

Database Project: Explore Care System

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# Table of Contents

Introduction.....	3
Background.....	4
Explore Care Database System .....	5
Database Purpose .....	5
Potential Users .....	5
System Architecture .....	7
Data Layer.....	7
Application Layer.....	7
Presentation Layer .....	7
Data Requirements .....	8
Database Design.....	8
Entity-Relationship Model.....	9
Relations and Attributes.....	10
Data Types and Constraints .....	11
Implementation Process.....	12
Maintenance and Support .....	14
Conclusion .....	15
References.....	16

## **Introduction**

In the past decade, there has been an increase in the demand for long-term care facilities, especially for the elderly population. Searching for a suitable facility can be pretty cumbersome, and patients and their families must have easy access to accurate and relevant information. This is where the Explore Care project comes in, to build a database that will be used to create a web-based application for users to search and view long-term care providers in various ZipCodes. The Explore Care database is designed to provide patients with the necessary information for informed decisions about their care. The database will contain a comprehensive list of long-term care providers, locations, and services. Those with access will be able to search for facilities based on specific criteria, such as service offered, location, and ownership type. The database will be updated regularly to ensure it remains accurate and current.

The Explore Care project also includes the development of a web-based application called Explore Care App. The app is built to be user-friendly and accessible from any device with an internet connection. Users will be able to access the app to search for long-term care facilities and view their information.

Moreover, the Explore Care project will significantly benefit the state's health department. The database and app will be a valuable asset for the department to use in ensuring that citizens, especially older adults, have access to certified long-term care providers. The database can identify locations lacking adequate long-term care facilities and implement policies to address the problem. In this way, there is an overall improvement in the quality of healthcare in the state.

## **Background**

According to the World Health Organization, the older population is growing worldwide. For every nation, the proportion of people aged 60 and above is experiencing unprecedented growth. The 2020 data indicate that the global number of individuals aged 60 years and above surpassed that of children under 5 (WHO 2022). The US population is aging at an even faster rate. It is projected that by 2030, 1 in 5 Americans will be 65 years old and over (US Census Bureau 2021). A longer life allows individuals and their families to pursue new activities like long-neglected passions. However, aging is also characterized by biological changes, often leading to an increased risk of diseases and a gradual decrease in mental and physical capacity. In such cases, seniors and their families have to make critical decisions regarding care and living arrangements. Therefore, how can individuals readily and easily get information regarding caregiving and healthcare options, especially in a world filled with massive amounts of data and misinformation?

In the United States, most states are seeing an increase in the proportion of their elderly population. For example, California has the highest number of the older population. According to its Department of Finance, by 2052, individuals age 65 and above will account for 26% of the state's population (Rowlands 2022). As the older population increases, there is a higher demand for long-term care and healthcare services due to cognitive and mobility decline. The big question is how can the government ensure that its citizens have access to quality care.

As I collected data and researched long-term caregiving, I got many advertisements from different facilities. These facilities were creating awareness about their services and location. On March 24, I attended the Health Policy Colloquium, where Dr. William Sage spoke. I asked Dr. Sage about how data can be used to address different problems in the healthcare sector. He suggested that a better way to analyze data is to avoid looking at it from the patient's view. Also,

an analysis of the adverts I received showed that most long-term care facilities promoting their services are private businesses. All these aspects change the direction of my database project. I began looking at building a database that facilities can use to advertise their services. As a direct benefit, patients, older adults, and their families get a resource for exploring long-term care. The increased elderly population will attract investors and firms into the long-term caregiving and healthcare market. Therefore, in this case, a critical question is how long-term care and healthcare facilities can promote their service, attract more clients, and increase revenue.

## **Explore Care Database System**

### **Database Purpose**

The proposed Explore Care Database will be used to build an application that the public can use to analyze and understand caregiving and health options. The Explore Care database will assemble data from nursing homes, long-term care facilities, rehabilitation centers, cost of care, and physicians. It allows seniors and their families to access and evaluate their healthcare and caregiving options through a single application (Explore Care App). As proof of concept, the database and application will cater to California users only. The database can be scaled later to facilitate the use of the application in other states.

### **Potential Users**

The Explore Care database and app benefit several parties involved in the healthcare industry. In addition to the state health department, the following are other potential users and buyers for the Explore Care database and application.

1. ***Long-term Care Providers*** - Long-term healthcare providers, including nursing homes, assisted living facilities, and hospices, can use the Explore Care database and application to promote their services and facilities to potential clients and their families. This will help them to attract more customers and increase profitability.

