ESTABLISHING NUTRISYS, A NUTRITION INFORMATION SYSTEM

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Abstract - A computer-based nutrition information system that is used by nutritionist-dietitians and clinicians can hardly be found in the Philippines. As such, nutritional records are still recorded on paper although some were already manually encoded in spreadsheets. Capturing the necessary information is time-consuming as it requires a lot of cross-referencing and computations, all the more with the generation of reports needed to do clinical research. As part of a class project of MS Health Informatics students of the University of the Philippines Manila enrolled in HI 210 (Systems Analysis and Design) and the BS Computer Science students enrolled in CMSC 128.1 (Software Engineering I) also from the same university, NutriSys was developed to capture, organize and disseminate electronic data accessible to nutritionist-dietitian, physicians, other ancillary health care providers, and even patients. Prototyping methodology was used over the 16-week period in order to guide the developers at each step of the systems development process as they have no background in nutrition care process. The prototyping method is best suited for this project because this allows the team to make revisions and modifications as necessary both in the front-end as well as in the back-end. The results are promising as this was successfully presented in class. However, there is still much to be done, especially on the encoding of records that are still on paper as well as migration of existing data from spreadsheet.

Keywords - Nutrition Information System, Electronic Medical Record, Prototyping

I. INTRODUCTION

Proper nutrition is the basis of human health for without which health balance is disturbed that leads to lifestyle disease like diabetes mellitus and hypertension. Good nutrition should come through education and must be applied to wide aspects of human activity from home to hospital care to sports.

In this particular importance, hospital care is crucial in the restoration and maintenance of health. Part and parcel of that process is the delivery of that nutritional care that cannot be overemphasized. The importance of nutrition to patient care is paramount and immense.

Malnutrition is defined as any form of imbalance in nutrition. It is broadly segmented between overnutrition seen in many developed nations, to undernutrition more prevalent in the developing world. Factors that cause malnutrition include but are not limited to dietary intake, lifestyle and economic realities, underlying illnesses or a combination of these reasons [1,2]. Malnutrition is associated with negative outcomes for patients, including higher infection and complication rates [3–6], increased muscle loss [6–8], impaired wound healing [4,9], longer length of hospital stay [10–12] and increased morbidity and mortality [13–17].

A body mass index <18.5 is the World Health Organization 1995 cut-off for malnutrition. The number of undernourished hospitalized patients is rising over the past ten (10) years. [18] It has been documented that hospitalized patients still develop undernutrition due to longer hospital stay, insufficient supply of calories, macronutrients, and micronutrients, and failure to identify, assess, and monitor their nutritional status.

One promising aspect of nutritional care is through the development of a computer-based nutritional information system which could have its maximum impact on hospital facilities and special nutrition clinics. Although some hospitals are increasingly shifting towards the use of an electronic medical records (EMR) system to improve its service, not all multi-specialty sections are included. A detailed nutritional profile of a patient isn't always covered in the deployed EMRs and thus has become a large silo of information often underutilized to paint a more comprehensive picture of the patient's health status.

A computer-based nutrition information system that is used by nutritionist-dietitians and clinicians can hardly be found in the Philippines. It should also be noted that the detailed nutritional information that should be captured is also time-consuming as it requires a lot of cross-referencing and computations and most of these is done through paper-based method as there is no available automated system. Difficulty in producing statistical reports or do clinical research in this area is another consequence of this paper-based system as it requires manual tabulation of each record. Some records were already entered in spreadsheets but not all as this process is also time consuming.

As part of a class project, the vision to develop a nutrition information system, NutriSys, could serve as an initial step towards the creation and utilization of a better system that could capture, organize and

disseminate electronic data accessible to nutritionists, physicians, and patients.

The development of "prototypal" nutrition information system could lay down the groundwork for hospital and nutrition facility applicability. Such system should be web-based and installable software that could be applied to desktop (including laptops) and hand-held devices (e.g. smartphones, tablets). Later, the system can be linked to an EMR in order to enable physicians and other health-care providers understand better the patients under their care.

