MHI Internship Report: Health Data Analyst at DGI Clinical

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Executive Summary

This report discusses the internship undertaken by the author at DGI Clinical, a Halifax based company that provides innovative clinical metric solutions that demonstrate clinically meaningful outcomes of treatments. The author contributed towards the transformation of DGI's SymptomGuide™ into a mobile health solution for patients suffering from Dementia.

At the end of the internship, the author successfully met the objectives and deliverables of the project, which are

1. Privacy Impact Assessment and Recommendations
2. Database Design
3. Database Migration
4. User Interface Prototype for SymptomGuide™

This internship report introduces background knowledge of the mobile health application in development, details the tasks performed by the author during the internship and its outcomes.

Contents

1. Introduction

The use of mobile computing and communication technologies in health care is a rapidly expanding area of research and practice. mHealth is a branch of Health Informatics broadly defined as the use of mobile technologies to improve health outcomes, healthcare services and health research (Schoenberger, Phillips, Mohiuddin, McNees & Scarinci, 2013). mHealth has been used to support a range of functions from clinical decision support for healthcare professionals, to supporting behaviour change and chronic disease management by patients (Free et al., 2010). Although there have been many mHealth interventions for management of chronic conditions like diabetes and hypertension, there are very few patient-centric mHealth tools for management of dementia (Brouillette et al., 2017). DGI Clinical aims to disrupt this by developing a mobile version of their SymptomGuide™ – a symptom tracking tool for patients affected with dementia. The present report focuses on the author's role related to transformation of SymptomGuide™ into a mobile health solution.

1.1 Project Objectives:

As a health informatics intern, the author was assigned several pivotal tasks in the transformation of DGI's existing web based SymptomGuide™ patient tracking tool on to a mobile platform.

The author was responsible for investigating privacy and security laws applicable to data collected by SymptomGuide™ and prepare recommendations to ensure compliance. In addition to this the author was tasked with improving the backend database architecture to ensure scalability for future growth. Lastly the author was also tasked with developing user flow for the SymptomGuide™ application.

1.2 Deliverables

1. Privacy Impact Assessment
2. Database design and Implementation
3. Data migration into the new schema
4. SymptomGuide™ application User Workflow

2. About the Organization

DGI Clinical is a Halifax-based company founded by Dr. Kenneth Rockwood, a world leading dementia specialist and geriatrician. The company is focused on the provision of tools and techniques for patient-centered research and health care. DGI leveraged its founder, Dr. Kenneth Rockwood's expertise to initially focus exclusively on research to further the field of Alzheimer Disease (AD) treatment. Along these lines, DGI launched SymptomGuide™ in 2006 as part of dementiaguide.com, a web-based tool that allows caregivers the opportunity to track their patients with respect to their symptoms. Currently, SymptomGuide™ is well-established with records of almost 8,000 users with self or caregiver-reported information on their dementia symptoms, across a range of geographic locations. Over time, DGI has expanded its offering and has built numerous bespoke symptom guides for AD and other disease states. These symptom guides allow patients to set goals for treatment in order to track them over time, have been used by diverse groups as outcome measures in clinical research and as patient monitoring tools in clinic settings. DGI's approach to collecting clinically meaningful outcomes is based on choice: patients and their caregivers are given the opportunity to report and track symptoms that are most troublesome to them. Use of older clinical measurement tools can lead to the loss of important clinical signals since non-relevant symptoms are tracked.

In addition to the focus on individualized outcome measurement, DGI works with pharmaceutical and biotech companies to build and customize clinical outcome measurement tools for use in development and testing of their treatment solutions. DGI has also developed a host of sophisticated analytical techniques focused on providing additional information around the clinical meaningfulness of pharmaceutical data. DGI is continually investing in the development of new analytical tools to increase the information value of existing clinical trial data.

3. SymptomGuide™

DGI Clinical has an online web-based tool and educational knowledgebase, the Dementia SymptomGuide™, developed in 2006, that allows patients as well as caregivers to record and track their dementia-related symptoms. To date, the SymptomGuide™ has served over 8000 users as an adjunct in the management of dementia

These 'Symptom profiles' created by users can then be shared with carers, other family, and health providers. The process starts with a user signing up to use the tool. After creating an account, users are prompted to create their symptom profile by selecting and adding from about 70 available symptoms, the ones most important to them. Each of these symptoms further include multiple plain-language descriptions using terms that are often employed and readily understood by patients and families. Typically, the symptom descriptors span a range from the types of problems that would be present in someone with mild dementia to those that would be present in a patient in whom the dementia is severe. These descriptors can help patients and caregivers describe their current symptoms. Once the patient selects the symptoms he/she is prompted to select one or multiple descriptors for each symptom during the process of symptom profile creation. If either the symptoms or descriptors available do not match the patient's need, he/she can enter both the symptom or descriptor manually. During the process of

selecting symptoms, the patient is also prompted to record frequency of each symptom. After entering the symptoms, the patient can rank each of the symptom as per its importance to the caregiver or patient. Once the initial symptom profile is set up, the patient and caregiver can track the symptoms over time using a 5-point scale: Much Worse, Somewhat Worse, No Change, Somewhat Better, Much Better. This longitudinal tracking data can be useful for caregivers or patients diagnosed/undiagnosed with dementia to observe progression of the disease. If the patient wishes, they can share this data with their physician in diagnosing dementia or evaluating therapy response. The 5-point scale used in SymptomGuide™ corresponds to respective numerical values on a modified Goal Attainment Scale (GAS) which lies at the heart of SymptomGuide™.

