

Medical Informatics and Medical Databases Approach in Modeling Healthcare Education System with Unified Modeling Language (UML)

Anil Khatri, Ph.D., Azene Zenebe, Ph.D., and David Anyiwo, Ph.D.

Department of Management Information Systems, Bowie State University, Bowie, MD, USA

Abstract

The research goal in our study of medical information systems tools is to improve the performance of patient decision making by integrating medical professional information with computer augmented information. In part, this goal may be reached by cost-effective software development with validated reusable PCESs object design models, object oriented approach for product line (family of products), UML and with the help of a valid Patient Headache Care Education System derived from these models.

Key Words: Information systems, patient education, software reuse, reference model, medical informatics and patient care.

1.0 Introduction

Currently, there are numerous clinical systems, decision support systems and medical database systems in healthcare delivery. These systems help clinicians in research, administration and in patient care management. These system provides valuable patient data to manage and improve patient care and patient satisfaction with health care delivery system. Mannai [1] reported that researchers need the data to support and validate research, healthcare providers need these automated systems and clinical data to support and enhance the quality of their services, and regulators need such data and its associated statistics for decision support. Information technology (IT) playing an increasingly important role in its delivery to support and enhance healthcare delivery system. The health care industry spent \$12 billion to \$16 billion on information technology in 1996. Further growth is expected as the health care industry implements electronic medical records, upgrades hospital information systems, sets up Intranets for sharing information among related participants and uses public networks. Most hospital and health care

delivery professionals recognize the significant impacts of computers on health care and medicine. The Internet can be used to distribute health-related information and provide remote diagnostics via telemedicine[2]. In spite of this growth in information technology and in the health care industry, use of IT in health care is presumed to be 10-15 years behind. Other IT sectors such as financial institutions, airlines, and manufacturing. Today's healthcare practitioners have realized that they are in an era of modern cyber technology and that they should be running at the same pace as technology is growing. The information super highway has played a major role in many forms in establishing connections, maintaining and organizing health information in a secure and efficient manner and helped health care providers and patients to make better decisions on health related issues.

Computer professionals are working on how information technology can bring changes that would affect health care delivery systems and make them more efficient and effective. Healthcare providers and computer professionals have introduced many applications in healthcare systems with system integration, designing effective and efficient systems to help health care providers to improve consumer's satisfaction. The various applications in health care developed in the 1990s include: patient billing system, patient medical record system, patient monitoring system, clinical decision support system, drug interaction system, medical imaging system and many more. Additionally, pharmacists of the 1990s are also moving well beyond their traditional role and becoming involved in use of information system by making efforts to make health care delivery systems better. Our major focus of this study is also to contribute to and improve health care delivery systems. We emphasize improving the quality of patient care and improve patient's decision making by integrating professional medical information with computers and educating patients about their

illness. In spite of tremendous growth and involvement of technology, health care delivery systems have several holes that need to be filled.

2.0 Problems and Issues: Patient Care Delivery & Medical Information System

Patient satisfaction is a major issue even though the health care industry has employed state-of-the-art technology in health care delivery systems. Patients are not always satisfied with the outcome and no one is to blame. This inadequacy is due to the lack of medical providers, sometimes about hospital systems, lack of software tools, and improper system integration, sometimes about health insurance companies and regulations and policies. Ultimately patients suffer whatever the reason is. The literature has published work on patient satisfaction and outcomes of health systems [3]. There could be many reasons why patients are unhappy and unsatisfied. Medical providers did not spend enough time with them because doctors are busy, lack of communication skills, do not provide enough education so he or she can manage their illness better, doctor and patient do not speak the same language so the patient cannot comprehend. Finham and Werthimer [4] found that physicians spend little time with patients in educating them about health care prevention. Our research hypothesis is that better-informed patients will:

- i) receive better care
- ii) better comply with the treatment plans and therapies
- iii) will have more of their questions answered and satisfaction
- iv) automated tools help healthcare delivery system to be efficient and effective

It appears that there is a clear need to have patient educational tools to provide education about their illnesses while doctors are busy or unavailable. Moreover, patients do not feel comfortable asking questions to health care providers or the lack of communication skills.

