Database Design of a Patient's Personal Health Informatics for Provincial Government Hospital – Plastic Surgery Department

Ma. Regina P. Bravo and Mary Jane B. Arcilla
De La Salle University - Manila
ma_regina_bravo@dlsu.edu.ph
mary.jane.arcilla@dlsu.edu.ph

Abstract: Provincial Government Hospital (PGH) is a healthcare provider established primarily to provide medical/surgical services to non-infective conditions, especially among indigent Palaweños. The Plastic Surgery Department (PSD) is one of the hospital's departments that needs innovative technologies to maintain its patient's health information. The systems being used within the hospital with its different departments are decentralized. Therefore, patients' information in PSD is remotely captured, organized, and stored through a server. However, this should be done accurately to identify the proper management.

This paper attempts to answer the question: How can a database design help in the creation of a Patient's Personal Health Informatics (PPHI)? To address this problem, designing a physical–logical database that adheres to the Department of Health's Electronic Health Records (EHR) regulation, Data Privacy Act 2012 (DPA 2012 also known as RA 10173), PGH privacy policy, and international EHR standards will ensure the process of capturing, organizing, and storing patients' health information specifically for PGH-PSD.

The design of the database will serve as a jumpstart for the development of a PPHI for PGH-PSD. The integrated and translated database design with its data requirements aligned to the information collected and protected by data privacy regulating bodies may be developed into one logical model using database normalization and data integration.

Key Words: personal health informatics; database design; electronic health records; healthcare, Data Privacy Act 2012

1. INTRODUCTION

According to HealthConnect International in 2014, Information and Communication Technologies (ICTs) help improve healthcare management for individuals and communities. By providing new and more efficient ways of accessing, communicating, and storing information, ICTs bridge the information divides that have emerged in the health sector in developing countries - between health professionals and the communities they serve and between the producers of health research and the professionals who need it. ICTs also provide the capacity to improve health system efficiencies and prevent medical errors. Also, the implementation of Electronic Health Records (EHR) has to revolutionize how health information is collected, stored, and used.

It is often advocated that healthcare professionals tend to deliver better healthcare by being able to efficiently provide up-to-date detail of a patient's healthcare to other healthcare professionals who are involved in treating the patient and by having better access to best practice and the latest research findings (World Health Organization, 2006). But with these initiatives, there are still significant data breaches occurring in different countries (Gabriel et al., 2018). For example, according to Health Insurance Portability and Accountability Act (HIPAA) in February 2019, the most significant healthcare data breach reported in February involved the accidental removal of safeguards on a network server, which allowed the protected health information of more than 973,000 patients of University of Washington Medical Center to be exposed on the internet.

In the Philippine setting, under the state policy enshrined in the Constitution to provide quality healthcare to the Filipinos while protecting and promoting the right to privacy, the Department of Health (DOH), in cooperation with the Department of Science and Technology (DOST), Philippine Health Insurance Corporation (PhilHealth), University of the Philippines-Manila (UPM) and the Commission on Higher Education (CHED), established the National eHealth Program (NeHP) that envisions widespread information-technology (IT)-enabled health services by 2020. It is to implement the Philippine Health Information Exchange (PHIE) to allow the electronic transmission of healthcare-related data among health facilities, healthcare providers, health information organizations, and government agencies, following national standards. The development and implementation of the PHIE will enable a patient's health information to follow the patient wherever healthcare services are provided. Healthcare providers will securely exchange patient's medical or health information to improve healthcare delivery and decision making (Health Privacy Code Implementing the Joint Administrative Order No. 2016-0002: Privacy Guidelines for the Implementation of the PHIE). However, as of this writing, these plans have not been realized. Healthcare providers like the Provincial Government Hospital (PGH) dream of having a Patient's Personal Health Informatics (PPHI), especially in the Plastic Surgery Department (PSD).

PGH-PSD is experiencing difficulties in accommodating patients concerning their health information and medical history, wherein massive data of patients are managed manually when patients are from another hospital or far-flung areas of the province. Transfer of information between departments is done via messaging applications, which compromises the security of patients' health information and violates the Data Privacy Act (DPA) 2012 (also known as RA 10173). Added to that is the current situation in the department where patients have difficulties in keeping their health information. Each department has its own stand-alone patient records management system that has different data formats and generates different reports.

With these, the researchers propose to design a database from a clean slate that would serve as a starting point for the development of a PPHI for PGH-PSD. The database design would adhere to the DOH EHR regulation, DPA 2012, PGH privacy policy, and international EHR standards.

