

E-healthcare: Child Monitoring Health System (CHMS) with SMS Functionality

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Abstract—Children go through distinct stages of development as they move through from infants to young adults. These stages are as follows: (1) Infants/Babies whose age ranges from birth to two years of age; (2) Toddlers/Preschoolers ranging from two to five years of age; (3) School Age Children considers those who are of six to twelve years old; and (4) Adolescents/Teenagers who are of thirteen to eighteen years old. During these stages their health and safety are utmost important because these will influence their formative years. The study emphasizes the benefits of implementing a Child Health Monitoring System (CHMS) to a private hospital in order to provide a more efficient way of monitoring child's health. The researchers were able to determine the system requirements through survey and interviews with hospital key personnel as well as the parents. Design of the different modules were also presented.

Keywords—health monitoring; immunization; SMS

I. INTRODUCTION

The use of technology in the medical sector has continuously increased. Medical records collected through paper is slowly emitted and thus help minimize the use of paper which perhaps, save the environment. The use of technology in the medical sector – EMRs, Heartrate trackers, and such – has benefited both the medical practitioners and professionals in minimizing the amount of work enabling them to maximize their working schedules. The percentage of child patients visiting the hospital for either check-ups, vaccinations, or admissions has always been high. With this, it is most likely important to make use of technology monitoring their health. Health Monitoring System tracks the condition of health of a patient and gathers a sequential health history of the patient.

The researchers conducted the study to a private hospital specializing on child care to develop a system that will provide an easier communication between the doctors and the patients especially when the doctor is away from the hospital, or in case an emergency is encountered at home. It will aid the medical assistants in making their job faster and convenient, maximizing their working load and time. Also, the system will minimize the conflicts and issues about loss of patient's data.

The web-based Child Health Monitoring System (CHMS) comes handy and efficient for both the medical assistants and patients. Parents will be able to have a close monitoring on their child's health through the web application provided. It will then help minimize the risk of having a high emergency cases on their child's health. A close monitoring on their

child's immunization progress may also be of great help to prevent unwanted complications on the health of their children.

II. REVIEW OF RELATED STUDIES AND SYSTEMS

Health Monitoring System monitors the condition of health of a patient and gathers a sequential health history of the patient. The data gathered does not particularly relate to a specific therapeutic condition, instead, it gives the necessary information to determine patterns which are characteristic of healthy patients as well as to those who are sick. The data collected is periodically transferred to a database in which it is stored alongside similar health histories for other patients. [1]

It is the application of mobile computing technologies for improving communication among patients, physicians, and other health care workers. As mobile devices have become an inseparable part of our life it can incorporate health care more flawlessly to our everyday life. It empowers the delivery of accurate medical information anytime anywhere by means of mobile devices [2].

In recent years, a number of applications have been developed. They provide mobile-based services to individuals in healthcare area. Lupe, Vida, and Tivadar developed a mobile-based application allowing patients to obtain information on their disease by loading the results of their analysis in the field of pediatrics and gynecology. Hsu et al. and Quinn et al. developed a cloud mobile phone application ensuring that diabetic patients can do their follow up on a daily basis. Kim et al. (2009). Connectivity on 7/24 basis between human to device and device to device have a crucial role in individuals' lives. [3]

Immunization Information Systems (IIS) are confidential, computerized population based-systems that collect and manage vaccination information IISs can help ensure that individuals are vaccinated and can estimate vaccination coverage at population levels to guide immunization programs IISs can provide denominators for vaccine safety and effectiveness evaluation, and provide useful information to public health authorities, vaccine providers, and vaccine recipients [4].

The researchers also considered the functionalities of existing healthcare systems as reference in the development of the proposed system. These are as follows:

The Community Health Information Tracking System (CHITS) is a low cost computerization activity for local health centers that aims to automate the core processes in the health center and add to viable and proficient conveyance of

services. It allows community health workers to send SMS messages to report wounds/injuries and receive preparation on health observation through their cellular phones. With the volumes of information being gathered in a typical rural health unit (RHU), it has dependably been a test to consolidate this information into a cohesive and relevant whole. Traditionally, patient-level information has been manually recorded on paper, a procedure that is tedious, but also prone to errors. Accessing and consolidating information in this way is labor intensive and the data can often be outdated or incorrect.