This concept of Goal Attainment Scaling (GAS) was first developed and utilized in the 1960s and has been applied successfully in numerous therapeutic areas (Kiresuk & Sherman, 1968) (Turner-Stokes, 2009). GAS lends itself quite well for use in tracking the progression of Alzheimer's disease because of Alzheimer's wide variability in clinical expression among different individuals (Rockwood, 2010). Studies have shown that patients/carers and physicians differ in their expectations and impressions of treatment effects. Clinically significant changes that may scale on Alzheimer's Disease Assessment Scale-Cognitive (ADAS-cog) may not accord with patient's treatment expectations or goals. Hence GAS serves as patient-centered, individualized tool to measure clinically meaningful outcomes relevant to the patient (Rockwood, 2002). The SymptomGuide™ tool provides a web based medium to operationalize Goal Attainment Scaling for patients suffering from dementia.

About 5000 profiles include three or more symptoms. In addition to completing their symptom profile, users are prompted to complete a care profile which captures demographic information, pre-existing medical conditions and current treatment information. SymptomGuide™ also includes a well detailed symptom library which serves as a knowledge base for users

seeking information regarding various aspects of dementia symptoms and management.

Recent data has shown that the percentage of mobile users accessing the website has risen to well over 50% of total traffic and due to the poor optimization of the website, majority of these visits did not necessarily translate to use of the SymptomGuide™ tool.

Considering these recent findings and several other factors DGI has decided to morph their SymptomGuide™ tool into a native mobile application. During this process DGI laid out key objectives for the next version of SymptomGuide™: Ensure compliance of SymptomGuide™ with health data privacy laws, Improve existing backend database architecture to be scalable with future growth, Optimize SymptomGuide™ for user friendliness.

4. Description of work at DGI Clinical

The first phase was to understand the project, including objectives, background, business drivers, project scope, and project considerations which was accomplished by meeting with the author's reporting supervisor along with participation of data analytics team and lead developer. The author's initial week involved acquiring good understanding about the SymptomGuide™ tool and its underlying GAS methodology. This was done by sifting through related research articles and DGI's internal literature. The initial week of research and testing was foundational for the author's first task of doing a Privacy Impact Assessment (PIA) of the SymptomGuide™ tool.

4.1 Privacy Threshold Analysis (PTA)

The scope of the PIA was limited to information collected, stored and disclosed by DGI's SymptomGuide™ tool in its current web based incarnation. At the end of the threshold assessment, the need for PIA was deemed

necessary as SymptomGuide™ collects and stores 19 data points that can be classified as Personally Identifiable Information (PII) of users. In addition to these 19 PII's, SymptomGuide™ also collects diagnosis status of dementia, drug and medical history of the users which combined with the PII's qualifies as Protected Health Information (PHI).

4.2 Privacy Impact Assessment & Recommendations

The findings of the PIA and its recommendations were planned to be incorporated in the development of the SymptomGuide™ application as the web-based platform was nearing its end of life and will soon be retired. The author identified all project stakeholders and consulted them in a series of meetings to identify key business aims and rationales in the collection, storage and usage of each of the data points identified in the initial threshold analysis. Following these meetings, the author developed workflow diagrams describing the business process flow of the SymptomGuide™ tool. In addition to workflow diagrams, information flow diagrams were also developed to identify flow of data. Currently existing administrative, physical and technical safeguards where thoroughly reviewed and drilled down during the assessment. Following this a bucket list of recommendations was drawn up by the author. Some notable recommendations are discussed below:

During the assessment, it was identified that most of the PIIs collected were not mission critical to any business processes in place and their collection and storage could not be justified moving forward. Although diagnosis status of users' as well as their medical and drug history was crucial to ongoing research and development by DGI, with restricted or minimal collection of PIIs the impact of this data can be minimized. Therefore, it was recommended that 15 out of 19 PIIs to be scrapped and the resolution of remaining 4 was to be reduced. This step alone by itself significantly reduced the impact of the application on privacy and security by several magnitudes.

It was also noted that there was a lack of transparency in the current privacy policy as the users are not provided any information regarding the purpose and usage of their data. Therefore, to maintain transparency and obtain legal basis for data collection, it was recommended that every user must agree to an updated DGI's Terms and Conditions and its Privacy policy. Failure to do so must restrict usage of SymptomGuide™ with no exemptions to this rule. It is also necessary that the privacy policy must detail the exact use, collection, storage and disclosure of collected personal information from the user.

Due to the indirect nature of data collection pertaining to certain aspects of diagnosis, medical and drug history of a non-user (care-recipient), the user (caregiver) providing the information must sign a consent declaring him/her as the personal representative of the non-user (care-recipient).

In addition to this, several administrative and technical recommendations were made to ensure compliance of the SymptomGuide™ application to Privacy and Security laws in Canada and in the U.S.