II. BACKGROUND

2.1 The Nutrition Care Process

Much of what is followed in the system was based on the process of nutritionist-dietitians' patient care. Developed by the Academy of Nutrition and Dietetics, it aims to provide a consistent individualized care for patients/clients or groups and the predictability of the patients/client outcome. [19] This is a general workflow adopted in order to implement a comprehensive nutrition management. It utilizes the common data required during the admission process. These data are grouped into the following: Demographics, nutrition screening, nutrition assessment, nutrition intervention, and nutrition monitoring and evaluation. See Fig. 1 Nutrition Care Process Model. The demographic data are the basic information of a patient collected upon admission. This is for the hospital to properly identify a patient. These are: full name, age, sex, birthday, address, contact number, ward/area admitted, room, physical activity, and social history. The Nutrition Screening is comprised of a four-question questionnaire. This is based on the Nutrition Risk Screening Tool 2002 of Kondrup et.al. [20] It is a validated screening tool that aims to identify patients who are at risk of developing undernutrition during the hospital stay. Questions about the current BMI status, recent/unintended weight loss, change in eating behavior, and the severity of illness are recorded.

Anthropometricmeasurements, iochemical/laboratory results, medical history and current medical condition, Subjective Global Assessment, usual food intake, and food frequency are collected as part of the Nutrition Assessment. Using these different data points, the overall nutritional status of the patient can be determined effectively. [21] Data such as the body mass index, waist-hip ratio, and percentage weight loss are computed and compared to the current medical condition.

The nutrition intervention is where the total calories and percentage distribution to each macronutrient (Carbohydrate, Protein, Fat) is determined based on the results of the nutrition assessment. This is also where the number of servings or exchanges per food group is determined based on the result of the total calories and macronutrients computed. These exchanges or servings are then distributed to each mealtime.

Finally, the nutrition monitoring and evaluation is a way to track the progress of patients under nutrition management. Data such as the total calorie and macronutrient intake are recorded and compared versus the required/computed one. Progress notes are also included in order to record the development of patient. When combined, these interrelated steps will produce a complete picture of the nutritional status of the patient. It could also serve as an efficient and effective documentation solution for nutritionist-dietitians and physicians.

2.2 NutriSys

The current problem of most nutritionists/dietitians in the Philippines is the time-consuming paperwork involved to capture, cross-reference, calculate, and assess a patient's nutritional requirements. To enable an efficient nutrition care process, a nutrition information system must be built with the following features: 1) has a screening mechanism to identify patients who are malnourished or are at risk of being malnourished, 2) can cross-reference tables such as food-exchange list to properly calculate calories, proteins and other important nutrients, 3) can easily access all necessary reports and records to allow clinician and dietitian to conduct clinical research and understand further how to improve the long-term nutritional care of patients, and 4) ready for integration with the hospital's existing EMR. This need fueled the development of NutriSys, a nutrition monitoring system with features corresponding to the features identified above. Phase 1 of the project involves the development of the first three features. Phase 2 will involve the development of the last feature. This paper will describe the design and implementation of Phase 1.

III. METHODOLOGY

The project started as a class requirement of the MS Health Informatics students of the University of the Philippines Manila enrolled in HI 210 (Systems Analysis and Design) and the BS Computer Science students enrolled in CMSC 128.1 (Software Engineering I) also from the sameuniversity. One of the graduate students is a registered nutritionist-dietician and hence served as the domain expert. In the attempt to develop a working Nutrition Information System as a graduate class project within the semester consisting of about 16 weeks, and with undergraduate student developers having no background on the nutritional screening and assessment process, the team chose the prototyping methodology in order for the undergraduate student developers to fully understand how the process works through weekly presentations and discussion of process flows, the associated paper forms, and the envisioned screen prototypes.

