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IN-SILICO APPROACH TO THE DEVELOPMENT OF A PROTOTYPE CLINICAL INFORMATION SYSTEM FOR PEDIATRIC UNITS

O. Oluwagbemi and T. Ogunmowoju
(Bioinformatics Unit), Department of Computer and Information Sciences, School of Natural and Applied Sciences, College of Science and Technology, Covenant University, Ota, Nigeria
Corresponding author: O. O. Oluwagbemi; E-mail: gbemiseun@yahoo.com

ABSTRACT

There is an observed serious challenge to the provision and management of pediatric healthcare and facilities in most African countries. This has probably contributed to the high mortality rates recorded among African children. It is thus imperative to evaluate all possible approaches to the development of the appropriate manage of the problem. *In-silico* approaches to information management of pediatrics sections of hospitals could for example help reduce mortality rates among children. This study was aimed at developing a prototype clinic information system for keeping track of infants' clinical records, diagnosis of their various ailments, proffering possible solutions and their respective responses to drug treatments. Research focus was on the pediatric sections of some hospitals located in southwestern part of Nigeria, particularly sections in care of the children between the ages of 5 and 9 years. A monthly or annual report generated from this system will assist in making proper recommendation to research institutions on ways of improving chemotherapeutic management of common diseases of infants and to governmental agencies on the need for more funding to support in this quest. C#.Net was the programming language used for the implementation of the system, while SQL server 2008 was used to provide the database support. It is hoped that the developed system will help in the reduction of infant mortality rates in hospitals were it is implemented.

Keywords: Hospitals, *in-silico*, pediatrics, clinical information system

INTRODUCTION

Pediatrics, as a branch of medicine, deals with the development and care of infants and children, as well as the diagnosis of the nature and treatment of their diseases. However, one of the problematic aspects of healthcare in Africa is in the provision, management and administration of children's healthcare facilities. High mortality rates in some African countries may be linked to poor management of healthcare facilities and lack of proper monitoring of the health status of sick persons. *In-silico* approaches to information management of pediatrics sections of hospitals could for example help reduce mortality rates among children. This implies adequate management of information streaming from the pediatrics sections of hospitals.

Over the years, clinical information systems have been developed for solving various health challenges. A recent work by McGregor (2007) involved a case study based research supporting the development of a framework for the design of Web-service-based clinical management systems to support intra- and inter-organizational patient journey workflows. The framework improved communication between doctors and removes duplications and excessive activities.

Clinical information system has been developed in the past for documentation purposes, especially in the pediatrics intensive care units (Menke *et al.,* 2001). Another study Ameh *et al.* (2006) reviewed the status of pediatric surgery in Nigeria and stressed the need for more pediatric surgeons and trainees to be mentored and encouraged to take up the specialty, but never mentioned the role of information systems towards the improvement and development of pediatric practices in Nigeria. Another study further showed the Store-and-forward Internet-based tele-consultation as an effective means of providing pediatric subspecialty consultation to a population of underserved children (Callahan *et al.,* 2005).

The implementation of an electronic medical record system in a pediatric psychopharmacology program was carried out in another study (Gonzalez-Heydrich, 2000). A study also recently considered how a hospital practice management system was used to provide initial data for a pediatric immunization registry (Jenders *et al.,* 1999) while yet another work centered on how the a pediatrics residency program instituted a computer-assisted information management system that

provided the means for documenting residents' patient contacts and learning experiences (Kallen, 1986).
It has been observed that appropriate information system to adequately manage the records, conditions and ailment of pediatric patients are not readily available in many African countries, thus the need of an *in-silico* or computational approach to the development of clinical information systems to manage daily activities of pediatric sections within south western hospitals in Nigeria.
The aim of this research is to develop a prototype of a clinic information system for keeping track of infants' clinical records, diagnosis of their various ailments, proffering possible solutions and their respective responses to drug treatments. A monthly or annual report generated from this system will assist in making proper recommendation to research institutions on ways of improving drug efficacy in diseases mostly common among infants. The focus will be on the pediatric sections of some hospitals located in southwestern part of Nigeria, particularly sections in care of the children between the ages of 5 and 9 years. It is hoped that with the development and implementation of this system, infant mortality rate will be on the decline.

MATERIALS AND METHODS

Data collection: Data was collected by interviewing pediatric specialists and other relevant health professionals in the pediatrics sections of four selected hospitals in different parts of the southwestern Nigeria. These included Oyo, Lagos, Ogun and Osun states of Nigeria.
Architectural design of the system: The design and development of this system employs 3-tier horizontal web architecture (Figure I).