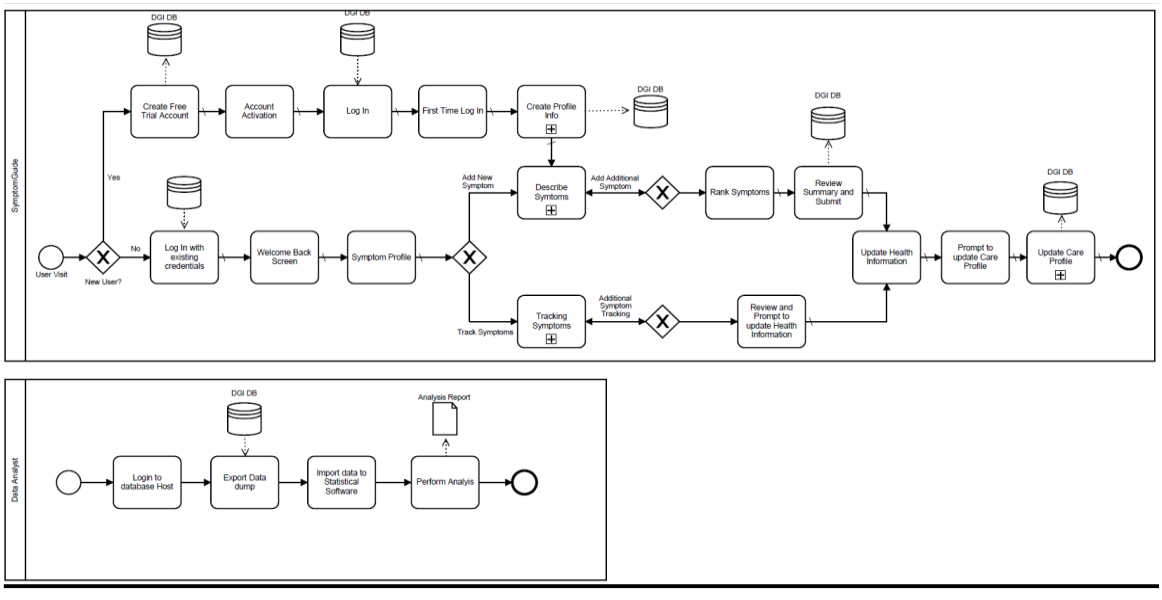

Fig. Workflow of current system

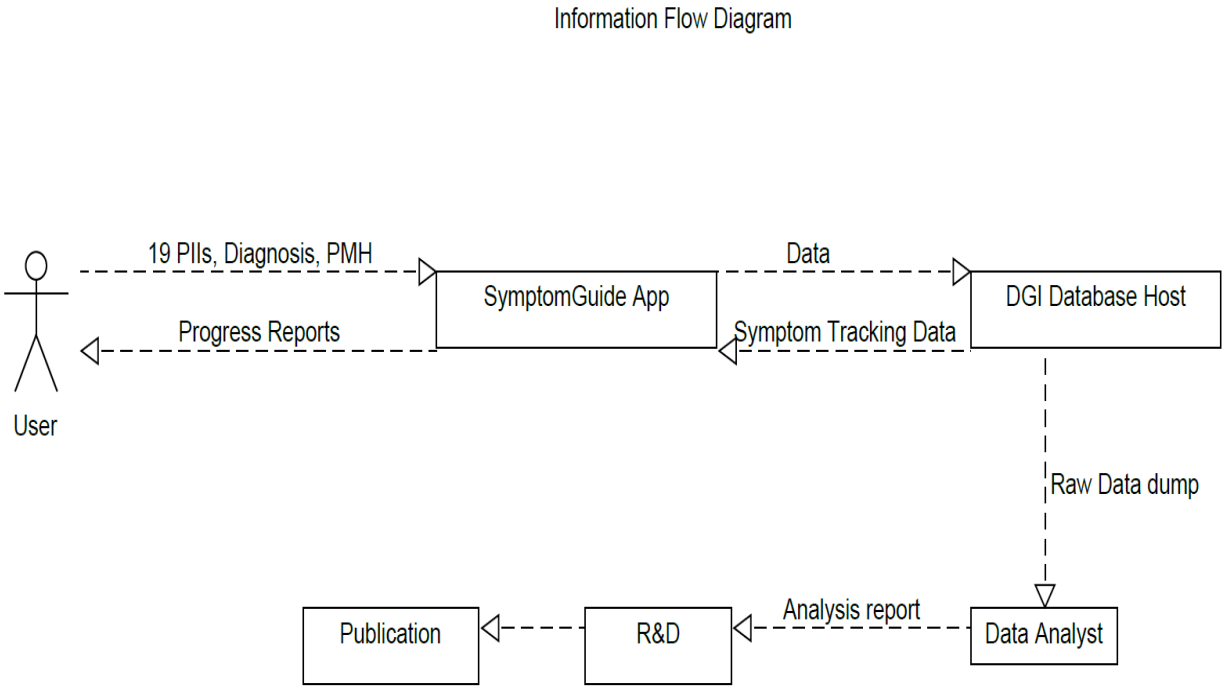

Fig. Information Flow diagram

4.3 Database Design

After completing the privacy assessment, the author was tasked with design and implementation of a new scalable database design for use in conjunction with the SymptomGuide™ application followed by migration of the existing data into the new schema. The new database was planned to be hosted on a HIPAA complaint host. The author began this task by performing requirements gathering and examining the existing database. Since there was no existing Database Administrator (DBA) the author examined DGI's internal data dictionary prepared by the last DBA. This data dictionary was not prepared by the original Database designer and therefore was missing some of the data capture logic which needed to be investigated and mapped by sifting through the website's PHP code. In addition, the author held multiple meetings with the members of the data analytics team. From these meetings, it came to light that the existing database had a poor data quality control