2. ***Healthcare Providers***: The Explore Care database also host information on various healthcare providers and specialists, especially those that work closely with assisted living and nursing facilities such as dialysis hospitals and cardiologists. These providers can use the app to advertise their services and expand their client base.
3. ***Insurance Companies*** - Insurance firms can use the Explore Care App to identify healthcare facilities and professionals offering their policyholders high-quality care. They can use the information collected to boost customer satisfaction and minimize lawsuits.
4. ***Healthcare Regulators*** - Healthcare regulators, such as the Centers for Medicare and Medicaid Services (CMS), can use the Explore Care database to monitor the quality of care provided by long-term care facilities and other healthcare providers. This will help them recognize facilities that provide high-quality care and take appropriate action against sub-standard services.
5. ***Caregivers*** - Caregivers, such as family members of older adults, can use the Explore Care app to search for long-term care facilities that meet their loved ones' preferences and needs. The app will streamline their decision-making process, ensuring their loved ones receive the best possible care.
6. ***Research Institutions*** – With additional information and updates, scholars or research institutions can use the Explore Care database for their studies on long-term care facilities and their services. Such research will help identify trends and patterns in the healthcare industry and develop strategies for further improvements in the quality of care.
7. ***Government Agencies*** - Government agencies, such as the Department of Veterans Affairs (VA), can use the Explore Care app and database to identify long-term care

facilities and healthcare providers that meet the specific needs of their beneficiaries. The app will help in ensuring that veterans receive the best available support and care.

## **System Architecture**

The Explore Care database project used a three-tier architecture which consists of the data layer, application layer, and presentation layer. This type of architecture accommodates flexibility, scalability, and maintainability for the database system.

### **Data Layer**

The data layer consists of a relational database management system (RDBMS) that stores and manages long-term care facilities, doctors, healthcare facilities and prescription cost data. The Explore Care database is created using PostgreSQL and the pgAdmin 4 Graphical User Interface. The database stores information in several tables, including a table for facilities, a table for dialysis providers, and a table for doctors. The tables are designed using best practices for data modeling. The data layer also includes a mechanism for data recovery. Access control (password) when using pgAdmin also ensures the security and privacy of information.

### **Application Layer**

Explore Care App is a web application created using Shiny, R, and GitHub. The Shiny web application is created using R and hosted on GitHub. It allows users to search and view various types of long-term care and healthcare facilities in various zip codes, counties, and cities. The Shiny application provides a secure platform for accessing and manipulating data.

### **Presentation Layer**

The presentation layer consists of a web-based user interface that allows users to search and view long-term care facilities, doctors, and healthcare providers by location, types of services offered,

rating, and other attributes. The web-based interface is designed using modern web technologies like HTML. The web-user interface allows users to access the database from their smartphones or tablets anywhere.

## **Data Requirements**

The Explore Care database project goal is to store and manage data related to long-term care facilities, including nursing homes, home health agencies, inpatient rehab facilities, and hospice care providers. It also aims at consolidating information on healthcare providers that work closely with long-term care facilities, including dialysis hospitals. The data requirements for the database project are as follows:

1. **Provider Information:** The database stores information about long-term care providers, including their names, certification number, and affiliation. It also has information about their specialization.
2. **Facility Information:** The database stores information about the long-term care facilities themselves, including the type of facility, the number of beds, and the availability of different services, such as late shifts. It should also include information about the facility's staff, including the number of workers.
3. **Billing and Payment Information:** The database should store information about payment for various prescriptions, such as chest pain, renal failure, and psychoses. The cost information includes the total drug charges and insurance coverage.

## **Database Design**

The database for the Explore Care Project is a PostgreSQL database created using pgAdmin 4 GUI. The purpose of the database is to store information related to long-term care facilities and



healthcare providers in various states in the United States. The database is designed to allow for efficient searching and retrieval of data by users of a web-based application.

## Entity-Relationship Model

The database employs the entity-relationship (ER) model. The schema diagram for the database is shown below. It shows the main entities and their relationships in the database.