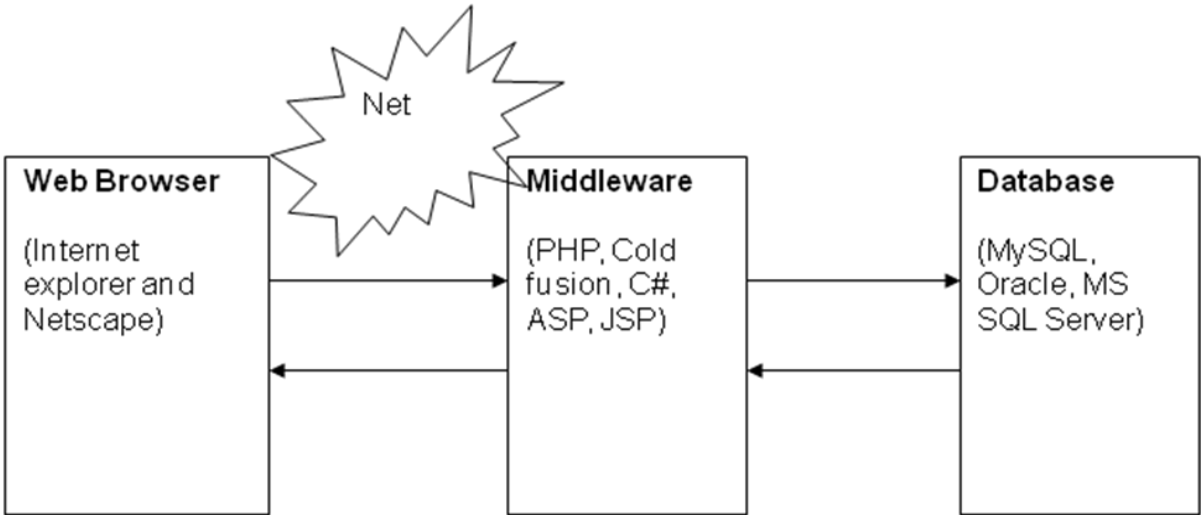


Fig. I: Architectural design of the clinical information management system for pediatrics sections

The system architecture consists of the web browser, the middle ware and the database. The Web browser acts as the channel through which the client communicates. It is a software application that enables a user to display and interact with text, images and other information that are located on the Web page or a local area network. The Web server (middleware) is responsible for communications with the browser, while the database server is responsible for storing the required information.
The C#.Net programming language was used to implement the middleware. The database used for the development of this system was the Microsoft SQL Server 2008.
System design and modeling: The system design of the pediatrics management system showed the overall plan or model that consists of all the specifications of the system, its form and structure. This included the logical design.
Logical design: This part of the design laid out the components and their relationships to one another, as they would appear to the users (Figure II). It described input and outputs, processing functions to be performed as well as data models and controls.
A model is the abstract representation of some features of a concrete entity. Thus, modeling is the act of building one or more graphical representations of a system. The modeling of this pediatrics

management system will be built using the (Universal Modeling Language) UML diagrams. This is the standard language for specifying, visualizing, constructing and documenting all the artifacts of a software system. It offers diagrams that provide different perspective views of the system parts. Two of such are the Sequence Diagram and the activity diagram as depicted in figures III, IV and V.

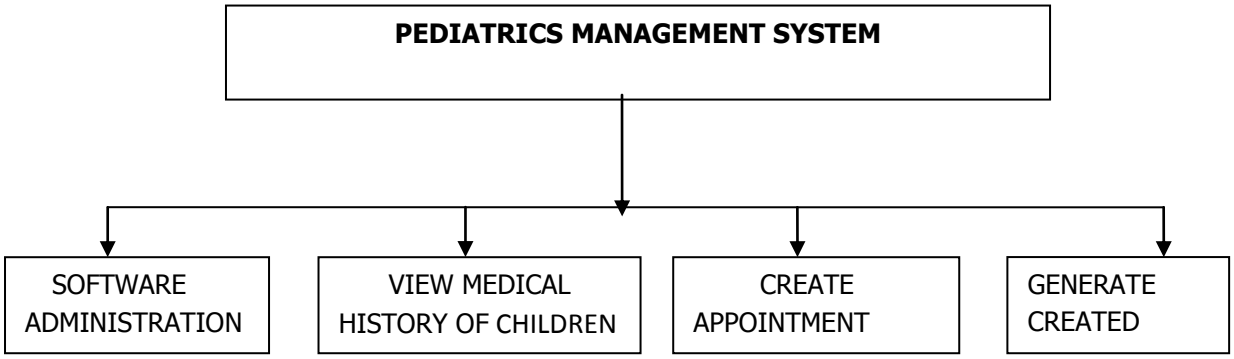


Fig. II: Logical design of the clinical information management system for pediatrics sections

