

Teaching Case:

Improving Healthcare Through the Use of Volunteerism: A Database Design and Development Case

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Abstract

With growing costs of healthcare affordability, we are seeing an increase in patients requesting care at free and charitable medical clinics to address their healthcare needs. However, this puts a large demand on our clinics and their ability to perform tasks and provide efficient and effective care. In an aid to minimize the gap in one town, students guided by a professor have been commissioned to develop an in-house clinical system. This case study provides a real-world semester-long project including a unique non-profit business scenario to design and develop a clinical information system. The case is designed for technology and health informatics students enrolled in an introductory database management course with no prior knowledge of relational database experience. However, the uniqueness and range of assignments allow this to be integrated into courses such as capstone or graduate-level management information systems courses, systems analysis and design, project management, and healthcare technology courses for example. The students are given sufficient information to design a moderately complex database for the community clinic, including the development of a physical database, data population, querying, and report creation. Finally, this case is not dependent on any specific database management software (DBMS) and therefore may be used with any DBMS, such as Microsoft Access, SQL Server, etc. Teaching notes containing suggested guidelines, deliverables, and sample data are provided upon request.

Keywords: Database design, database development, health informatics, real-world teaching case

1. INTRODUCTION

Today, more than 1,400 free medical clinics and pharmacies provide essential healthcare services to underserved communities (*The National Association of Free & Charitable Clinics (NAFC)*, 2024). This past year, over 190,000 volunteers served nearly 2 million unduplicated patients across over 5.7 million total visits. Free medical clinics emerge as a response to the many

Americans who are uninsured and live in healthcare deserts due to financial constraints, lack of insurance, and geographical constraints.

2. CASE SUMMARY

Free Medical Clinic of Chapleton County is a non-profit center offering FREE non-emergent health, dental, vision, mental health counseling, charity referrals, and women's wellness services for

uninsured adults in Chapleton County meeting the 200% Federal Poverty Level (FPL) or below. For 2023, to qualify for FPL, a family of four would have an annual income of \$60,000 or less. The clinic needs a well-established information system to serve the patients, staff, and community. The existing paper-based system has made it difficult to access and share information across the different departments, slow recording and processing of information, and slow retrieval of patient details. The clinic's Board of Directors found an Information Systems (IS) professor to volunteer their time (and their students' time) to explore and report on the hardware and software requirements of a new medical system. After the initial analysis was completed, an extensive investigation was done to see if an off-the-self software package would meet the functional requirements of the community clinic's stakeholders. It was determined that no such software package was available. Due to the expertise and financial benefit of enlisting the IS professor and her students, the board decided to hire them to design and implement the relational database for the new medical information system.

3. ORGANIZATIONAL BACKGROUND

Portmore is the county seat of Chapleton County, located in a southeastern state. Chapleton County has had one of the highest growth rates in the state over the past five years. Portmore has a population of approximately 5,200 and the county's total is about 32,000. About 7.8% of families and 12.0% of the population were below the poverty line (\$60,000 or less), including 16.0% of those under age 18 and 5.3% of those age 65 or over. The county is in the foothills of the Blue Ridge Mountains. Portions of the mountain chain extend into the far northern and western portions of the county, with elevations around 3,500 ft. in this area. For the past decade, like many other rural areas in the United States, Chapleton County has been experiencing a shortage of medical personnel and facilities.

The Free Medical Clinic was the vision of Dr. Paul Cadogan, Organizing Pastor for St. Thomas More Church in Portmore. Dr. Cadogan and the congregation at St. Thomas More saw a need in the community and began to serve the community's underprivileged with holiday meals and then a café. Dr. Cadogan began sharing his vision of a clinic for those with no health insurance, and church members took on many roles in their journey to establish a clinic for the Chapleton County community. In September 2009, the clinic opened its doors in the basement of the church, with three exam rooms and an

office where Prescription Assistance volunteers worked during clinic hours to help provide free prescription assistance to clinic patients. In 2010, the clinic lost its visionary, Dr. Cadogan, to a fatal brain aneurysm, but his vision lives on. An expanded Board of Directors, drawing on talented volunteers from within the community, has helped lead the clinic to its status as a vitally important part of the community. Now located in modern facilities at 200 Chapleton Circle, Suite 200 in Portmore. An expanded wider range of services includes general medical care; basic dental care; women's wellness screening; prescription assistance; eye exams and glasses; and information, referral and advocacy for health and support services. The clinic does not provide emergency care or treat chronic pain requiring narcotics.