2. METHODOLOGY

Figure 1 shows the research methodology from data collection to validation. Qualitative approaches were used to gather and validate data from and with the respondents of PGH-PSD.

Data collection was done through interviews, focus group discussions (FGDs), and adopting best practices from the methodologies used by different international journals and studies. Then, triangulation was used to compare and contrast all gathered data to develop one specific PPHI database design for PGH-PSD.

Data gathered from the DOH EHR regulation, DPA 2012, PGH privacy policy, and international EHR standards were integrated through the database normalization process to create the Entity-Relationship Diagram (ERD). FGDs were then conducted to validate the database design. The final output of the study was presented to the respondents through an FGD.
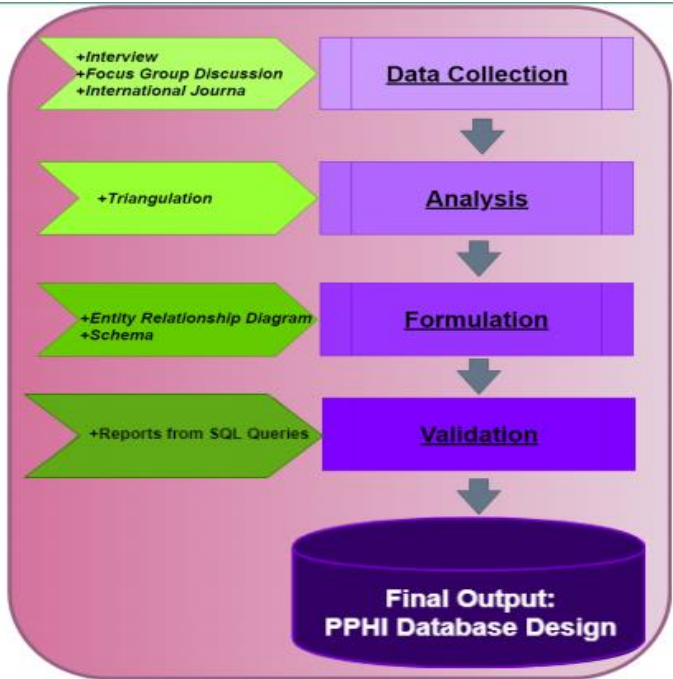
Figure 1: Research Methodology

2.1 Data Collection

Data collection is a way to get information significantly in creating the PPHI database design for PGH-PSD. It was done through an interview and a focus group discussion with six healthcare professionals, which includes one (1) consultant, two (2) resident doctors, one (1) clerical staff, and two (2) nurses from the department. In addition, interviews with the five (5) patients admitted at the PGH - PSD were also conducted to gather additional insights on how database design would benefit them in keeping their health information.

Secondary data from research and international journals related to personal health records, electronic health records, plastic surgery, and database design were studied and used to formulate questions to collect essential data from healthcare professionals and patients. Creating the PPHI database design for PGH-PSD requires reliable information where healthcare professionals give detailed answers on how they capture, organize and store such critical patient's health information. Focus group discussion was conducted to study and validate the collected information for data integration that adhered to DOH EHR regulation, DPA 2012, PGH privacy policy, and international EHR standards.

2.2. Analysis

With the patients' health information being handled and managed at the PGH-PSD, analysis was one of the methods used to effectively evaluate and analyze the process of capturing, organizing, and storing health information. To better understand and study the diverse data and information that has been collected for the study, triangulation became the best approach to formulate the most effective solution to address the problems in handling patients' health information electronically. In addition, triangulation was used to compare and contrast what and how data is being used and processed information adhered to DOH EHR regulation, DPA 2012, PGH privacy policy, and international EHR standards.

The methodological triangulation (analytical induction) made it possible for the researcher to understand the complex process of capturing, organizing, and storing patients' health information from PGH-PSD. It gave direction towards a systematic performance to utilize the database design. The involvement which has been asked from the respondents for data collection within the interview and conducted FGDs led to the comparison and integration of processes and common data that adhere to the DOH EHR regulation, DPA 2012, PGH privacy policy, international EHR standards. It became useful to finish the database design as it was used as a tool to come up with a reliable process for capturing, organizing, and storing patients' health information applied to the PPHI database design for PGH-PSD. Comparisons and analyses have also been done and were taken from the interviews, FGDs, international journals, and research's common findings and results.

2.4 Formulation

To create the PPHI database design, analysis and thorough investigation of data and its sources was formulated from the triangulation. With the studied process of capturing, organizing, and storing patients' health information from the data collection within the PPH-PSD, it was agreed with the respondents to integrate the data requirements and processes being used at PGH-PSD.