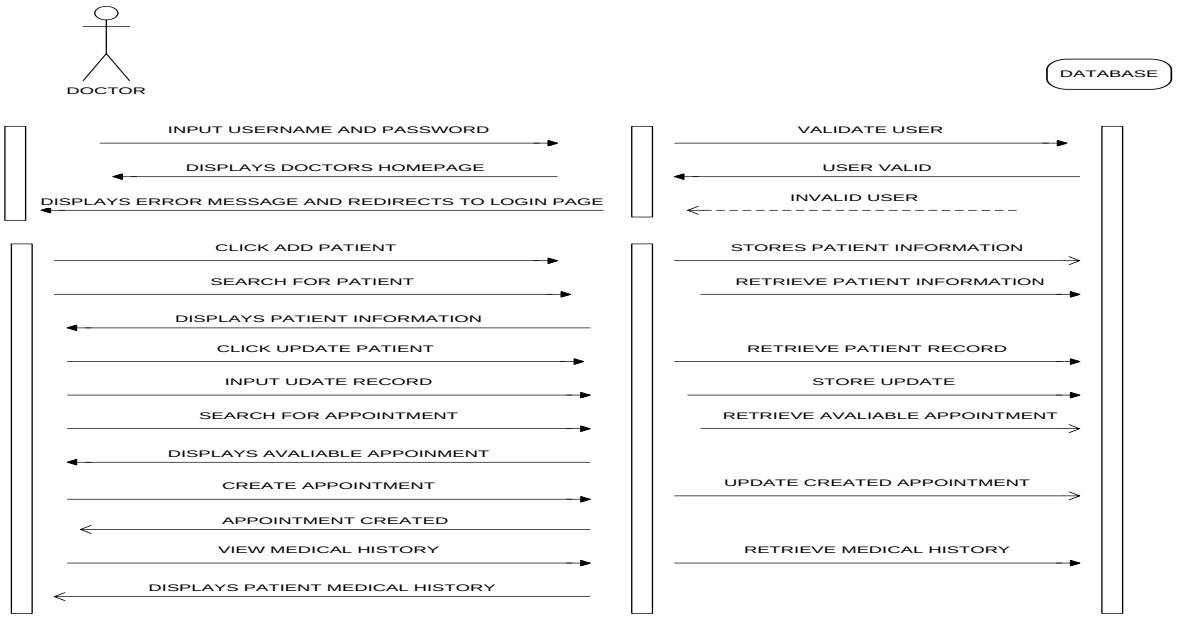


Fig. III: Sequence diagram for the doctor

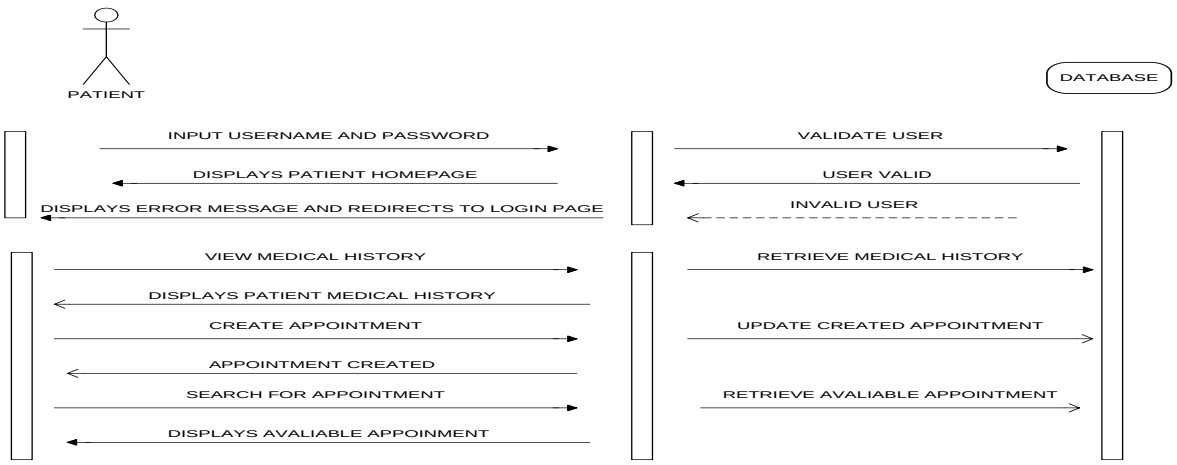


Fig. IV Sequence diagram for the pediatric patients.

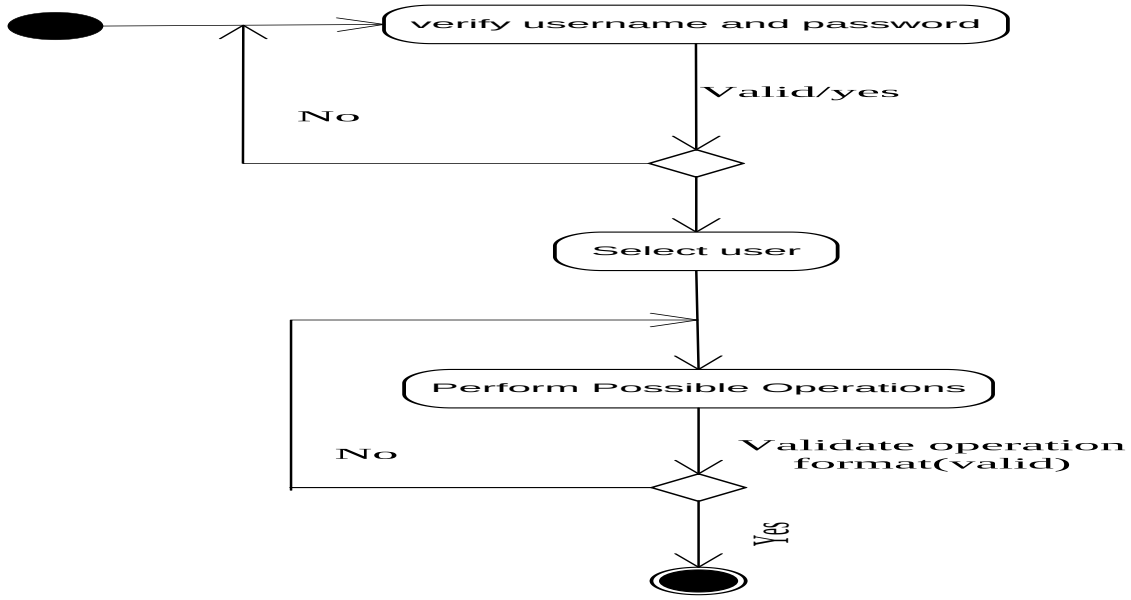


Fig. V: Activity diagram for user authentication and verification into the pediatrics management system

Activity diagrams showed the sequence of activities in a process, including sequential and parallel activities, and decisions that were made. It also means describing the workflow of activity. Figure V showed the activity diagram of the user authentication and verification into the pediatrics system.