measures in place and during each analysis, the data analysts spent a majority of their time in cleansing the data prior to analysis. The existing database was normalized to a high degree and this impaired the speed of data analysis as it required complex joins to extract the desired data. In its lifetime, the existing database also underwent several minor revisions under different DBAs with no record or documentation of the changes implemented which proved to be a hurdle later in the migration process. During the examination of the existing database, the author noted several poor design choices and the general lack of enforcement of appropriate data types.

Fig. Overview of existing DB reverse-engineered in mySQL workbench

Fig. Lack of enforcement of appropriate datatypes

Certain tables were unusually horizontal due to less than stellar design choices. One such notable example is the storage of user's drug information which was stored as individual Boolean columns along with adjoining dosage column for that specific drug. This drug information must ideally be stored as its own table as only a small percentage of users enter drug information. The user's pre-existing medical conditions are stored in a similar fashion.

profileAricept	tinyint(4)
profileAriceptDosage	int(11)
profileAriceptDosageOther	varchar(255) latin1_swedish_ci
profileExcelon	tinyint(4)
profileExcelonDosage	int(11)
profileExcelonDosageOther	varchar(255) latin1_swedish_ci
profileExcelonPatch	tinyint(4)
profileExcelonPatchDosage	int(11)
profileExcelonPatchDosageOther	varchar(255) latin1_swedish_ci
profileReminyl	tinyint(4)
profileReminylDosage	int(11)
profileReminylDosageOther	varchar(255) latin1_swedish_ci
profileReminylER	tinyint(4)
profileReminylERDosage	int(11)
profileReminylERDosageOther	varchar(255) latin1_swedish_ci
profileReminylXL	tinyint(4)
profileReminylXLDosage	int(11)
profileReminylXLDosageOther	varchar(255) latin1_swedish_ci
profileRazadyne	tinyint(4)
profileRazadyneDosage	int(11)
profileRazadyneDosageOther	varchar(255) latin1_swedish_ci
profileRazadyneER	tinyint(4)
profileRazadyneERDosage	int(11)
profileRazadyneERDosageOther	varchar(255) latin1_swedish_ci
profileEbixa	tinyint(4)
profileEbixaDosage	int(11)
profileEbixaDosageOther	varchar(255) latin1_swedish_ci
profileNameda	tinyint(4)
profileNamedaDosage	int(11)
profileNamedaDosageOther	varchar(255) latin1_swedish_ci

Fig. Drug History in the Existing Schema

profileConditionHearthAngina	tinyint(4)
profileConditionHeartHeartAttack	tinyint(4)
profileConditionHeartIrregularHeart	tinyint(4)
profileConditionHeartCongestiveHeart	tinyint(4)
profileConditionHeartOther	varchar(255) latin1_swedish_ci
profileConditionLungAsthma	tinyint(4)
profileConditionLungCancer	tinyint(4)
profileConditionLungOther	varchar(255) latin1_swedish_ci
profileConditionStomachUlcer	tinyint(4)
profileConditionStomachCancer	tinyint(4)
profileConditionStomachGallBladder	tinyint(4)
profileConditionStomachLiverProblems	tinyint(4)
profileConditionStomachChronicDiarrhea	tinyint(4)
profileConditionStomachOther	varchar(255) latin1_swedish_ci
profileConditionKidneyRecurrentInfection	tinyint(4)
profileConditionKidneyChronicRenalFailure	tinyint(4)
profileConditionKidneyProstatis	tinyint(4)
profileConditionKidneyCancer	tinyint(4)
profileConditionKidneyOther	varchar(255) latin1_swedish_ci
profileConditionArthritisOsteoarthritis	tinyint(4)
profileConditionArthritisInflammatory	tinyint(4)
profileConditionArthritisOsteoporosis	tinyint(4)
profileConditionArthritisFracture	tinyint(4)
profileConditionArthritisOther	varchar(255) latin1_swedish_ci
profileConditionPsychiatricAnxiety	tinyint(4)
profileConditionPsychiatricDepression	tinyint(4)
profileConditionPsychiatricOther	varchar(255) latin1_swedish_ci
profileConditionEndocrineThyroid	tinyint(4)
profileConditionEndocrineDiabetes	tinyint(4)
profileConditionEndocrineOther	varchar(255) latin1_swedish_ci
profileConditionBloodAnemia	tinyint(4)
profileConditionBloodOther	varchar(255) latin1_swedish_ci

Fig. Medical History in the Existing Schema

The author had also noted the serpentine linking of user's table to the symptom tracking table which was proving to be vexatious to the data analyst team. This linking was a classic example of a fan trap (1:M:M:M:M):