2.1 The Importance of the Problem

Patient satisfaction is an important issue and patients can help themselves through education in making and managing illness better. Health care providers and especially HMOs have always encouraged patient education concepts and in a way they have enforced this in many disciplines such as pregnancy, weight loss program, hypertension, quit smoking, diet, exercising and side effects of OTC products. HMOs also

provide a variety of literature, booklets, pamphlets and flyers that show how patients can be better educated and comply with prevention plans for illnesses. Many efforts have been done in this direction from health care providers, communities, many federal agencies have participated to educate and inform patients and make them aware, but still there is a gap that needs to be filled. The patient expectations are not met and they still need to be educated and make their lives better. We have developed an automated educational system in the headache domain to educate patients about their illness and how they can educate themselves and manage their headache better. We took a new and cost-effective approach to develop medical instructional software reuse approach to provide effective and efficient ways of quality educational tools for Patient Headache Care Education (PHCE) using domain analysis and object-oriented approach for product line (family of products). The major role of our PHCES would be educating patients in the headache area providing quality education in three headaches such as: Migraine, Tension and Cluster [5].

3.0 Research Approach & Domain Model

In our study, we elicited knowledge from different sources such as literature; books, journals; pharmaceutical company's brochures; medical experts and Internet in the area of what we derived from our domain model. We collected information and knowledge in the headache domain.

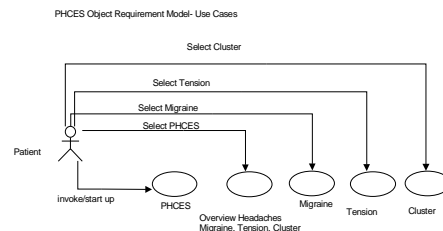


Figure 1. Represents Patient Use Case in PHCES

We then used the Unified Modeling Language (UML) tool to build our domain model as use case diagrams [see figure 1]. Use case diagrams represent a basic and overall functionality of the PHCES. The UML is a graphical language that uses a variety of visual elements to show the semantic elements in a way that is easily grasped and manipulated by a

modeler. Each use case associates software functions with “actors” in the system environment. An actor is an object outside the scope of the system but interacts with the system [6]. This actor may refer to the systems user’s such as patients in our case, as represented in figure 1. Secondly, we analyzed from our domain model what level of language, vocabulary and interface should be used in PHCES system, so that patients do not feel lost but enjoy the education they have received from the system in order to manage their illness better.

We considered number of elements in our PHCES reference model:

- Modeling tool (UML)
- PHCES domain model
- Text, language, terminology and vocabulary
- Graphical user interface (e.g. buttons commands, color etc.)
- Images and
- Databases

We carefully evaluated and analyzed a good user interface for our patients so that they do not have to spend many hours and efforts in learning or navigating the system. Shniederman [7] has suggested screen representation, color combination for designing a good user interface for application development and to make system user friendly and simple. Visual Basic programming language was used to develop for front end user interface and a centralized database was used to store, retrieve and update headache educational information and patients symptoms.

4.0 System Overview

Today, medical and clinical computing environment consist of Internet, graphical user interface, integrated database, data import tools and user friendly systems for computing patient data, clinical data and other types of medical related information to make healthcare delivery much more efficient and satisfactory. Our system provides the mechanism to access information from different databases within PHCES to support multi-database retrieval process. In our system we allow user (patient) to interact with the PHCES in graphical user interface environment. The patient invokes the PHCES and then it is ready to provide number of capabilities to the patients as represented in figure 2.

1. Access to three different headaches databases (Migraine, Tension and Cluster) through a unified interface. This capability provides control to the patient to access any desired headache information, as they preferred

2. Ability to select advance or general headache information depending on their prior knowledge on headaches from the databases
3. Ability to select and store their headache symptoms into the patient record and retrieval
4. Ability to access computerized headache diary to keep track their headache triggering factor, occurrence, time, severity etc. and;
5. Ability to access help and tutorial, if needed.