Experiments/Implementation: C#.Net programming language was used to develop and implement the system. The software was implemented using C# because it readily supports features such as Active Server Page.NET (ASP.NET), ActiveX Data Object.NET (ADO.NET) and Visual Studio 2010 that facilitates the development of wed based applications. These features were needed to implement the software that will meet the necessary requirements.

Microsoft SQL Server management 2008 was the Relational Database Management System (RDBMS) used since it is a robust RDBMS that could manage the large amount of data usually generated in a hospital and could integrate with the development platform. It also has tools that facilitate the design and implementation of databases. It is responsible for storing, retrieving and manipulating the data in the database or other repositories.

RESULTS AND DISCUSSION

The home page of the developed pediatrics information system was shown in figure VI. This page provides an overview about the system. Figure VII showed the doctor's login page. This page provides a secured environment for authorized doctors to login into the system. Such authorized doctors are required to provide a valid username and password assigned to them by the system administrator. This enables such a doctor to view and approve appointments scheduled by the patients. It also allows the doctor to input the diagnosis and prescriptions of the patients (in this case, children between the ages of five and nine years) and also to search for or view the medical history of such patients.

Fig. VIII showed the doctor's view appointment page. This is the page where doctors could view appointments scheduled by the parents of pediatric patients. Doctors could either approve or disapprove such appointments.

Diagnosis and prescription plays a very important role in ensuring the well-being of patients, particularly in the area of children's health. The diagnosis and prescription page thus represents a platform where doctors can diagnose the health challenges of patients and make appropriate

prescriptions to address the health challenge of such patients. This was adequately depicted in figure IX. The search page allows doctors to search for any particular patient they want to operate on. It also provides the opportunity for doctors to update and edit patient's information. This was shown in figure X.

The patient history page enables doctors to check the medical history of patients in order to understand the history and pattern of sickness that has affected such patients in the past. It also allows doctors to effectively track the previous drugs administered on such patients and how the patients responded to treatments. It further enables patients to view their medical history and records since their admission into such hospitals, but it does not allow patients to modify any aspect of their medical records (Figure XI). This is to ensure security and that authentic information about patients health status are available (Figure XI). Figure XII on the other hand enables the patient to check for the diagnosis and prescriptions by doctor. Lastly, figure XII, shows the administrator page, where the administrator could edit information about hospital staffs and any updates on recent appointments.