4. CURRENT SYSTEM AND STATE

To address the tremendous population growth and increased needs of the community, Free Medical Clinic faces a major challenge: the existing paper-based system has led to the loss of patient and staff/volunteer records.

You have been commissioned to develop a clinical information system based on the processes managed at Free Medical Clinic (FMC). For sample clinical information systems sources, see <https://www.powerdiary.com/us/features/online-booking/> or <https://www.how2shout.com/tools/best-free-open-source-clinic-management-software.html>.

Patient Eligibility

Before being assigned an appointment, patients must be qualified for eligibility. This occurs every Thursday afternoon from 1pm – 4pm in person at the clinic. To be eligible, patients must be adults over the age of 18, live in the county without insurance and income 200% of the Federal Poverty Level (FPL) or less. Remember – a family of four would have an income of \$60,000 or less. The patient must also bring an ID (e.g., driver's license or identification card), documentation showing household income with current address, and all current medications.

Patient Registration

Once the patient has been verified and qualified for treatment, they will follow a standard procedure to receive an appointment and begin a patient record. The staff member requests general patient information (name, address, date of birth, email, gender, marital status, number of children,) and their reason for the appointment. Based on the reason for the appointment, the

staff member will assign a clinician or team member to the appropriate medical service department. The clinicians assigned will be based on availability and the appointment will be created. Once an appointment is given, an email to the patient will be sent including a link to the form where medical information, such as medical history, current health issues, and any current medications, will be filled out and submitted before arriving at the appointment.

Patient Arrival

Upon arrival, the patient will check-in at the front desk. Initial information will be pulled from the database and the patient will confirm it is still accurate and fill in any remaining medical record information required (medical history, current health issues, any current medications).

Patient Visit

At the medical appointment, an initial assessment is conducted by a medical assistant or nurse. This could include measuring vital signs (blood pressure, temperature, pulse, and blood oxygen levels) and asking for patient health concerns. *(Note: For complexity, the instructor may add here that when many patients are being seen, a triage process may be applied to prioritize patients based on the urgency of medical needs).*

Next, the patient is greeted by a healthcare provider (i.e., doctor, nurse practitioner, physician's assistant) to discuss their concerns. They will review the patient's history, discuss symptoms, and perform necessary examinations. Based on the consultation, the healthcare provider will offer a diagnosis and recommend a treatment plan, which may include prescribing medications, referrals, or lifestyle changes. In addition, FMC offers support services (information, referral, and advocacy). Should the patient require further care or specialist treatment, FMC will assist in arranging referrals (within the related medical system). FMC will also set up follow-up appointments or check-ins to monitor the patient's progress. Lastly, FMC may provide additional resources such as information about free or low-cost medication programs, community health services, or support groups. If medication is prescribed, FMC will provide it directly to be filled at the FMC pharmacy.

Finally, upon completion of the consultation, the patient goes through the checkout process. Since the clinic is free, there is no charge to the patient. However, this is an opportunity for FMC to encourage donations if the patient has the means. Also, a feedback survey to determine FMC's service is requested. Based on the

consultation if a follow-up appointment or care is requested, staff will set up a new appointment and/or advise on how to seek additional help such as patient advocacy.

Staff, Clinician, and Health Provider Information

FMC is a non-profit organization and therefore uses volunteers to accomplish their goals. Employees/Volunteers include doctors, dentists, nurses, and administrative personnel. Since it is volunteer services, individuals work for the period they are available. This could be a few weeks, months, or years and the clinic is happy to extend its space and efforts to all who are willing and able. FMC would like to collect general information about their volunteers – name, address, phone, specialty, degree(s), skillset, and availability.

Community Health Services

FMC addresses several services in their community. The following list of services may be addressed at their local center.