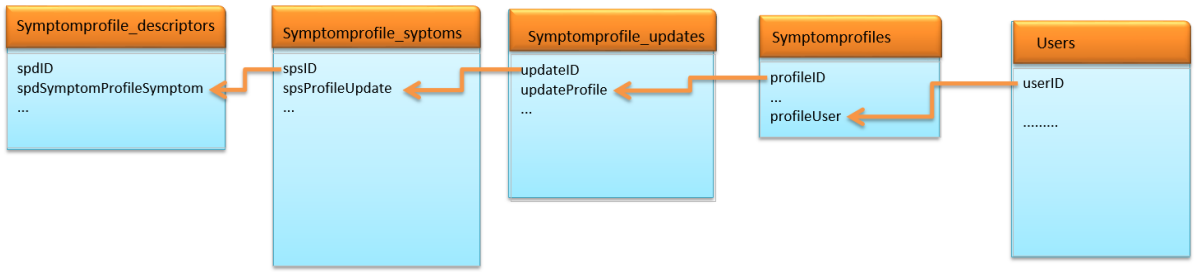

Fig. Fan Trap in the Existing Schema

MyISAM was the storage engine under use in the existing database and due to the lack of foreign key constraints in the MyISAM engine, compounded with absence of any database routines to check the integrity of the data, there was significant accumulation of fractured data over the years.

The author was consulted on the feasibility of migrating existing data into the new proposed design while preserving required information or simply archiving the existing database as it is and moving forward with the new database design on a fresh slate was also considered, and the author was confident of achieving the former.

To this end after thoroughly examining the existing database, noting its various shortcomings and after a productive requirement gathering phase the author proceeded to design the new schema using MySQL workbench software. The core design goals of the new database at the outset were:

1. Introduce new concepts while maintaining backward compatibility with previous database design.
2. Simplify the database while maintaining maximum flexibility and scalability for future feature additions to the SymptomGuide™ application.

3. Design the database to play a dual role: operational database and function as data warehouse for efficient data mining.
4. Resistance to loss of integrity by incorporating multiple constraints and checks

The result was a much more simple and robust database capable of accommodating all pre-existing data (barring the 14 PIIs which were discarded as per recommendations in the PIA report) while improving modularity thus allowing scalability for future upgrades.