Fig. VI: The Home Page of the Pediatrics Management System

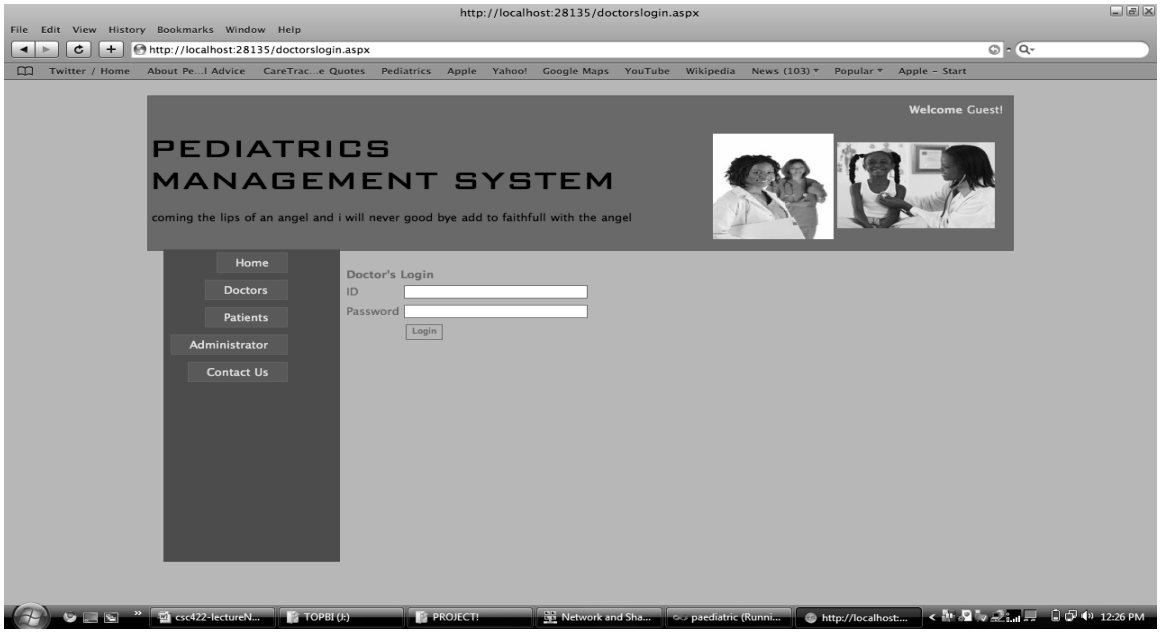


Fig. VII: Doctor's Login page

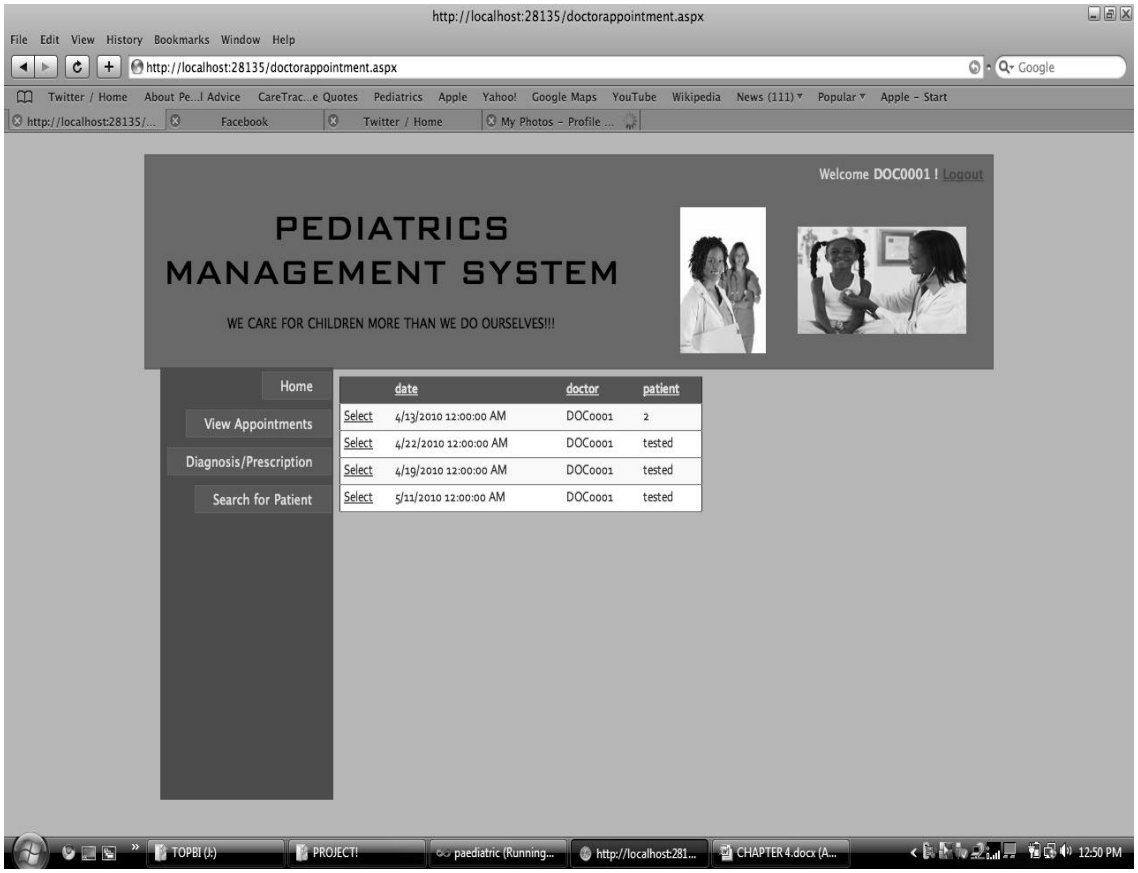


Fig. VIII: The View Appointment Page

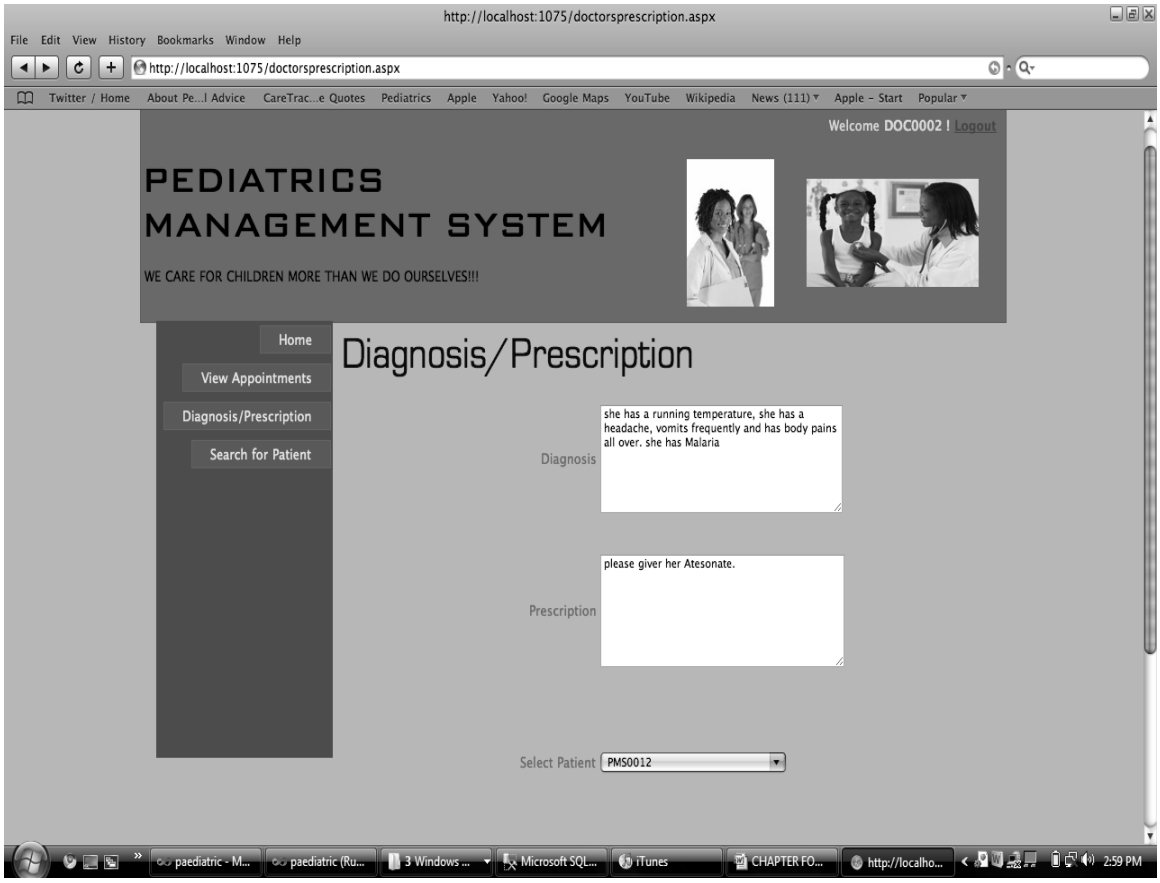


Fig. IX: The Diagnosis and Prescription Page

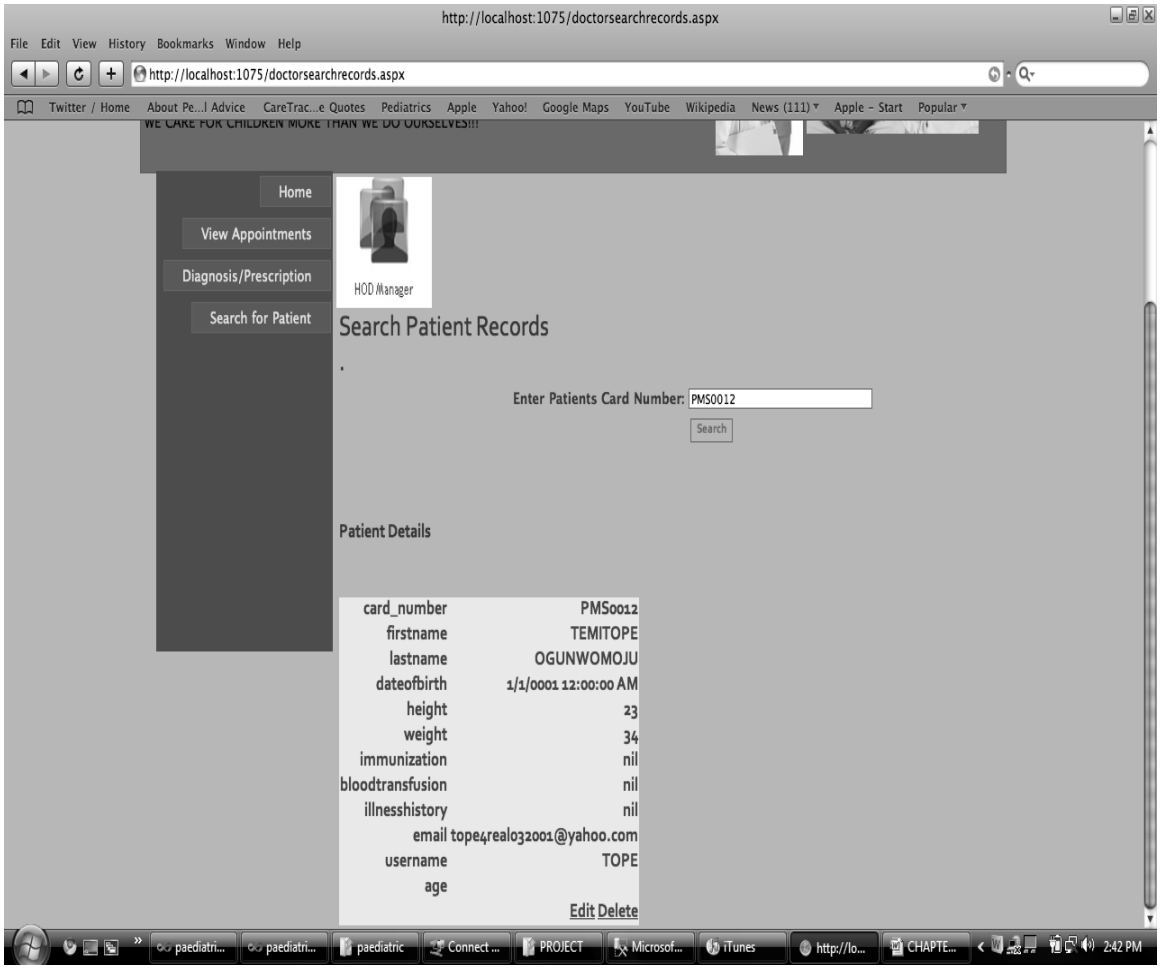


Fig. X: The Search Page

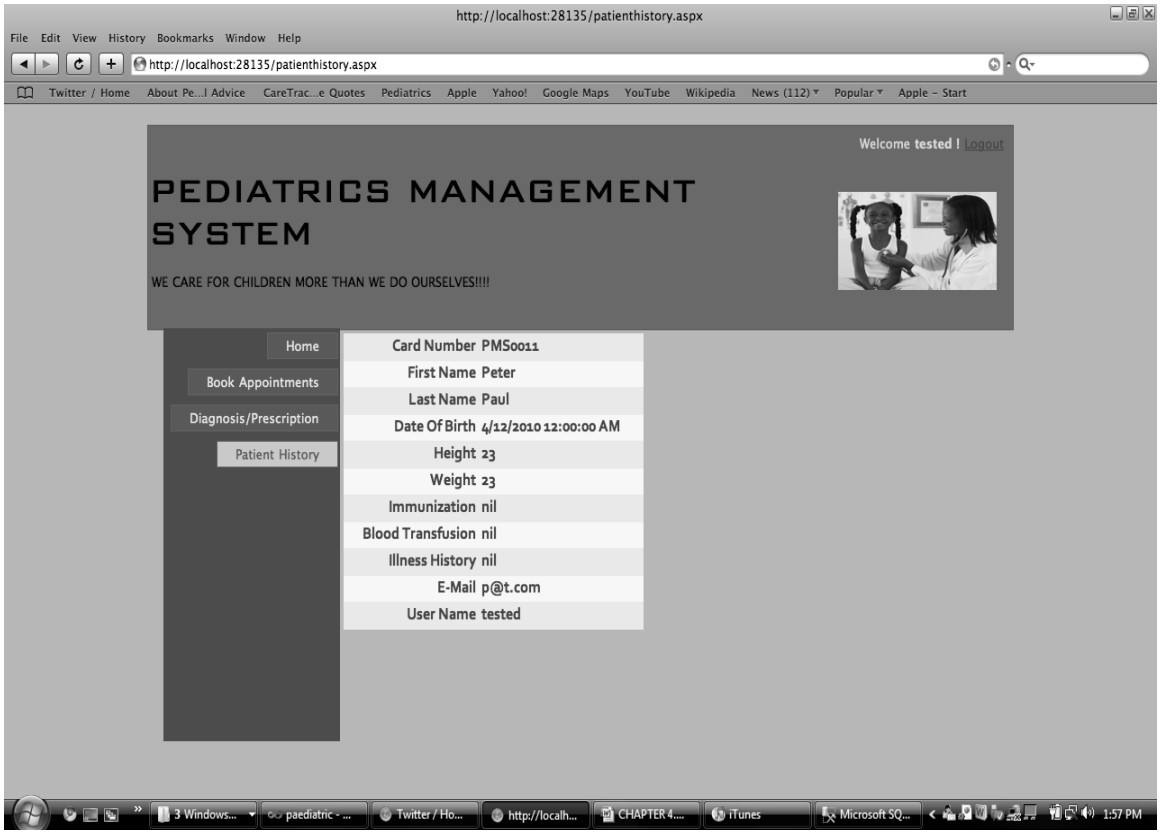


Fig. XI: Patient History Page