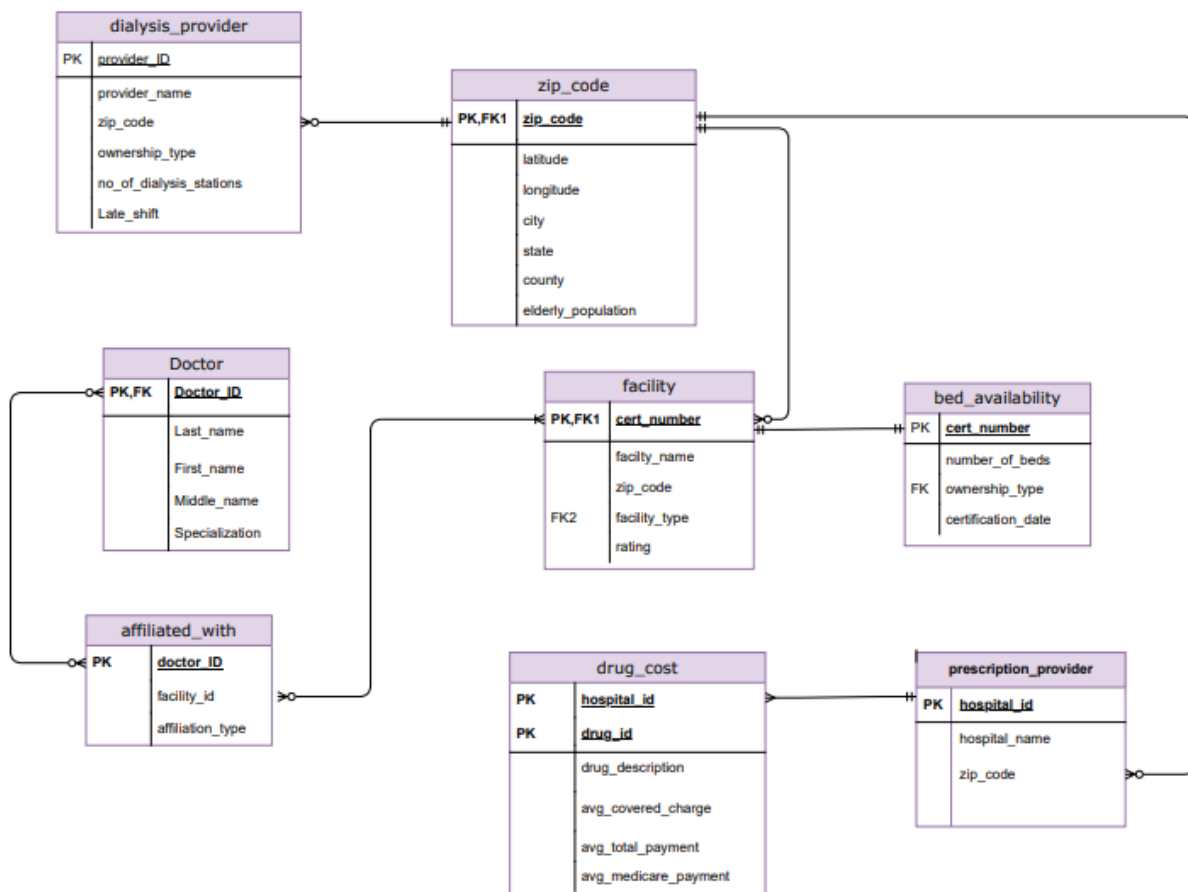


Figure 1. Schema diagram of Explore Care database

The main entities in the database are:

- **Facility:** Contains information about each long-term care facility, including its name, zipcode, facility, type of care provided, and rating.

- **ZipCode:** Contains information about each zipcode, including its code, latitude, longitude, state, and county.
- **Doctor:** Contains information about each doctor, including their name, specialization, and affiliated facility.
- **Dialysis Provider:** Contains information about each dialysis hospital, including its name, zipcode, ownership type, number of dialysis stations it has, and whether it has late shifts.
- **Prescription:** Contains information about each prescription including its id, description, where to get it, and cost.

## Relations and Attributes

Based on the schema diagram, the following relations were created in the database:

- **facility:** Contains fields for Centers for Medicare and Medicaid Services (CMS) certification number, zip code, facility type, and customer rating.
- **bed\_availability:** **bed availability** is a weak entity that depends on the facility table. It contains information about a facility, including the number of beds, the ownership type, and the certification date.
- **doctor:** Contains fields for **doctor\_id** which represents the Provider Advertising ID (PAC ID), a unique identifier assigned by CMS to healthcare providers. It is used to identify a specific provider during the advertisements to patients.
- **Affiliated\_with:** The table provides more information about a doctor's affiliated facility and type of employment (full-time or part-time). **Affiliated\_with** is a weak entity that depends on the doctor and facility relations.