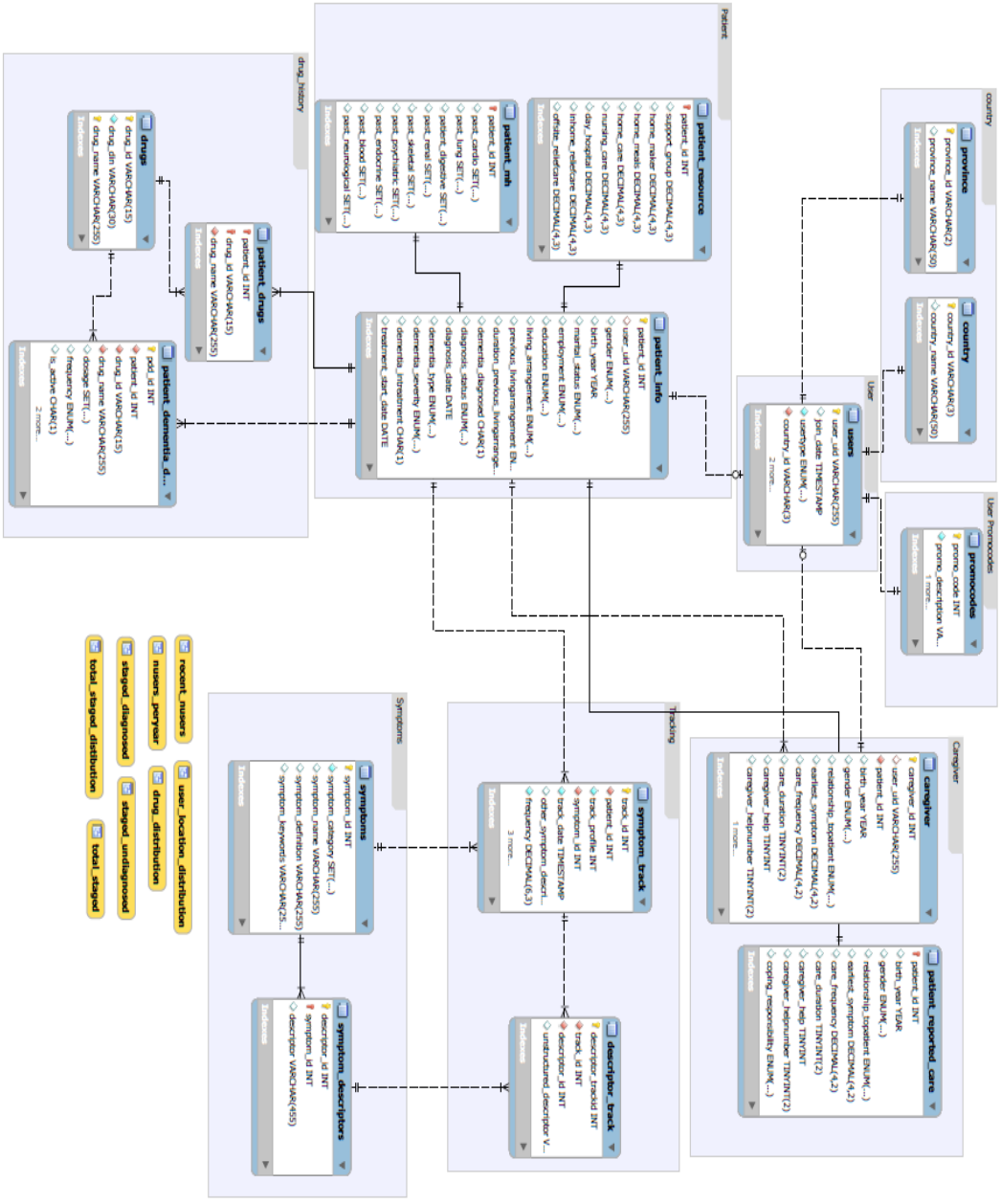

Fig. ER Diagram of the New Schema

4.4 Database Migration

Following the design of the new schema, the author proceeded to plan and execute the migration of old database in to the new schema. To achieve successful migration an Extract-Clean-Transform-Load process was required as it was not a simple migration of existing data and structure to a new host. Due to budget limitations, off-the-shelf Extract-Transform-Load (ETL) tools were not used and as a result the author proceeded to develop an in-house ETL shell script.

The current database (DB) is still under operation and required for functioning of the existing web based SymptomGuide™ Tool. Therefore, the ETL process was staged; the first operation by the ETL script is to extract the data from the source DB and dump it into a staging area (Test Server) before proceeding to perform a manifold set of operations to cleanse and transform the data prior to loading the data to the target database schema.

The ETL Script proceeds to clean the data by performing a series of cascading and complex joins to identify and remove orphan data. During the cleaning process, PIIs that were identified as non-mission were scrubbed from the data set. The author also noted that if a user updates his/her personal profile, a new record was created in some cases rather than the intended update operation. This logic was persistent in a small fraction of older records and absent in recent records signifying a change in underlying logic of the database midway during its lifecycle. Unfortunately, due to the absence of version control by previous DBAs, the rationale behind this change could not be discovered. After confirming that longitudinal tracking of users' personal information was not required, the cleaning portion of the ETL script was tweaked to identify the record with the most information in the case a user had multiple records present in the personal information table.

Post cleaning of the data, the ETL script then proceeds to transform the data in order to conform it to the new schema. A good bulk of the script is

dedicated to this stage of the process. Some notable examples of data transformation are:

patient_id	drug_id	drug_name	dosage	frequency
[redacted]	1	ARICEPT	10mg	o.i.d
	74607	EBIXA	10mg	o.i.d
	2	EXCELON	1.5mg	b.i.d
	6	REMINYL XL	8mg	o.i.d
	4	REMINYL	4mg	b.i.d

Fig. Drug History in the new Schema

The individual Boolean columns for each drug and its specific dosage value was transposed and stored in a separate table with vertical entries.

patient_id	past_cardio	past_lung	patient_digestive	past_renal	past_skeletal	past_psychiatric	past_endocrine	past_blood	past_neurological
[redacted]	Angina,Heart Attack,Arrhythmia,Heart Failure	Asthma,Cancer	Ulcer/Reflux,Gall Bladder Disease,Liver Disease,Ch...	Recurrent Infection,Chronic Renal Failure,Prostati...	Osteoarthritis,Rheumatoid Arthritis,Osteoporosis,F...	Anxiety,Depression	Thyroid Disease,Diabetes	Anemia	Eye Disease,Impaired Hearing,Migraines,Stroke,Park...
	NULL	Asthma	Ulcer/Reflux	NULL	Osteoarthritis,Rheumatoid Arthritis,Osteoporosis,F...	Anxiety,Depression	Diabetes	NULL	NULL
	Heart Attack	NULL	NULL	NULL	Osteoarthritis,Rheumatoid Arthritis,Osteoporosis,F...	NULL	NULL	NULL	Eye Disease,Impaired Hearing
	NULL	NULL	NULL	NULL	Osteoarthritis,Rheumatoid Arthritis,Osteoporosis,F...	Anxiety,Depression	NULL	Anemia	NULL
	NULL	NULL	NULL	NULL	Osteoarthritis,Rheumatoid Arthritis,Osteoporosis,F...	NULL	NULL	NULL	Eye Disease,Impaired Hearing
	Angina	NULL	Ulcer/Reflux	NULL	Osteoarthritis,Rheumatoid Arthritis,Osteoporosis,F...	NULL	Thyroid Disease	Anemia	Eye Disease
	Arrhythmia	NULL	NULL	Recurrent Infection	Osteoarthritis,Rheumatoid Arthritis,Osteoporosis,F...	Anxiety,Depression	NULL	Anemia	NULL

Fig. Medical History in the New Schema

The ETL script creates a new table for storing medical history and condenses the medical conditions in to a SET datatype and proceeds to populate the table by employing a combination of CASE expressions with nested REGXP functions achieve the result seen in the above figure.

Fig. Date storage in new schema

The ETL script also converts unstructured date entries by user into structured dates in the new schema.