- General Medical, non-emergency care
- Women's Wellness
- Laboratory Testing
- Prescription Assistance
- Basic Dental Care
- Support Services (Information, Referral, and Advocacy)
- Vision Services
- Mental Health Counseling

Diagnosis Codes - DRG Codes

Diagnoses are typically coded using the International Classification of Diseases (ICD) system, which is used worldwide to classify and code all diagnoses, symptoms, and procedures. Specific codes will vary based on the conditions being treated. We have been provided with a few standard and common types of diagnoses.

Common Acute Conditions

- Ear Infection (H66.9)
- Flu (J10.1)
- Upper Respiratory Infection (J06.9)

Chronic Conditions

- Asthma (J45.909)
- Hypertension (I10)
- Type 2 Diabetes (E11.9)
- Coronary Artery Disease (I25.10)
- Hyperlipidemia (High Cholesterol, E78.5)

Preventive Care and Screening

- Immunization (Z23)
- Routine Check-Up (Z00.00)

Screening for Diabetes (Z13.1)

Minor Injuries and Conditions

Minor Burns (T20.30)

Minor Wounds (S01.01)

Sprains and Strains (S03.90)

Women's Health

Menstrual Disorders (N92.6)

PAP smear exam (Z01.411)

Wellness Screening (Z01.41)

Mental Health Concerns

Anxiety (F41.9)

Depression (F32.9)

These codes help ensure that the patient's medical records are consistent, and that the clinic can properly track and manage the care provided. The actual codes used will depend on the specific conditions and circumstances of each patient.

5. FUNCTIONAL REQUIREMENTS

Forms Requirements

Management at FMC would like to have user-friendly forms to ease the process of entering data related to patients, appointments, clinicians, etc. Input forms, data entry forms, and application forms, complex forms including data from multiple tables, are requested to accomplish their goals. Application forms are designed to add new information related to the combined data. These forms may include split forms, simple forms, multiple-item forms, and/or navigation forms.

1. Create an input form for every table.
Remember attributes are developed from the functional requirements mentioned throughout this case
2. Create application forms for the following:
 - a. Medical History
 - b. Visit Procedure

Query Requirements

Free Medical Clinic's new medical information system must support the following reporting and query requirements:

1. Physician Schedule Query: List all Doctors, available days, and services they may perform.
2. Pharmaceutical and Lab Query: Same query as above but only for pharmacy and laboratory services.
3. Patient information Query: List all patient information for patients who meet the

three requirements for eligibility.

4. Patient Medical History Query: List patient name, DOB, gender, assigned clinician, diagnoses per visit, and medications.
5. Daily/Weekly Schedule Appointment Query: List all appointments per day/week for FMC office. This should highlight the date, time, doctor, patient name, and patient phone number. List the order by date and time.
6. Visitation Summary Report Query: List the number of visits per week and month.
7. Patient Follow-Up Query: List patients who currently do not have follow-up appointments.

Reporting Requirements

To further understand their business needs, FMC would like to create management reports. All fields of the report must be labeled with user-friendly descriptions. **Note:** New queries may be needed to develop some of the reports.

1. Weekly Schedule Report
2. Patient Eligibility Count
3. Prescription Log
4. Patient to Clinician Ratio Report
5. Patient Medical Report
6. Patient Visit Discharge Report

7. MILESTONES

The following section highlights the milestone assignments to be completed and submitted at designated due dates.

Milestone One

Milestone One includes the following:

1. **Executive Summary:** Write an executive summary. This should be a 1–2 page project overview. This is based on your initial analysis of the case scenario as it pertains to designing the clinical information system for FMC. This document will be considered your contract with FMC. It will clearly outline your intentions about the system and what you will develop in terms of specific functionality and your final product. The executive summary should be as detailed as possible. Some assumptions may be made (in the early phases it is often the case that some things are a little fuzzy), but these must be reasonable and defensible within the context of the FMC scenario. The customer is not a technical person so there should be little to no

technical jargon that may confuse them. When technical jargon is required, please properly define and provide a technical document.

2. **Assumptions/Data Generation:** In a separate section, students should record any assumptions made regarding the business process and create at least 10 sample records of data to be used to illustrate the database application.