- **Dialysis\_provider:** The table contains attributes including the dialysis center's CMS ID, name, ZipCode where it is located, ownership type (profit or non-profit), number of dialysis stations, and whether the provider has night shifts.
- **Prescription\_provider:** Contains fields such as hospital\_id, hospital\_name, and zip\_code that provide information about hospitals where patients can get different prescriptions.
- **Drug\_cost:** Drug\_cost is a weak entity that depends on the prescription provider entity. The drug\_cost relation has information on a hospital's pricing of different prescription drugs.
- **zip\_code:** Contains fields for ZipCode's latitude, longitude, city, county, and state.

Each table has a primary key field that uniquely identifies each record. The **bed\_availability** will have a foreign key field (**cert\_number**) referencing the **facility table**. Also, the **affiliated\_with** relation will have foreign key fields (**doctor\_id** and **facility\_id**) that reference the **facility** and **doctor** tables. The **facility**, **prescription\_provider**, and **dialysis\_provider** tables have a foreign key field (**zip\_code**) that references the **zip\_code** relation. Lastly, the **drug\_cost** table has a foreign key field (hospital\_id) referencing the **prescription\_provider** relation.

## Data Types and Constraints

The following data types:

- **SERIAL** - An auto-incrementing integer that serves as the primary key for a table.
- **VARCHAR** - A string containing data such as a facility's name, doctor's name, ZipCode, and drug description.
- **NUMERIC** – Used to store numbers in the database, such as average total payment and rating.

The following constraints are used in the database:

- **PRIMARY KEY** - It protects the integrity of the database by ensuring that each record in a table has a unique primary key.
- **FOREIGN KEY** - It protects the integrity of the database by ensuring each foreign key references a valid record in the referenced table.

## **Implementation Process**

The Explore Care project was implemented using PostgreSQL, a powerful open-source relational database management system. The database is hosted on a local server. The database is then used to create a web-based application. The following section provides a step-by-step process of the Explore Care project.

### **Phase 1: Research and Data Collection**

The first step in the Explore Care project involved searching for reputable data sources. The information in the database was mainly sourced from the Centers for Medicare & Medicaid Services (CMS).

### **Phase 2: Database Creation**

The process of creating a database involves the following steps:

- a. Installing and opening pgAdmin GUI.
- b. Creating a new database by right-clicking on the "Databases" node and selecting "Create" and "Database."
- c. Enter the necessary database details, including the database name (explore)
- d. Creating the necessary relations and relationships (DDL) based on the database design described in the previous section. A snapshot of the CREATE TABLE statements for the entities in the database is provided below:

```

CREATE TABLE zip_code (
  zip_code VARCHAR(5) PRIMARY KEY,
  latitude NUMERIC,
  longitude NUMERIC,
  city VARCHAR (30),
  state VARCHAR (2),
  county VARCHAR(30)
);

CREATE TABLE facility (
  cert_number VARCHAR(10) PRIMARY KEY,
  facility_name VARCHAR(200),
  zip_code VARCHAR(5),
  facility_type VARCHAR(50),
  rating NUMERIC,
  FOREIGN KEY (zip_code) REFERENCES zip_code (zip_code) ON DELETE SET NULL
);

CREATE TABLE dialysis_provider (
  provider_id VARCHAR(10) PRIMARY KEY,
  provider_name VARCHAR (200),
  zip_code VARCHAR(5),
  ownership_type VARCHAR(20),
  dialysis_stations NUMERIC(3,0),
  late_shift VARCHAR(3) CHECK (late_shift IN ('no', 'yes')),
  FOREIGN KEY (zip_code) REFERENCES zip_code (zip_code) ON DELETE SET NULL
);

```

Figure 2: Explore Care DDL

e. Entering data into the relations using SQL. The following is a snapshot of the Data