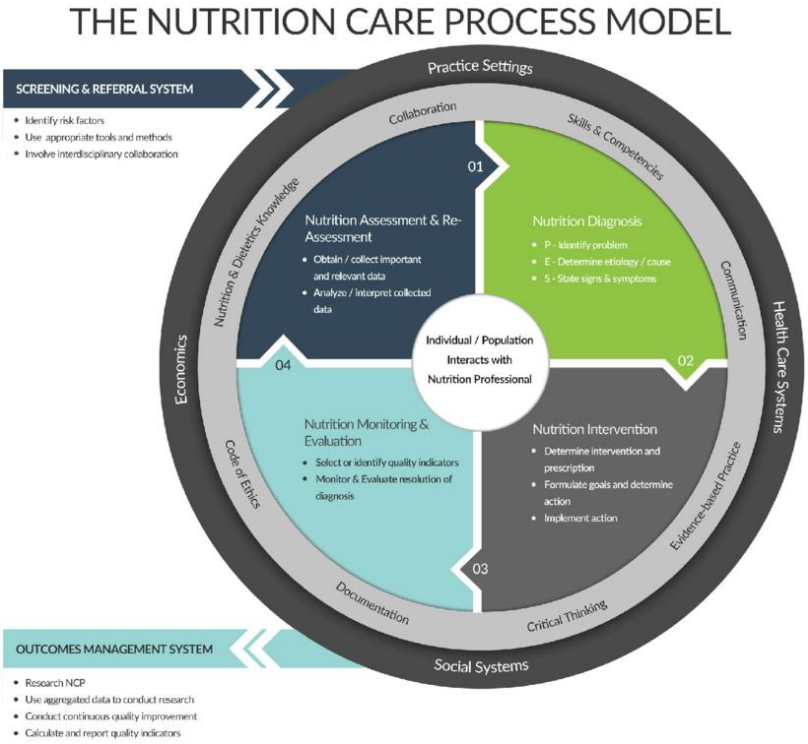

Fig. 1. The Nutrition Care Process Model

IV. RESULTS

4.1 NutriSys Design

This section will discuss the design and implementation technique used by the team to come up with NutriSys. It starts by discussing the context diagram in 4.1.1 to highlight the environment in which NutriSys is envisioned to operate. In 4.1.2, the database structure is shown followed by the NutriSys core modules in 4.1.3. Section 4.1.4 covers the development tools used to design and code NutriSys. In 4.1.5, we take a peek into Phase 2 which covers NutriSys plan for integration with an existing EMR. Finally, in 4.1.6, we see the results which consists of screenshots of the modules as captured while doing a live demo.

4.1.1 Context Diagram

NutriSys was envisioned to enable nutritionist-dietitians and physiciansto access the system to enable them to perform essential functions using any web browser on a desktop, laptop or mobile phone. The data is managed in a server that is in the cloud. Provided that the user enters the correct access credentials, the system can be accessed using a web browser over a laptop or mobile phone. In particular, a nutritionist-dietician can display the main menu, encode demographic data, encode pre-formulated data inputs, encode individual dietary requirements, encode nutritionist-dietitian's visits, organize demographic data, calculate pre-formulated data inputs, calculate individual dietary requirements, display the summary of data, generate demographic data, generate clinical monthly reports, generate patient handout, generate nutritionist-dietitian's report.Finally, the SysAd can do user account management i.e. add, edit, delete, display users.

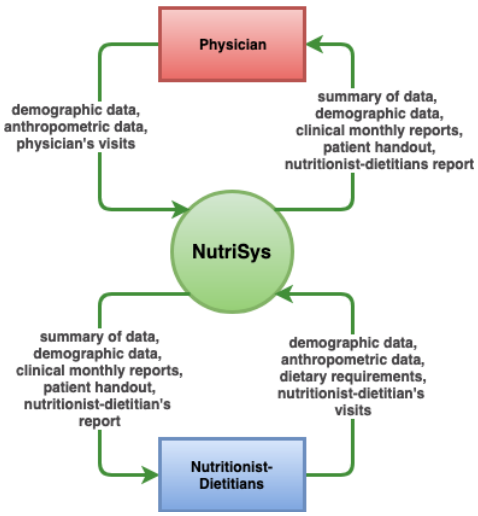

Fig. 2. Context Diagram of NutriSys

4.1.2. Database Structure

The Entity Relation Diagram (ERD) describes the relationship between the superuser and the patient, and patient to the different components of the nutrition care process. In this ERD, anutritionist-dietitian or physician can treat many patients. The patient also has a one-is-to-one relationship with the following entities: patient information, social history, nutrition screening, family history, medical history, anthropometric assessment, subjective global assessment, biochemical assessment, dietary/usual food intake, food frequency, calorie and

macronutrient computation, food exchange list, patient's handout, intake monitoring, and progress notes. See Fig. 3 Entity Relation Diagram of NutriSys.

4.1.3. NutriSys Core Modules

In order forNutriSys to capture every data possible for proper nutrition management, the team has included the following modules: Patient Admission module, Nutrition Assessment module, Nutrition Screening module, Nutrition Intervention module, Reports module, and User Account Management module. The demographic, nutrition assessment, nutrition screening, nutrition intervention, nutrition monitoring and evaluation steps were earlier discussed in Chapter Two (2), the Nutrition Care Process. On the other hand, the reports module is made in order to produce reports necessary for the perusal of patient, department managers, and hospital administrators. For the patient, a handout can be exported and printed in order to serve as a guide for their dietary management when discharged from the hospital. For the department manager, they can have a report of the total number of patients admitted in the hospital, to be matched against the number of patients enrolled or managed a nutritionist-dietitian. Finally, hospital administrators can have a census, on a given month/year, on the number of enrolled patients, the breakdown of patients depending on the nutritional status, and a historical comparison based on previous reports generated. User Account Management involves the creation of a superuser for dietitians and/or physicians upon endorsement to the website administrator.