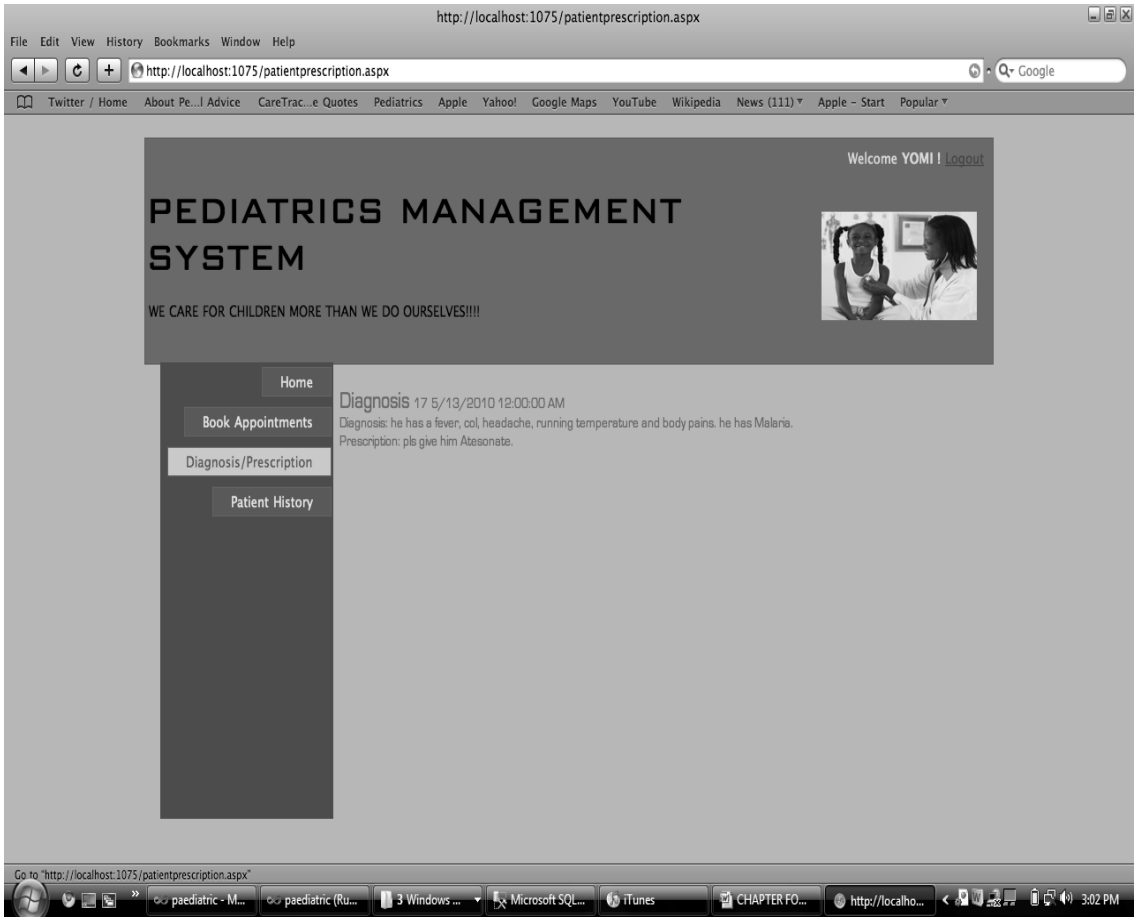
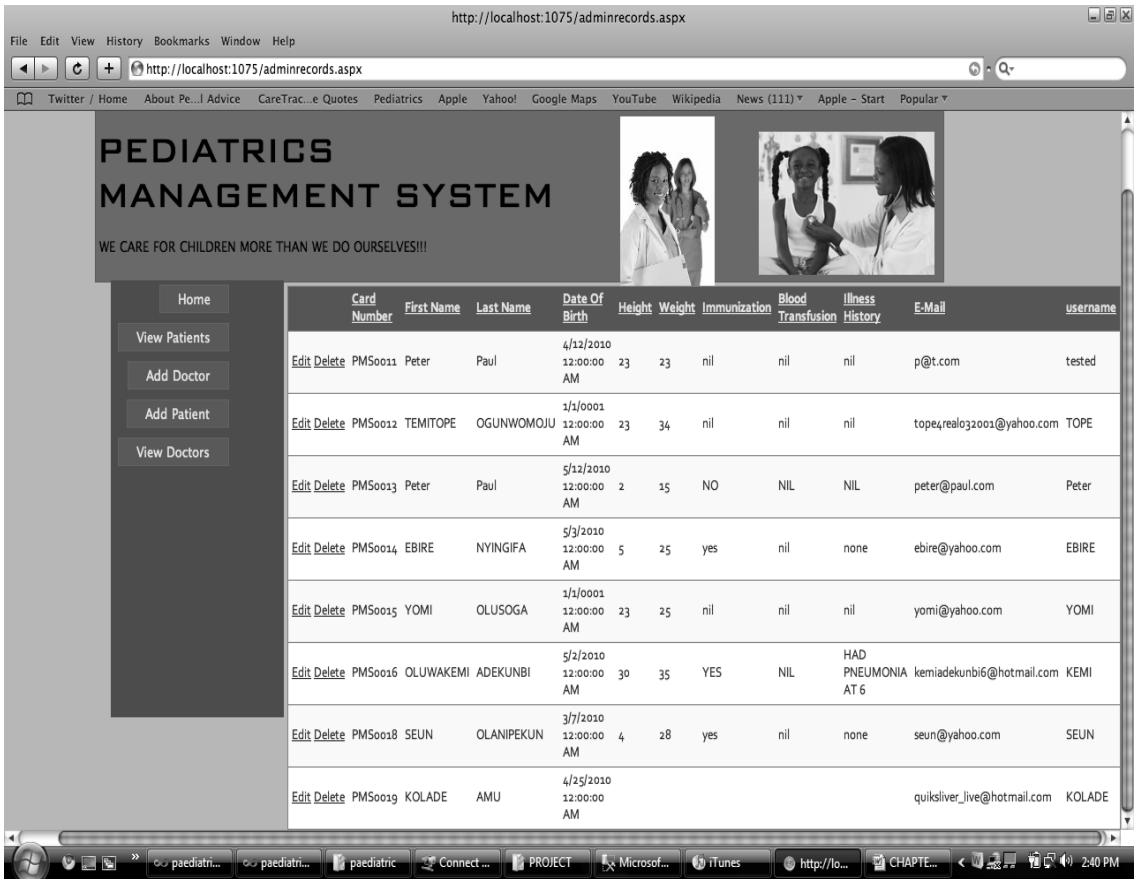


Fig. XII: Check for the diagnosis and prescriptions by doctor



	Card Number	First Name	Last Name	Date Of Birth	Height	Weight	Immunization	Blood Transfusion	Illness History	E-Mail	username
Edit Delete	PMS0011	Peter	Paul	4/12/2010 12:00:00 AM	23	23	nil	nil	nil	p@t.com	tested
Edit Delete	PMS0012	TEMITOPE	OGUNWOMOJU	1/1/0001 12:00:00 AM	23	34	nil	nil	nil	tope4real032001@yahoo.com	TOPE