The PPHI database design was created using the formulated Entity and Relation Diagram (ERD) and the created schema using MySQL. The ERD was used to formulate information relationships and prove the data integrity of patients' health information in making the most effective database design for PGH-PSD.

2.5 Validation

Validation of the data requirements and processes was conducted by the healthcare professionals, clerical staff, and patients through FGDs. The database design was conceptually explained to the respondents by showing the integrated tables for a non-technical interpretation of the database design. Data population was done within the database design to generate reports of patients' health information. Generated reports using MySQL queries from the created schema of the latter were presented and approved by the healthcare professionals who are the primary respondents of the study.

3. RESULTS AND DISCUSSION

As the researcher studied and analyzed of how patients' information is collected at the PGH-PSD, normalization was used to organize data. This includes creating tables and establishing relationships between those tables according to rules designed both to protect the patient's health information and to make the database design more flexible by eliminating redundancy and inconsistent dependency. First normal form (1NF) was used to eliminate repeating groups of data requirements in the tables of DOH ERH regulation, DPA 2012, PGH privacy policy, and international EHR Standards. Then creating of a separate table for each set of related patients' health information to identify the related information using primary key. Second normal form (2NF) has been done to create separate tables for sets of patients' health information that apply to multiple patients' records and relate these tables with a foreign key. With this, the integration of all generated data requirements was presented using the table to see the related patients' health information and how they are collected.

In the table 1, the color legend represents the relationship of data requirements which will be used to develop an ERD of the database design of PPHI such that

blue: DOH EHR regulation, orange: DPA 2012, green: PGH privacy policy, magenta: international EHR standards, and black: common data.

Table 1. Integration Table

Integration of all generated data requirements of DOH, DPA, PGH Existing Policies, and International EHR Standards					
General Information	Health Information	Medical History	Illness Management and Diagnosis	Wound Character	Etiology
PatientID	Blood_Type	previous_illness	present_allergies	WoundID	woundID
PHIC	Height	previous_lab_test	present_illness	Woound_size	woundType
Last name	Weight	previous_management	Medication	Wound_dimension	duration
First name	Lab_Test	previous_maintenance	Prescription	Wound_age	Location_Injury
Middlename	Maintenance	previous_surgery	Admission_Status	Wound_photo	Circumstances
Case No	Allergies	previous_allergies	Discharge_diagnosis	Woundcare_dressing	Pressure_injury
Birthdate	blood_pressure	family_health_history	Factors_wound_healing	Rationale_type_of_dressing	
Age	heart_rate	previous_prescription	ImmuneSystemStatus		
Occupation	oxygen_rate	previous_attending_physician	PrimaryManagingService		
Address	blood_sugar_level	previouss_diagnosis	vital_signs		

Patient_Type			Lab_test_results		
Sex			Lab_test_results		
Marital_Status			Complication		
Nationality			Management		
			Diagnosis		
			Immunization		
			radiology_images		

Discharge			Description		
Discharge_summary					
Disposition_on_Discharge					

Integration of data requirements with the use of 1NF and 2NF, ERD has been develop to identify relationships of each table and to visualize how patient's health information are connected and useful for constructing the database design. The Figure 2 shows the ERD which will be used to create a schema based on the data requirements develop from the normalization process. It is a structural diagram used to design database that follows a relational model to create the database design of a PPHI for PGH-PSD using MySQL.

Table 2. Cont.

Integration of all generated data requirements of DOH, DPA, PGH Existing Policies, and International EHR Standards						
Procedures Done	Diagnostic Performed	Health Financing	Information Controller	Information Management	Progress Notes	Cost Service
Procedure_DoneID	Surgical_operation ID	Source_Income	Lastname	Manner	Attending Physician	discharge_cost_bill
Operative Procedure	Operative_technique	Monthly_Income	Firstname	Security	Referral	Billing_type
Date_admitted	Systematic_antibiotic_administration	Health_Insurance	Middlename	Level_Encryption	Disposition	Billing_date
Date_discharge		Medical_Assistance	Position		Discharge_plans	Discharge_details
PE_on_			Job_			