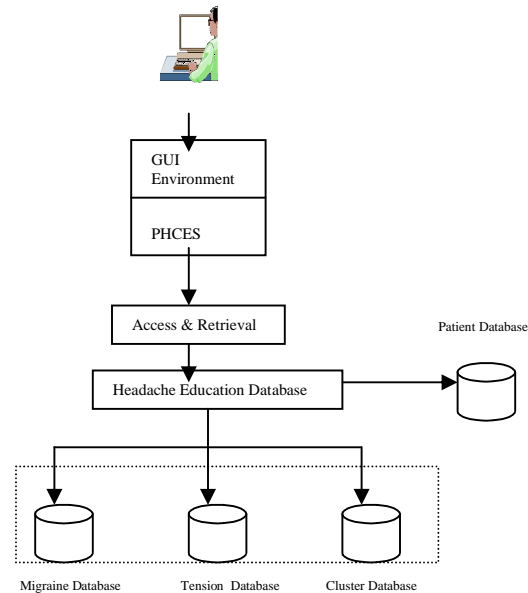


Figure 2. Represents System Overview (PHCES)

5.0 Patient Interaction with The PHCES

The UML provides two different forms of interaction diagrams: Collaboration and sequence diagram. Collaboration diagrams are nothing more than object diagram with small arrows representing the message sent during the course of the collaboration. A sequence diagram represents objects as vertical “instance lines” as shown in figure 3. Messages are shown as horizontal or downward-slanting directional lines that an actor “patient” is interacting with PHCES system and number are displayed for in what order the sequence took place. Figure 4 represents welcome screen for patients to select one of the headaches (Migraine, Tension or Cluster) in which patient can get an education on, and to proceed then click on next command button. This screen provides an opportunity to the patients to navigate the PHCES system back and forth with no efforts. This screen is parallel to developed domain model by using UML in figure 3 message trace diagram at state 3 displaying types of headache education is available in PHCES. This

screen also provides help and assistance to the patients in order to tutor them about the PHCES system, if needed.

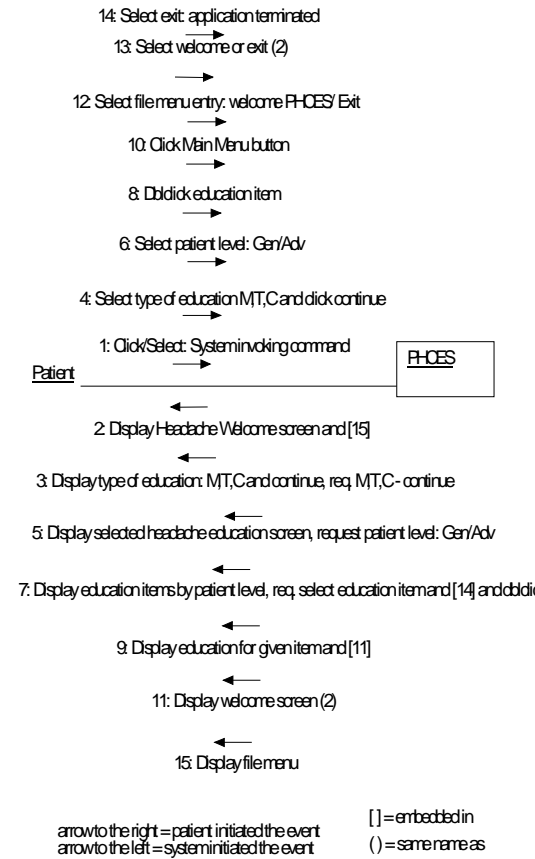


Figure 3. Message Trace Diagram for PHCES

6.0 Data Collection Procedure and Validation Method

Our research hypothesis names two major areas in which a patients feel satisfied with health care delivery system and demand quality education regardless the sources he obtained it from. We have evaluated two scenarios. First, Overall satisfaction with PHCES as an alternative source to learn about headaches. Secondly, in patient’s opinion is using PHCES a better way to provide headache education to the patients. We chose an empirical method to develop and a test solution to a hypothesis, and based upon our results of the test, and improve the solution as needed. PHCES validation process falls under observational category and sub category project monitoring method. An observational method collects Figure