Secured Health Information Network and Exchange (SHINE) is accessible using Java empowered mobile phones and computers connected to the internet. It is readily deployed in zones with wireless broadband, 2G/3G and GPRS availability. Its key features include the 4 “Rs”: recording, reporting, reminding and referral; with the security of patient records at the center of the system [5]. MedConnect application is thought to be the first and completely useful application for the healthcare industry. It incorporates unique components, wherein users can request a medical checkup, access one’s laboratory results, reserve a room, pay online, make schedule for executive checkups, and it has fundamental data that the users can read. [6]

III. METHODOLOGY

A. Determining System Requirements

The researchers conducted interviews to hospital administrators, staff and parents of the patients to identify and analyze the current business rules.

- Doctor will check the records of the child on what vaccinations they need to take. If only one vaccination is needed, the pediatrician will give the vaccination outright to the patient. If there are more than one vaccinations required to be taken, the schedule of giving the vaccines will be scheduled.
- The scheduling of appointment for vaccination purposes is not recommended due to instances that vaccines are automatically scheduled in accordance to when he/she took his/her first vaccine as well as the age of the child and the rest will follow as scheduled.
- Patients cancel appointments through messaging the pediatrician/secretary.
- Patients may reschedule their appointments as long as the pediatrician has a clinic schedule on that day.
- Scheduling of appointment may be done through calling the pediatrician itself or the secretary. Appointments may be done beyond the clinic hours of the pediatrician as long as he/she is in the hospital vicinity.
- Appointments are a “first-come, first served” basis.
- Payment of checkup and vaccinations happen right after the patient has been checked up and vaccinated.

The current processes will be further improved by utilizing an automated system in terms of monitoring the patient’s health and medical records. It may also help in minimizing the use of paper in recording all their patient

records and thus provide a faster recording and retrieval of patient’s records.

B. Proposed CHMS Modules

The system will cover the following:

- Electronic medical record that will store all the patients’ record, checkup history, immunization records, and other patient’s data gathered in the monitoring of the child’s health.
- Appointment scheduling that will enable the patients schedule an appointment to be in the list of the pedia’s schedule, which allows up to ten patients to be listed per doctor per day. The user (both the pediatrician and the patient’s parent) is allowed to cancel and reschedule their appointment in case of abrupt activities that conflicts their scheduled appointment. When a patient cancels their appointment, another patient may make use of the slot they cancelled.
- SMS notification system that would be used to monitor the patient’s appointment. The system would notify the child’s parent of their appointments (the day of the confirmation of appointment, week before, and day before the appointment) to avoid overlooked schedules.
- Health tip module in which the parents could use a reference or tip for their child’s health. The system will provide list of sickness common at a specific age of children and thus provide information about these sickness (symptoms, cure and prevention).
- Report generation module that will provide a faster and convenient way to monitor the progress of the child. The child’s immunization records will be generated into a single document which may be printed.

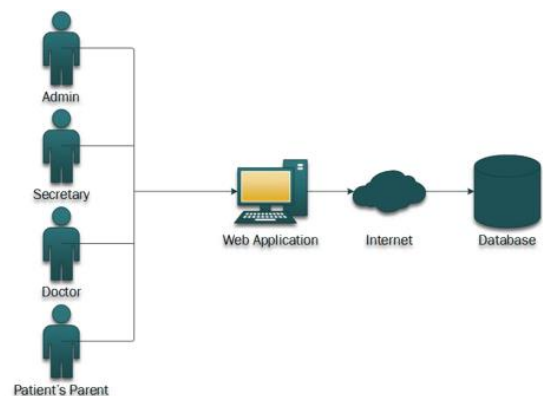


Figure 1. System architecture.

IV. RESULTS AND DISCUSSION

A. System Architecture

The users of the proposed system are the following—admin, secretary, doctor and the patient’s parent. They may all make use of the web application, but with specified restrictions and different user interface. The admin’s user

interface will contain the account management as well as managing the doctor's schedule. The secretary's user interface will contain the EMR, schedule management, account management for the patients and report generation. As for the doctor's interface, it will contain the EMR, schedule management, immunization monitoring and the SMS feature. . Lastly, the patient's parent contains the profile view of their respective health records, immunization monitoring, scheduling of appointment, SMS feature and developmental milestones. Internet connection is needed to be able to access the web-application, then all the data will be stored in an online database. Figure 1 below shows the System Architecture.