Some data points such as body mass index, calorie computation, calorie distribution, and food exchange list distribution are automatically computed upon encoding the data based on the parameters given.

4.1.4 Development Tools

The software applications and tools used to create the system are as follows: Xampp, phpMyAdmin, Python, Django, and Visual Studio.

XAMPP is an easy to install Apache distribution containing MariaDB, PHP and Perl.

Python is an interpreted high-level programming language for general-purpose programming.

Django is a high-level Python Web framework that encourages rapid development and clean, pragmatic design.

phpMyAdmin is a free software tool written in PHP, intended to handle the administration of MySQL over the Web.

Visual Studio Code is a code editor redefined and optimized for building and debugging modern web and cloud applications.

4.1.5. NutriSys Plan for Integration with an EMR

Phase 1 involves the development of NutriSys core modules and these have been discussed intensively in previous sections. The core modules were tested usingdata

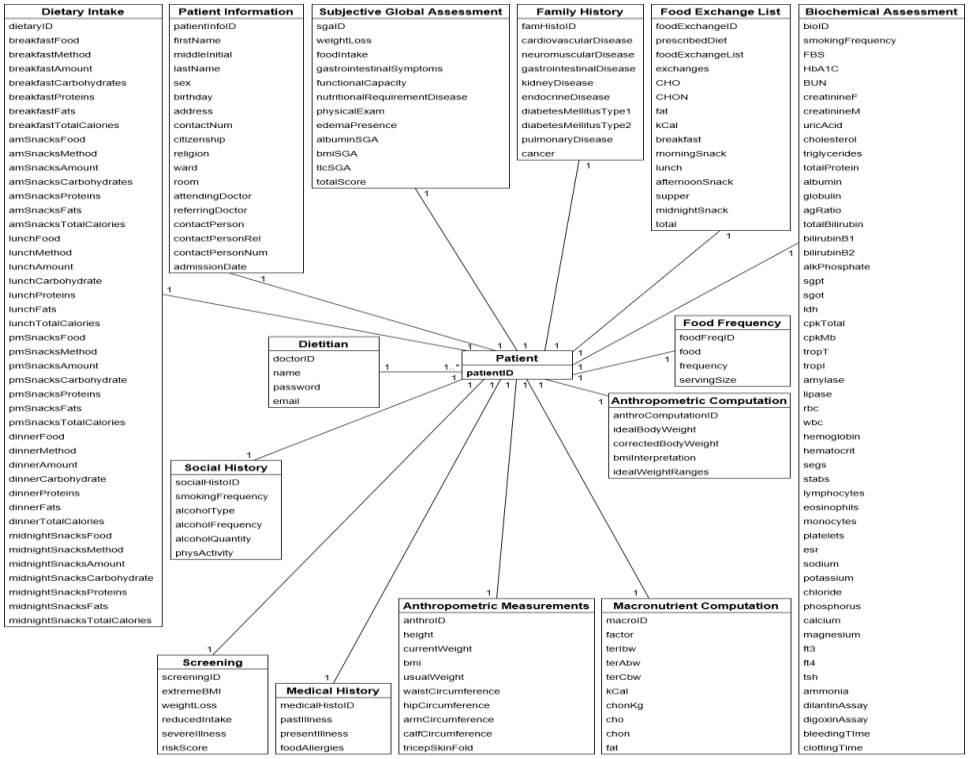

Fig. 3. The Entity Relation Diagram of NutriSys

provided by proponent nutritionist-dietitian and results have so far been successful. All envisioned functionalities were implemented correctly. Phase 2 involves the integration with an electronic medical record, in particular with the Community Health Information Tracking System (CHITS), an electronic medical record system deployed in various barangay health centers in the Philippines. CHITS is the flagship project of the National Telehealth Center of the University of the Philippines Manila and is based on the OpenMRS platform. Integrating NutriSys with CHITS requires installation of the Open Health Information Mediator (OpenHIM) to both CHITS and NutriSys. OpenHIM is a software component that enables easier interoperability between disparate electronic information systems by providing a central point where the exchange of data is managed. This interoperability layer receives transactions from different information systems such as CHITS and NutriSys and coordinates the interactions between them. The OpenHIM provides a single point of entry into the services of a health information exchange (HIE). It receives transactions from client systems, coordinates interaction between the different components of the HIE by routing requests to the correct orchestrator orregistry,and provides the centralized common core functions to simplify data exchange. [22]

4.1.6 Getting Started

Before using NutriSys, a user must have an account. Only nutritionist-dietitians and doctors are given accounts. In case of forgotten passwords, the user must contact the website administrators to reset the password.