Edit Delete	PMS0013	Peter	Paul	5/12/2010 12:00:00 AM	2	15	NO	NIL	NIL	peter@paul.com	Peter
Edit Delete	PMS0014	EBIRE	NYINGIFA	5/3/2010 12:00:00 AM	5	25	yes	nil	none	ebire@yahoo.com	EBIRE
Edit Delete	PMS0015	YOMI	OLUSOGA	1/1/0001 12:00:00 AM	23	25	nil	nil	nil	yomi@yahoo.com	YOMI
Edit Delete	PMS0016	OLUWAKEMI	ADEKUNBI	5/2/2010 12:00:00 AM	30	35	YES	NIL	HAD PNEUMONIA AT 6	kemiadekunbi6@hotmail.com	KEMI
Edit Delete	PMS0018	SEUN	OLANIPEKUN	3/7/2010 12:00:00 AM	4	28	yes	nil	none	seun@yahoo.com	SEUN
Edit Delete	PMS0019	KOLADE	AMU	4/25/2010 12:00:00 AM						quiksliver_live@hotmail.com	KOLADE

Fig. XIII Administrator page for editing.

CONCLUSION

The implementation of this pediatrics information system in pediatrics sections of southwestern hospitals in Nigeria will help achieve good and great results in reducing mortality rate.

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