B. Design of Proposed Business Process

There are 4 users of the system: the doctor, patient's parent, secretary, and the administrator. The doctor is capable of viewing and confirming the scheduled appointment made by the patient. With this, the doctor may also cancel and reschedule an appointment. The doctor may also view and manage the patient's health records and immunization monitoring. As for the SMS notification with regards to immunization monitoring, the doctor may enable or disable the SMS feature in notifying the patient's parent as to when will be their child's next dose of a certain vaccine. The doctor has the authority to create a temporary account for his/her patient which will be used prior to patient registration. Only the patient's parent is capable of registering their own account and would be able to view. The patient's parent has a similar capability with the doctor, they could also schedule and cancel an appointment. The patient may also view immunization record list, health tips and developmental milestones. The secretary may view and manage all scheduled appointments, manage patient's records and generate patient reports. The admin is the one who will register new doctors and secretaries' account. The admin also manages all user accounts as well as the doctor's schedule. Figure 2 shows the use case diagram for Child Health Monitoring System (CHMS).

Registration - new unregistered patients may ask their respective pediatricians to have them registered for a temporary account. These patients may register themselves for an actual account upon receiving their temporary ones. These new patients will need to provide few basic information needed for registration, including the credentials they will use in accessing their own account. If the new user is a doctor or a secretary, it would be the administrator's work to register these users' their account. The admin will then provide the users their own credentials in accessing the web application.

Scheduling of appointment- the user will log in to their account. If the user is a doctor, he/she may view his/her scheduled appointments. When the doctor has other important errands to do, he/she may cancel his/her scheduled appointments for the said date by just selecting the date to be cancelled. Also, if the doctor is unavailable for a specific date, he/she may opt to gray out that particular date so that his/her patients will not be able to schedule an appointment. If the user is a secretary, he/she will first choose a doctor

from the list and if the secretary was tasked by the doctor to cancel/reschedule his/her appointment, the secretary may do so. If the user is a patient, he/she will click the Manage Appointment from the web application. Then, the patient will choose a schedule from the list. Right after choosing a schedule, he/she may choose a date. Otherwise, the patient may cancel his/her scheduled appointment with the doctor by just clicking delete.

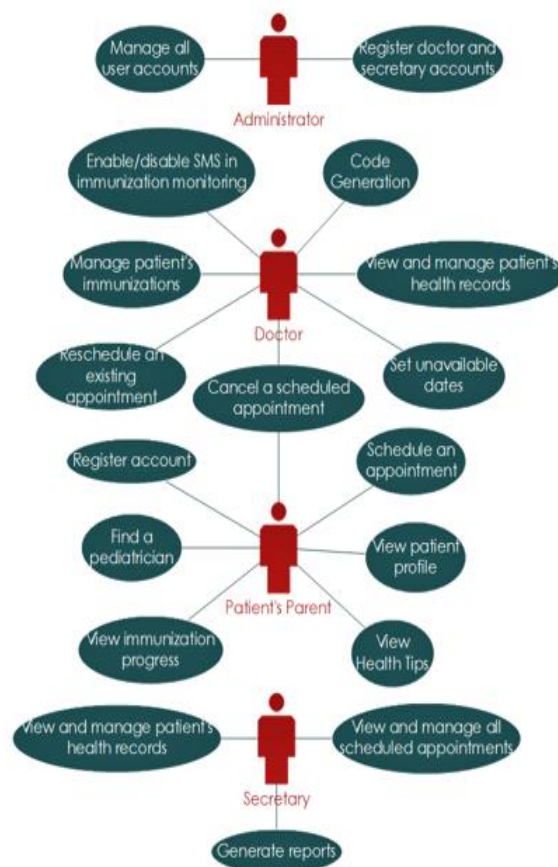


Figure 2. Use case diagram.