Milestone Two

Milestone Two includes the following:

1. **Update/Corrections:** Make corrections based on instructor feedback from Milestone One.
2. **Relationship Diagrams:** Create an entity-relationship diagram (ERD). Your first task after your initial analysis is to provide a conceptual data model for your proposed system using a suitable graphical modeling representation. You may use any tool you choose to create the ERD, such as Visio, LucidChart, Word, PowerPoint, etc. Normalization is a necessary process to ensure that all tables and fields meet integrity requirements, reduce redundancy, and ensure a well-structured database. Final ERD diagrams should be in third-normal form with no transitive or functional dependencies (no many-to-many relationships, no composite attributes, no multi-valued attributes, etc.). Be sure to accomplish the following:
 - a. Attributes that serve as identifiers must be underlined.
 - b. All attributes of the entities must be shown using appropriate notation.
 - c. Show all relevant entities and their relationships, including the cardinalities of the relationships and participation requirements set by the FMC scenario.
 - d. Be sure to list all the business rules and any other assumptions.
3. **Data Dictionary:** Create a data dictionary. A data dictionary ensures data understanding and consistency. Your data dictionary provides a clear and concise explanation of each attribute of the clinical information system. You are to include each attribute's appropriate field names, data types, field sizes, identify keys, and format. This ensures that all stakeholders have a basic knowledge of the data and should be used for all tables as described in the scenario.
4. **Database Creation:** Initial database

creation. (*Note: If using a personal database management system (DBMS) such as MS Access, then students should create the tables. If using enterprise DBMS, such as SQL Server, then students should include all necessary SQL CREATE statements enabling the database to be built in the DBMS.*)

5. **Data Population:** Populate all tables with the sample data. (*Note: If using a personal database management system (DBMS) such as MS Access, then students should add all the data. If using enterprise DBMS, such as SQL Server, then students should include all necessary SQL INSERT INTO statements.*)

Milestone Three

Milestone Three includes the following:

1. **Updates/Corrections:** Make corrections based on instructor feedback from Milestone Two.
2. **Functional Requirements:** Review FMC case functional requirements for forms, queries, and reports. Create all necessary forms, queries, and reports.
3. **Design:** Create a simple logo for FMC. Incorporate the logo in your forms and reports.
4. **Navigation:** (*Advanced Option for MS Access*) Create a navigational menu using the Switchboard Manager.

Milestone Four

Milestone Four includes the following:

1. **Documentation:** Create the final documentation representing the creation of your prototype (e.g., database, SQL code, screenshots of forms, queries, reports, navigation menu, etc.).
2. **Prototype:** Submit the completed prototype that illustrates your implementation of the work you have completed in prior milestones. Your prototype, i.e., the database management system, should be performing properly. All functional requirements should be able to be executed.
3. **Presentation:** Create a formal, professional group presentation demonstrating your prototype. Your presentation audience is the Board of Directors and other stakeholders of Free Medical Clinic. It should be well organized and rehearsed. You must be prepared to address the overall scope

and functionality of your project.

7. CONCLUSION

As noted, growing costs of healthcare and increased populations are placing a demand on local clinics to address citizen's healthcare needs and provide effective care. Free Medical Center desires to meet these demands by updating its current paper-based file system to a modernized clinical information system. To address these needs, students guided by a professor have been commissioned to develop an in-house clinical system. The board of directors are relying on your expertise to apply data management skills to address their needs.

This is a term-long database project for students enrolled in an introductory data management course for any business, technology, and/or health informatics program. With the addition of increased complexity, the project may also be prepared for students in intermediate/advanced

levels of database management and systems analysis. To complete the project, students will be exposed to various database development skills. Students will learn to (1) understand the fundamentals of logical and physical data modeling by developing entity-relationship (ER) diagrams, including normalization, (2) create and populate database tables while applying business rules, and (3) create forms, queries, and reports. This project is designed for any relational database management system (RDBMS), such as Microsoft Access, Oracle Database, Microsoft's SQL Server, MySQL, MariaDB, and others.

8. REFERENCES

The National Association of Free & Charitable Clinics (NAFC). (2024). Retrieved September 12 from <https://nafcclinics.org>