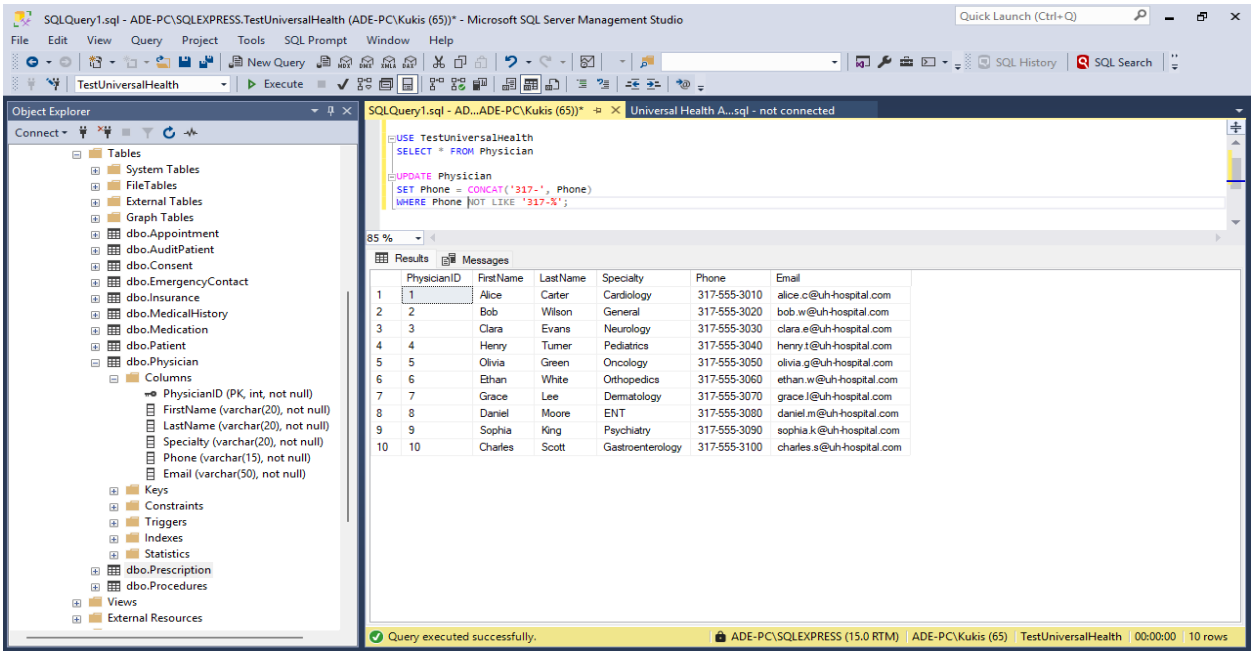


Figure 6.8 - Prescription Schema with Sample Data

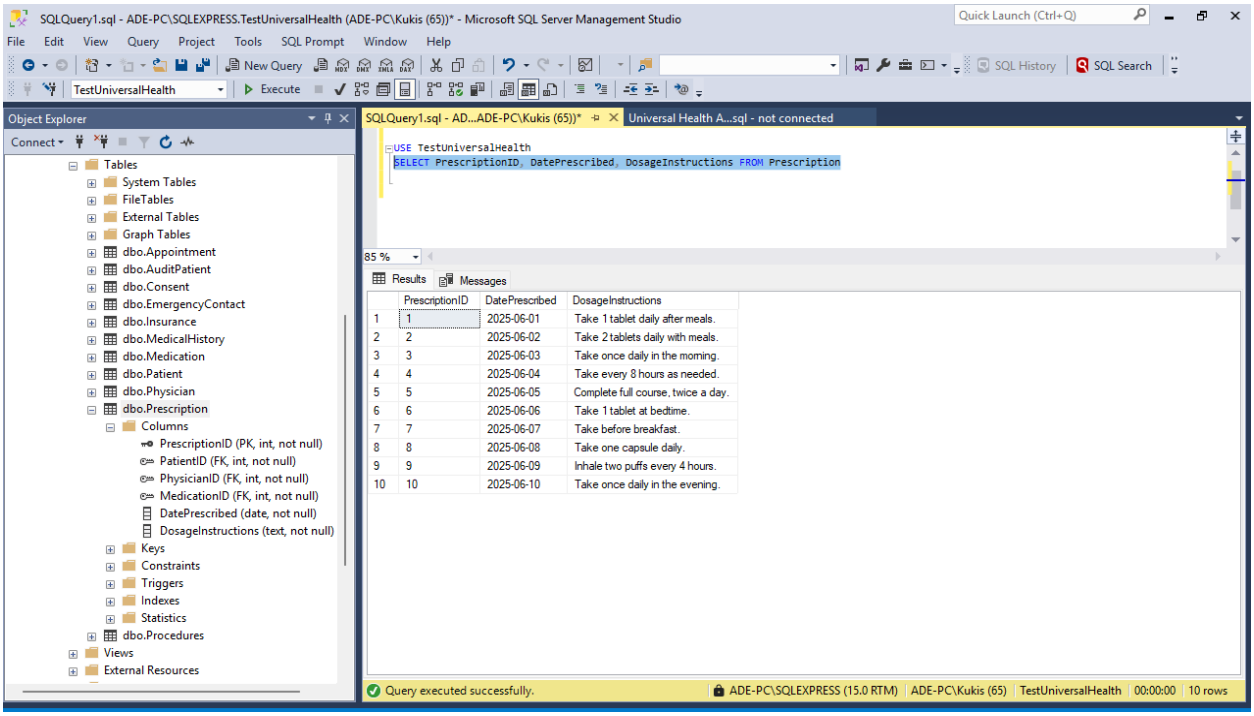
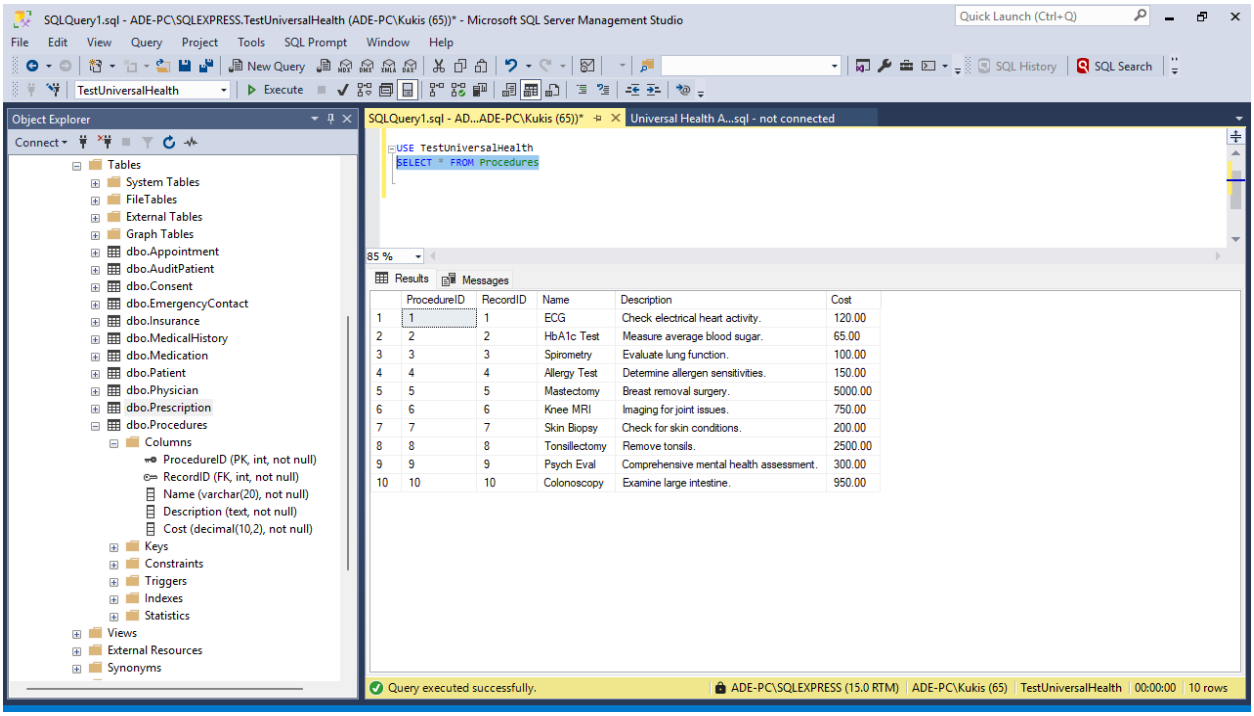


Figure 6.9 - Procedures Schema with Sample Data



	ProcedureID	RecordID	Name	Description	Cost
1	1	1	ECG	Check electrical heart activity.	120.00
2	2	2	HbA1c Test	Measure average blood sugar.	65.00
3	3	3	Spirometry	Evaluate lung function.	100.00
4	4	4	Allergy Test	Determine allergen sensitivities.	150.00
5	5	5	Mastectomy	Breast removal surgery.	5000.00
6	6	6	Knee MRI	Imaging for joint issues.	750.00
7	7	7	Skin Biopsy	Check for skin conditions.	200.00
8	8	8	Tonsillectomy	Remove tonsils.	2500.00
9	9	9	Psych Eval	Comprehensive mental health assessment.	300.00
10	10	10	Colonoscopy	Examine large intestine.	950.00

REFERENCES

- Kendall, E. K and Kendall, E. J (2020). *Systems Analysis and Design 10th Edition. (pp. 409-439).* Pearson Education Limited.