Electronic Medical Record -upon accessing the web application, both the secretary and the doctor have the authority to input the patient's record. In order to input the patient's checkup findings, the doctor/secretary must first choose the patient's name from the list provided. Once the system has found the specific patient, the doctor/secretary may now then enter the findings they gathered for the patient.

SMS notification system will allow patients to be notified of their follow up checkups most specifically for immunization. The doctor will click the "Enable SMS" feature in the Monitor Immunizations page so as to notify his/her patients regarding the vaccine that they took for that day and it is also indicated there when will they will come back for the next dose.

Health Tips will allow parents to see weaning and infant care recommendations.

Report generation will allow the secretary to print relevant reports such as child immunization records.

C. Design of User Interface

Figures below show the user interface of each module as discussed (CHMS modules).

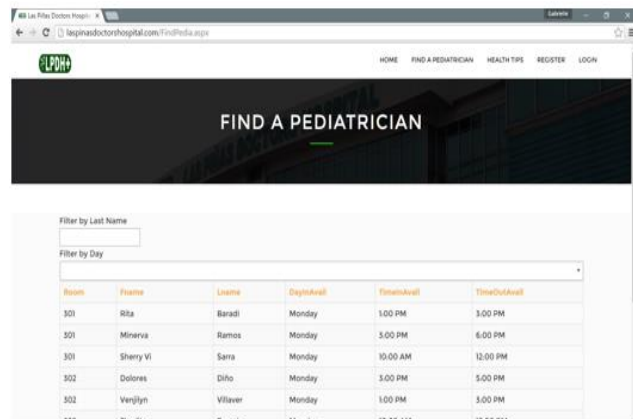


Figure 3. Finding pediatrician.

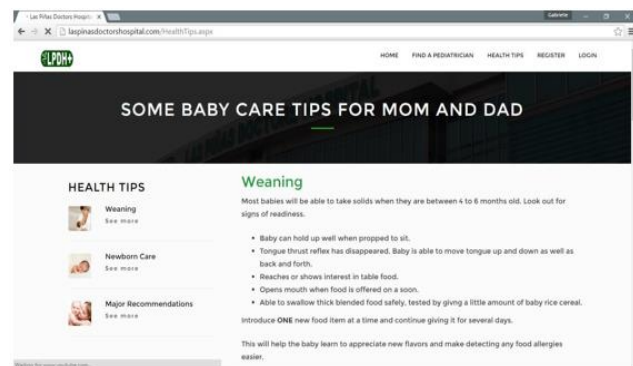


Figure 4. Health tips.

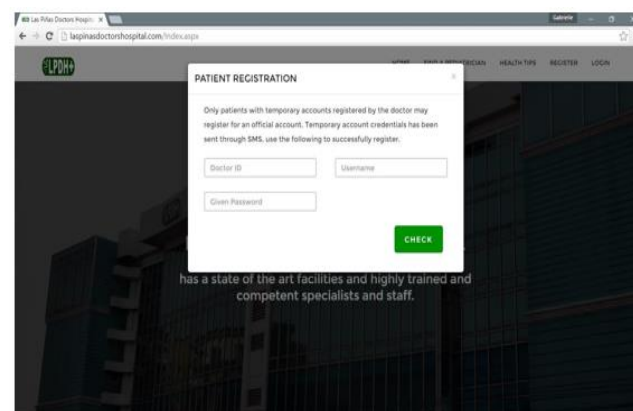


Figure 5. Patient registration.

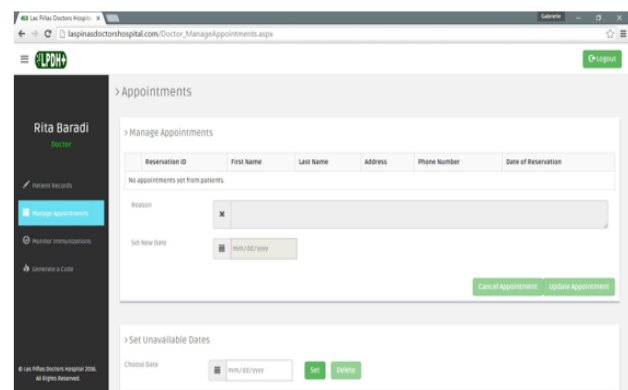


Figure 6. Manage appointments.