Once the accounts are ready, the user may now log in to thewebsite using a computer or a mobile device connected to the Internet. The URL is http://nutrisys.pythonanywhere.com/home/ where the user will be required to input his credentials. User must click on the 'New Patient' button to add a patient.

To complete the whole nutrition care process and to register all of the data points necessary for a comprehensive patient management, the nutritionist-dietitian should complete the four (4) step process. It starts with the Patient Admission module, Nutrition Screening module, Nutrition Assessment, and Nutrition Intervention module. They can also search for patient to update and/or check records and check the patient database summary to generate reports. The user must ensure that all answers on the required fields are provided in order to move forward with the admission process. Fig. 4. shows the Nutrition Screening Page. Initially all buttons are blue. Buttons turn to greento indicate they have selected.

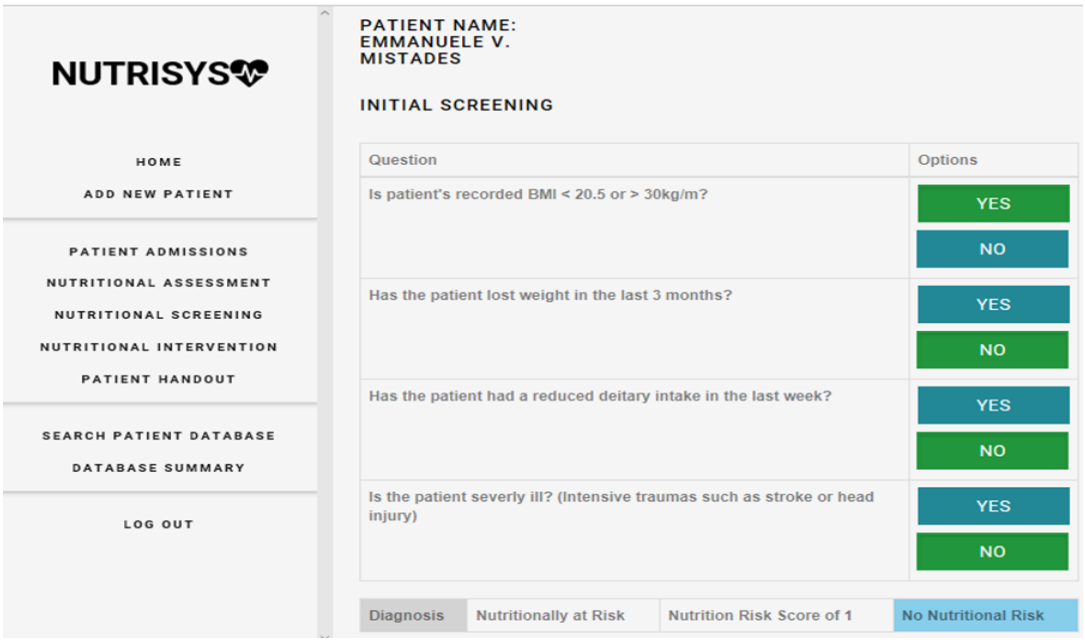

Fig. 4. Nutrition Screening page

DISCUSSION

The project started as a class requirement of the MS Health Informatics students and the BS Computer Science students enrolled in the same university, University of the Philippines Manila. This project was selected because one of the graduate students is a registered nutritionist-dietician and hence can serve as the domain expert. The undergraduate student developers had no background on nutritional screening and assessment and had to be taught by the domain expert. Identifying the reasons why an automated nutrition information system should be built, understanding the nutritional screening and assessment process, translating this into design, implementing and testing each component until a final working system is created and presented in a span of 16 weeks is both challenging and rewarding

to all members of the team considering that each member is a student who is also doing projects for other subjects. The team chose the prototyping methodology in order to guide the developers at each step of the systems development process so as to not waste time. The prototyping method is best suited for this project because this allows the team to make revisions and modifications as necessary both in the front-end as well as in the back-end. A pre-scheduled meeting every week was agreed upon by each member of the team since developers are given enough time to implement the design while requiring them to present at the start of each meeting their outputs in order to assess their progress, receive feedback, and/or validate their work.

CONCLUSIONS

The prospective application of this Nutritional Information System is promising from the perspective of the resident nutritionists-dietitian. The system development came out good and was successfully presented in class. However, there are still much to be done, especially on the encoding of records that are still on paper as well as migration of existing data from spreadsheet.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest relative to this work.

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