Figure 2. ERD of database design of a PPHI
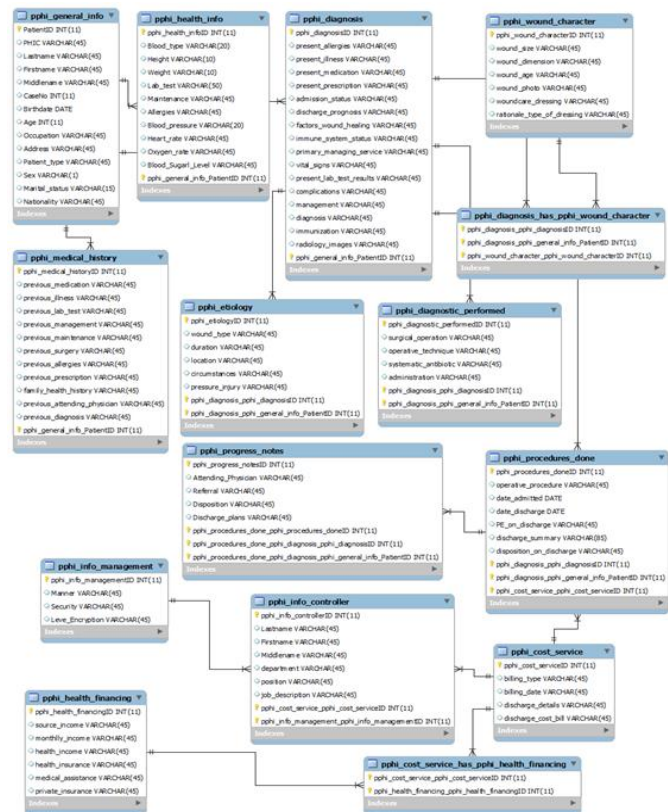
4. CONCLUSIONS

As the researcher studied and analyzed the data requirements that adhere to DOH EHR regulation, DPA 2012, and international EHR standards, the created database design of PPHI for PGH-PSD may help healthcare professional to capture, organize, and store data in the most efficient way. It may help to formulate relevant clinical practice guidelines thus practical and economic health policies with the use of processes and data requirements within the database design.

5. ACKNOWLEDGMENTS

6. REFERENCES

Afshar, M., Ahmad, K. (2015, November 30). A New Hybrid Model for Electronic Record Management. Journal of Theoretical and Applied Information Technology. E-ISSN: 1817- 3195. Vol.81. No.3.

Alabdulaly, W. (2016, April). Database Management System. International Journal of Scientific & Engineering Research, Volume 7, Issue 4. ISSN 2229-5518

Asiminidis, C., Kokkonis, G., Kontogiannis, S., (2018, December). Database Systems Performance Evaluation For IoT Applications. International Journal of Database Management Systems (IJDMS) Vol.10, No.6

Aziz, H. (2015, October). Health Informatics. ResearchGate: Journal of the American Society for Medical Technology

Brumm, B. (2019, August). What is Database: Beginning Oracle SQL for Oracle Database. ResearchGate.

Damodaran, D., **Salim, S., Vargese, S.M.** (2016, April). Performance Evaluation Of MySQL And MongoDB Databases. International Journal on Cybernetics & Informatics (IJCI) Vol. 5, No. 2p. F1. Retrieved October 12, 2004, from LexisNexis.

Das, P. (2019). Telemedicine and Clinical Practices. International Journal of Telemedicine and Clinical Practices. ISSN online: 2052 - 8442

Department Of Health, Department Of Science And Technology, Philippine Health Insurance Corporation. (2016). Health Privacy Code Implementing The Joint Administrative Order No. 2016-0002 "Privacy Guidelines For The Implementation Of The Philippine Health Information Exchange"

Gabriel, M., Noblin, A., Rutherford, A., Walden, A., Cortelyou-Ward, K., (2018, February). Data Breach Locations, Types, and Associated Characteristics Among US Hospitals. American Journal of Managed Care

HealthIT.gov.(2019, May). Electronic Health Records: The Basics. https://www.healthit.govfaq/what-electronic-health-record-ehr

Kazeem Oluwakemi Oseni, Kate Dingley, and Penny Hart. (2018, January). Instant Messaging and Social Networks — The Advantages in Online Research Methodology. International Journal of Information and Education Technology, Vol. 8, No. 1.

Mamlin, B. W., & Tierney, W. M. (2016). The Promise of Information and Communication Technology in Healthcare: Extracting Value From the Chaos. The American journal of the medical sciences, 351(1), 59-68. http://dx.doi.org/10.1016/j.amjms.2015.10.015

The Philippines. (2011). Republic Act No. 10173: Data Privacy Act of 2012. Fifteenth Congress, Second Regular Session, Metro Manila. Republic of the Philippines

Philippine General Hospital. (2017). PGH Official Website Copyright. Retrieved from http://www.PGH.gov.ph/en/about-us-1/