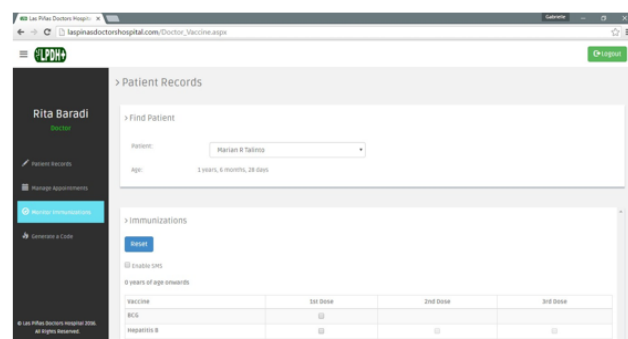


Figure 7. Monitoring immunizations.

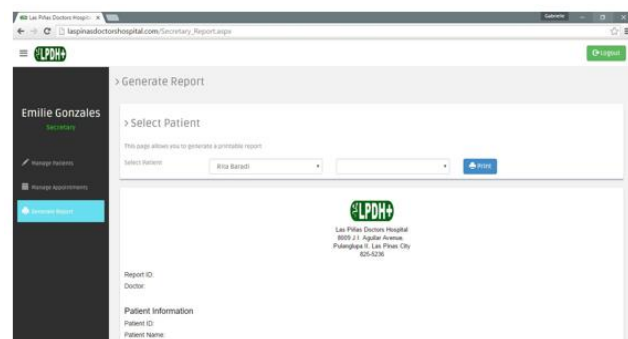


Figure 8. Report generation.

V. SYSTEM TESTING

Once the priorities have been determined, the proponents proceeded with the development. The researchers did a preliminary testing that determined the systems capabilities. The following tests were implemented in an orderly manner: (1) Unit testing for the individual modules. The proponents tested each and every module that was developed all throughout this phase to check if errors were still present. (2) Integration testing of the combined modules to see if there were errors once the modules were combined. (3) System testing for the entire system. (4) Cross Browser testing to check if the system is compatible and if it works properly using different browsers. Lastly, User

Acceptance Testing. The users are the following: administrator, secretaries of the pediatricians per clinic, the pediatricians and the parents of the patient.

There are three (3) iterations done. During the first iteration, 60% of the test cases failed and 40% of the test cases passed. The problems that were discovered by the proponents were mostly about input validations and failure to receive text messages from the website. During the second iteration, 40% of the test cases failed and 60% of the test cases passed. . The problems that were discovered by the proponents were, again, mostly about input validations, failure to receive text messages from the website and a security issue caused by exporting a pdf file. As for the third iteration, none of the test cases failed. All issues that were mentioned earlier were resolved by recoding the input validations, availed a text messaging service and replaced the save button in the report generation part to avoid security issues.

VI. CONCLUSION

The web-based Child Health Monitoring System is a system that tracks the condition of health of patient and gathers a sequential health history of the patient which comes handy and efficient for both the medical assistants and patients. Parents will be able to have a close monitoring on their child's health through the web application provided. It will then help minimize the risk of having a high emergency cases on their child's health. A close monitoring on their child's immunization progress may also be of great help to prevent unwanted implications on the health of their child. A developmental milestones and health tips feature were added to be well informed.

Furthermore, incorporating relevant functionalities of health information which were determine through related studies will make the system more efficient. Table 1 shows the comparison of the proposed system with other healthcare systems based on significant functionalities such as immunization monitoring, appointment and follow-up

scheduling, SMS notification, electronic medical records, health tips and reports generation.

TABLE I. COMPARISON OF PROPOSED CHMS VERSUS OTHER HEALTHCARE SYSTEMS

	Community Health Information Tracking System	Secured Health Information Network and Exchange	MedConnect	Proposed
Immunization Monitoring	✗	✗	✗	✓
Appointment and Follow-up Scheduling	✓	✓	✓	✓
SMS Notification System	✓	✓	✓	✓
Electronic Medical Record	✓	✓	✓	✓
Health Tips	✗	✗	✓	✓
Report Generation	✓	✓	✗	✓

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