Post transformation the ETL script finally loads the data in to the newly designed schema hosted on a different server. The final resultant data set was thoroughly validated by the data analysts to find inconsistencies. Based on findings from the data analyst team, the cleaning component of the ETL script was tweaked to be slightly less aggressive. The data analyst team also noted that data no longer needed to be pre-processed prior to analysis and required only simple joins to get the desired outcome.

The author also incorporated one of DGI's proprietary algorithms in the new database as a VIEW in addition to several other common analytic VIEWS to free up data analysts from performing repetitive tasks. These virtual tables were then used in conjunction with PHP code and JavaScript to produce a proof-of-concept analytics dashboard to view common metrics from SymptomGuide™.

Fig. Proof-of-concept Analytic Dashboard

4.5 SymptomGuide™ Application Prototype

Following the successful completion of the database design and migration, the author was assigned to develop a user flow for the in-development SymptomGuide™ application. Workflow diagrams using BPMN notation were developed depicting the user flow and illustrate important business rules to be incorporated in the application.

In addition to developing workflows, the author also developed an interactive working interface design prototype of SymptomGuide™

application. This prototype was improved following feedback from all stakeholders and is planned to be used in early user experience tests to identify and resolve potential user interface issues.

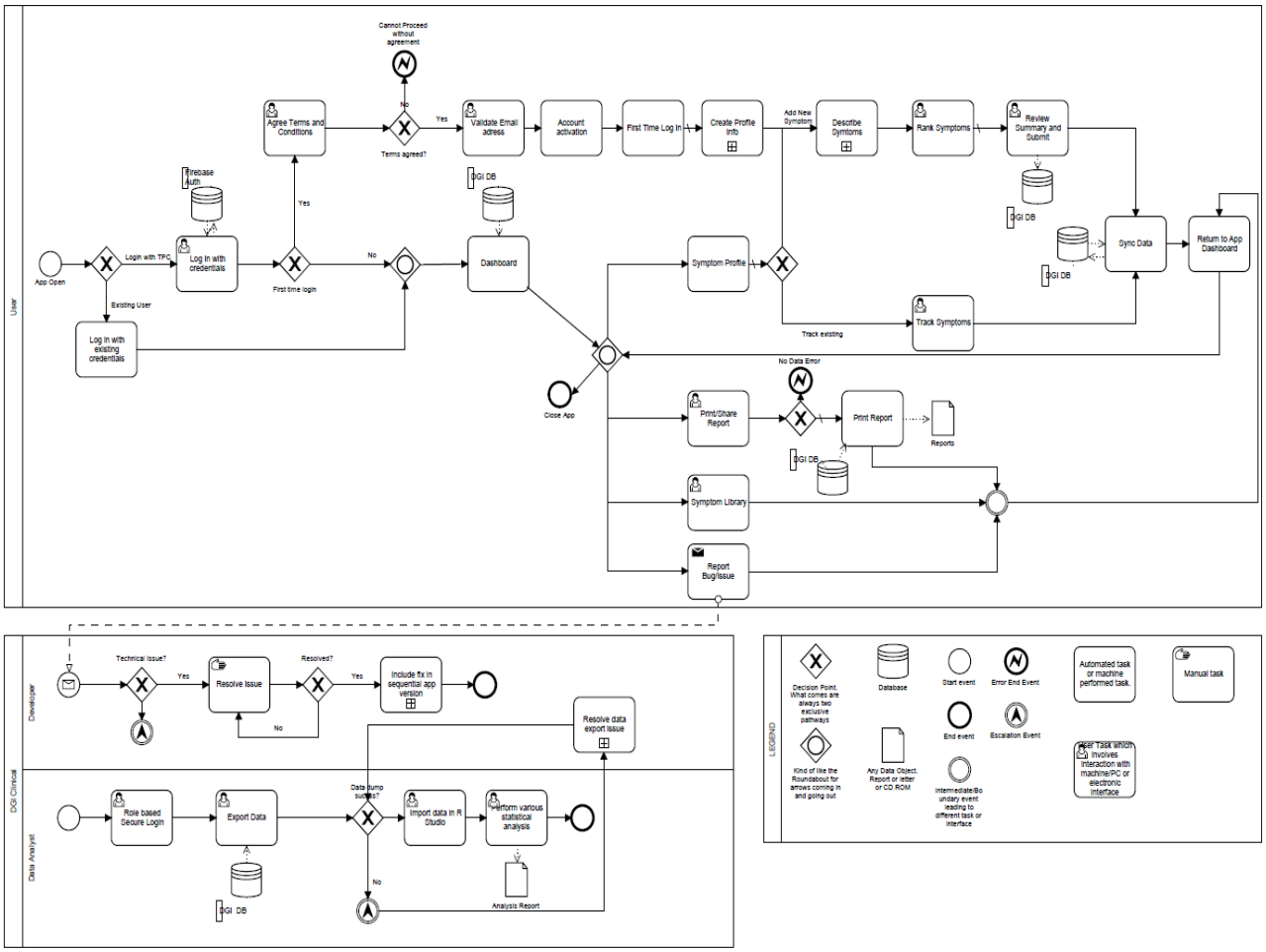

Fig. App process workflow

Fig. SymptomGuide™ Application Wireframe and Prototype

5. Relation to Health Informatics

The author had successfully completed eight courses before undertaking this co-op term with DGI Clinical. These courses laid the foundation allowing the author to undertake and successfully complete the assigned tasks. The work conducted during the initial phase of the internship greatly leveraged the knowledge gained from HINF 6101 to analyse the flow of health information and map these flows and processes using the Business Process Model and Notation (BPMN). These workflows were central to completing the privacy impact assessment of the SymptomGuide™ tool. While performing privacy impact assessment the author learned a great deal regarding privacy laws in general and in relation to protected health data. The author was able to leverage this research in formulating recommendations for the SymptomGuide™ application.