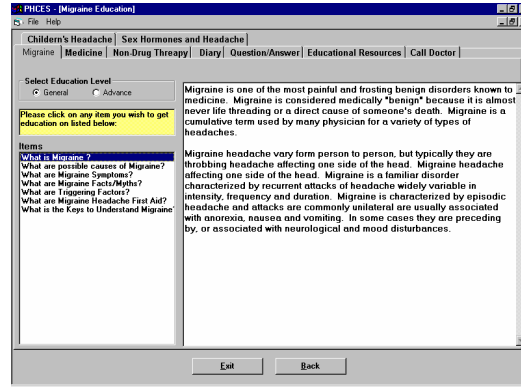


Figure 4. Represents Headache Screen for Patient to Select Education for Headache

relevant data as project develops. The study was done at Veteran (VA) Hospital in Maryland. Forty-five walks in patients were selected on volunteer basis. Outside the study room we have posted a banner stating “Do you get headache? Participate in headache study and get latest information”. In this study room we provided a comfortable chair and table. Patient sat in front of the computer and with keyboard, mouse and colored monitor. PHCES icon was displayed on the desktop and patients were told to double-click on this icon to invoke the PHCES. Our system was place on the table with plenty of room for user to feel comfortable and has enough room for them to answer our experimental survey form. Each individual was briefed as any patient walked in the purpose of this and the objective of this study. We took patients consent after they were briefed that they are willing to participate in this study. Patients were informed that no personal data will be collected other than computer literacy level, college education, age, pattern of their headaches, frequency and severity of their headaches, what medicine do they take to treat their headaches. Rest of the question in our survey was asked about the quality of educational material provided by the PHCES, its interface and satisfaction with the PHCES system.

7.0 Results

I) Overall Satisfaction with PHCES System as an Alternative Source to Learn about Headaches

The purpose of these experiment studies was to investigate that patients are satisfied with alternative resources such as PHCES about their headache illness. Forty-five patients participated in this study from both sexes. Twenty-three participant were female and twenty-two

participants were male with age mean was 44 years. 53% of patient's population agreed, and 42% patients strongly agreed that PHCES system was satisfactory in order to deliver quality education for headaches purpose and willing to learn from other resource. Table 1 represents these results and results are significant as compare to agreed participants with strongly agreed. Only 6% patients responded neutral on PHCES satisfaction.

Table 1. Represents Overall Satisfaction with PHCES

		% of responses
Agreed	24	53.3
Strongly Agreed	19	42.2
Neutral	3	6.6

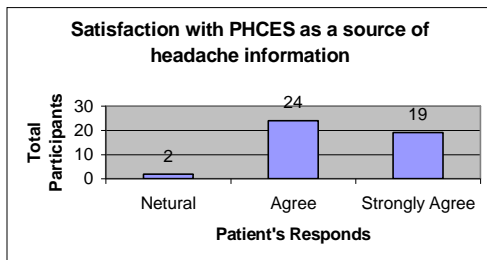


Figure 5. Represents Overall Satisfaction with PHCES

II) In Patient's Opinion is Using PHCES a Better way to Provide Headache Education to the Patients

The purpose of this experiment study was to investigate patient demands and care about good quality education and would like to learn from other sources for their illnesses. Same forty-five patients responded this questions and 51.1% patients agreed, 40% strongly agreed, and only 8.8% patients were neutral in their response. Table 2. depict these results.

Table 2. Represents PHCES a Better way to Provide Headache Education to the Patients

		% of responses
Neutral	4	8.8
Agree	23	51.1
Strongly Agree	18	40.0

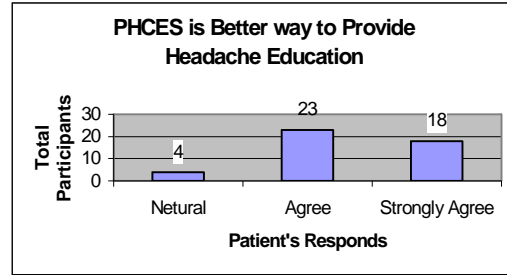


Figure 6. Using PHCES a Better way to Provide Headache Education to the Patients

8.0 Conclusion

One of the major insights gained from this research and contribution was to educate patients from alternative sources as PHCES. As results indicated that 53.3% patients agreed and 42.2% strongly agreed that they are willing to learn and to comply with treatment plans and manage their illness better from alternative sources. In second scenario 51% patients agreed and 40% strongly agreed that PHCES has provided quality headache education. Both results indicate that patients were satisfied and willing to learn about their illness such as headache from alternative sources. The another contribution from this research is the relationship between domain modeling and patient education system development. UML was found to be very useful tool in software development and design architecture for domain modeling. We also conclude that having reuse efforts and designed reuse model there are many more software system can be derive from the domain model in other areas of healthcare and will reduce software development efforts and products can be marketed faster in the market.

9.0 References

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