Manipulation Language (DML) of the Explore Care database:

```

insert into bed_availability values ('55060', '93', 'For Profit');
insert into bed_availability values ('55064', '96', 'For Profit');
insert into bed_availability values ('55067', '74', 'For Profit');
insert into bed_availability values ('55070', '80', 'For Profit');
insert into bed_availability values ('55072', '106', 'For Profit');
insert into bed_availability values ('55074', '122', 'Non-profit');
insert into bed_availability values ('55076', '126', 'For Profit');
insert into bed_availability values ('55077', '117', 'For Profit');
insert into bed_availability values ('55078', '60', 'For Profit');
insert into bed_availability values ('55079', '162', 'For Profit');
insert into bed_availability values ('55084', '99', 'For Profit');
insert into bed_availability values ('55085', '49', 'For Profit');
insert into bed_availability values ('55095', '59', 'For Profit');

insert into dialysis_provider values ('52524', 'BMA Santa Rosa', '95404', 'Profit', '16', 'no');
insert into dialysis_provider values ('52543', 'FMC Eureka', '95503', 'Profit', '15', 'no');
insert into dialysis_provider values ('52610', 'RAI Piedmont', '94612', 'Profit', '33', 'no');
insert into dialysis_provider values ('52703', 'RAI West March', '95219', 'Profit', '36', 'no');
insert into dialysis_provider values ('52711', 'Southgate Dialysis', '95823', 'Non-profit', '22', 'no');
insert into dialysis_provider values ('52714', 'Desert Cities Dialysis', '92391', 'Profit', '30', 'yes');
insert into dialysis_provider values ('552668', 'DaVita Pacific Dialysis', '94115', 'Profit', '30', 'yes');
insert into dialysis_provider values ('552689', 'DCI Ukiah', '95482', 'Non-profit', '24', 'no');
insert into dialysis_provider values ('752511', 'Woodland Hills Dialysis', '91367', 'Profit', '15', 'no');
insert into dialysis_provider values ('752549', 'Care Dialysis Center', '91204', 'Profit', '11', 'no');
insert into dialysis_provider values ('752539', 'Spectrum Dialysis', '91335', 'Profit', '1', 'no');
insert into dialysis_provider values ('552516', 'FMC Rancho', '92127', 'Profit', '16', 'no');
insert into dialysis_provider values ('552899', 'Tricity Riverside Dialysis', '92504', 'Profit', '22', 'no');
insert into dialysis_provider values ('52818', 'UCSD Dialysis Centre', '92103', 'Non-profit', '18', 'yes');
insert into dialysis_provider values ('52555', 'Satellite Healthcare Capitola', '95010', 'Profit', '24', 'no');
insert into dialysis_provider values ('52565', 'DaVita Silverado Dialysis', '94558', 'Profit', '10', 'no');

```

Figure 3: Explore Care DML

f. Running/Executing the DDL and DML to create the Explore Care database and saving the database as an SQL file.

### **Phase 3: Data Export for Deployment**

The process of preparing the database for deployment involved the following steps:

- a. Converting the database into an SQLite format using DB Browser.
- b. Saving the db file in a location accessible to the shiny app.

### **Phase 4: The Web Interface**

The process of building a shiny app in R involved the following steps:

- a. Installing and loading required packages, including Shiny, DBI, and RSQLite.
- b. Using the app.R program (UI and server functions) to load data into R and run the shiny app.
- c. Hosting the Explore Care app on GitHub using shinyapps.io

The Explore Care App is a web-based application that acts as an interface to view and query the data in the Explore Care database. The users can search long-term care facilities based on type.

They can also view information on doctors, prescriptions, and dialysis providers. This is the link to the Explore Care App: <https://sharonjepkosgei.shinyapps.io/ExploreApp/>

## **Maintenance and Support**

When Explore Care App is launched, and users can access it, the database will require maintenance and support. I will discuss some steps that can be undertaken to ensure that the Explore Care system remains practical and functional over time.

1. **Regular Backups:** Performing regular database backups protects it against data loss in case of software bugs, hardware failure, or human errors.

2. Database Security: Monitoring and updating database security measures, including access controls, password policies, and encryption.
3. Technical Support: If the app is made operational, technical support should be provided to the database users. There should also be a response to user feedback and implementation of changes or improvements to the database.
4. System Updates: Monitoring and installing software updates and patches ensure that the database remains current and secure.
5. User Training: Providing training to new users of the database ensures that they understand how to use the system efficiently and effectively. Moreover, ongoing training and support to existing users ensure that they are informed about new features and updates.

## **Conclusion**

In conclusion, the Explore Care project is a vital initiative allowing easy access to information on long-term care facilities, healthcare providers, and common prescriptions. With improvements, the app could be sold to the state health department, where it will be used to ensure that citizens have access to certified healthcare providers. The facilities can also promote their services, attracting more clients and higher profit margins. With the limited time period, the database project is just a proof of concept. More records can be added to the tables. Also, additional relations could be added for other healthcare providers, including cardiology centers. Also, the Explore Care app can be used in other states if the information is updated to include facilities in those states. One challenge encountered with completing the project is the time limitation. However, all the requirements have been met.

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