The principles of effective database design and implementation taught in HINF 6220 was crucial in the author's task of database design and migration during the internship. Understanding the unique requirements in the storage of health data imparted during this course bolstered the author's ability to understand the needs and formulate an appropriate design for the database.

HINF 6110 imparted into the author of systematically breaking down a system into its component parts to identify bottlenecks and resolve them. Knowledge of effective user interface design imparted during this course

greatly assisted the author during the prototyping the user interface for the SymptomGuide™ app.

As a health informatician, the author could quickly grasp understanding of goal attainment scaling used to track the progression of dementia. This allowed to author understanding required to operationalize GAS in the database and while developing the user flow. During development, the author could leverage his understanding of mhealth concepts learned during the study terms of his health informatics program and contributing those ideas and knowledge to the effective development of the SymptomGuide™ application.

It is also worth noting that all recommendations regarding collection and storage of health data made by the author during the course of his internship were implemented to ensure compliance with applicable privacy and security laws.

6. Conclusion

The internship at DGI Clinical was a great learning experience and work opportunity for a Health Informatics student. DGI's commitment to putting the patient at the centre and basing their methodologies on ground-breaking research earned the author's admiration and provided inspiration to strive for excellence. It also provided the author the opportunity to showcase the wide gamut of skills a health informatician can bring to the team.

7. Glossary

Terms	
BPMN	Business Process Model and Notation (BPMN) is a graphical representation for specifying business processes in a business process model.
Database	A database, often abbreviated as DB, is a collection of information organized in such a way that a computer program can quickly select desired pieces of data.
ETL	In computing, Extract, Transform, Load (ETL) refers to a process in database usage.
GAS	Goal Attainment Scale. Goal Attainment Scaling (GAS) is a therapeutic method that refers to the development of a written follow-up guide between the client and the counsellor used for monitoring client progress.
IFD	An information flow diagram (IFD) is a diagram that shows how information is communicated (or "flows") from a source to a receiver or target.
JavaScript	JavaScript is the programming language of HTML and the Web. The most common use of JavaScript is to add client-side behaviour to HTML pages, also known as Dynamic HTML (DHTML)
mySQL	MySQL is an open-source relational database management system (RDBMS).
PHP	PHP (recursive acronym for PHP: Hypertext Pre-processor) is a widely-used open source general-purpose scripting language that is especially suited for web development and can be embedded into HTML

PIA	Privacy Impact Assessment (PIA) is a process used to evaluate and manage privacy impacts and to ensure compliance with privacy protection rules and responsibilities.
Schema	The database schema of a database system is its structure described in a formal language supported by the database management system (DBMS)
SymptomGuide	DGI's flagship tool for tracking symptoms related to dementia
VIEW	A database view is a searchable object in a database that is defined by a query.

References

1. Brouillette, R., Foil, H., Fontenot, S., Correro, A., Allen, R., & Martin, C. et al. (2017). *Feasibility, Reliability, and Validity of a Smartphone Based Application for the Assessment of Cognitive Function in the Elderly*. Retrieved 14 August 2017, from
2. Free, C., Phillips, G., Felix, L., Galli, L., Patel, V., & Edwards, P. (2010). The effectiveness of M-health technologies for improving health and health services: a systematic review protocol. *BMC Research Notes*, *3*(1), 250. http://dx.doi.org/10.1186/1756-0500-3-250
3. Rockwood, K. (2002). Goal setting and attainment in Alzheimer's disease patients treated with donepezil. *Journal Of Neurology, Neurosurgery & Psychiatry*, *73*(5), 500-507. http://dx.doi.org/10.1136/jnnp.73.5.500
4. Rockwood, K. (2010). An Individualized Approach to Tracking and Treating Alzheimer's Disease. *Clinical Pharmacology & Therapeutics*, *88*(4), 446-449. http://dx.doi.org/10.1038/clpt.2010.68
5. Kiresuk, T., & Sherman, R. (1968). Goal attainment scaling: A general method for evaluating comprehensive community mental health programs. *Community Mental Health Journal*, *4*(6), 443-453. http://dx.doi.org/10.1007/bf01530764
6. Schoenberger, Y., Phillips, J., Mohiuddin, M., McNees, P., & Scarinci, I. (2013). Acceptability of Delivering and Accessing Health Information Through Text Messaging Among Community Health Advisors. *JMIR Mhealth And Uhealth*, *1*(2), e22. http://dx.doi.org/10.2196/mhealth.2641
7. Turner-Stokes, L. (2009). Goal attainment scaling (GAS) in rehabilitation: a practical guide. *Clinical Rehabilitation*, *23*(4), 362-370. http://dx.doi.org/10.1177/0269215508101742