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An Integrated E-Prescription System for Reduced Error in Drug Administration

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ABSTRACT

Due to the increasing number of errors associated with the paper-based prescription system, E-prescription systems came into play with technological advances. E-prescription brought about better medication management and management decisions through a modularized system (Prescriber, pharmacy and patient) leading to efficiency of the prescription process and information. However, most of the e-prescription systems lack proper interface for monitoring patients who are on medication and no feedback from the medical practitioner, leading to a one-way communication between the medical practitioner(s) and the patient(s) involved. This work designed a concept for a more comfortable and efficient prescription information exchange using the existing components of the E-prescription systems with the implementation of some improved functionalities that address the ineligibility of handwriting, a more dynamic user interface for medication prescription and administrative monitoring of the patient undergoing medication. The proposed system was tested using ergonomics approach which tests the system's ease of use. The response from the tests was positive.

1.0 INTRODUCTION

The increase in technology has brought about various improvements in different spheres of life, most especially the health sector giving way for the human race to challenge long-term diseases, and create solutions for themselves with the aid of drugs. With the introduction of information and communication to the healthcare industry, e-health and telemedicine were birthed. Telemedicine is the administration of healthcare at a distance. It reduces the need to visit the hospital and manages the doctor-to-patient ratio which has hitherto become a problem in some African countries. One of the major challenges for health services today is to provide safe, effective, timely and individualized care; with technological and scientific advances and the inclusion of increasingly complex techniques, the risks for patient safety have been potentiated. Medically inappropriate, ineffective, and economically inefficient use of drugs is commonly observed in health care systems throughout the world. Pharmacotherapy is the most common therapeutic intervention in healthcare to improve health outcomes of patients. However, there are many instances where prescribed medications resulted in patient morbidity and mortality instead [13]. Also Self Medication has been the order of the day due to communication breakdown between the medical practitioner and the individual and also no means of supervision on the individual under medication.

When the medical practitioner issues the right prescription of a drug to an individual (patient), but the individual doesn't clearly understand the prescription due to his level of education or other factors and goes on to use the drug with little or no idea of how to go about it (known also as self-medication), this can lead to Adverse Drug Event (ADE). However, this can be curbed by providing a system or a way by which this individual can get the right information and also providing administrative monitoring. Paper-based drug prescription systems involve the use of written or printed paper forms to prescribe and administer medications. The use of such systems cannot help to ensure effective communication of drug dosage information between healthcare professionals and drug administration for monitoring purposes. Electronic prescribing (e-prescribing) can improve physicians' workflow, increase pharmacy efficiency, and improve patient safety [15-17] E-prescribing improves the eligibility and clarity of prescriptions [19, 20] reduces prescribing errors, improves coordination, and ensures the privacy and security of personal health information [23]. However, it can also create new errors, such as incorrect dosage instructions, missing information, incorrect product (medicine or strength), and wrong quantity or duration of therapy [25].

E-prescription systems allow healthcare providers to electronically send prescriptions to pharmacies, eliminating the need for handwritten prescriptions. These systems can help to improve medication safety and reduce errors by providing more accurate and complete medication information. Research on e-prescription systems has shown that they can be effective in improving medication safety and reducing medication errors. [26]

found that e-prescribing was associated with a reduced risk of medication errors in a primary care setting. [27] found that e-prescribing improved medication safety and reduced the risk of adverse drug events in hospitalized patients. [14] evaluated the introduction of e-prescribing and its potential advantages. This research work therefore developed a Mobile based Application and a Web Application for drug prescription system for effective communication of drug dosage and administrative monitoring. This was developed with user friendly interfaces with object orientation and representation. The system was implemented with some features of an electronic medical records system. However, the research did not include the real drugs prescribed for a particular illness, patient diagnosis, health problems in the report to avoid drug abuse by readers and to preserve doctor-patient confidentiality. It is advised that the patient visit with the medical practitioner for consultations. The solution however proved that the problem space has a veritable solution.

Electronic prescribing or Electronic prescription (EP) is the computer-based electronic generation and transmission of a prescription. EP systems help to increase accuracy and safety of patient prescription and reduce costs through improved legibility and electronic delivery. [1] surveyed four hospitals in Nigeria to determine the economic, technical and organizational feasibility of adopting e-prescribing. Respondents included 42 medical practitioners-doctors, pharmacists, pharmacy technicians and assistants-working at the hospitals at the time of the survey. [2] conducted similar process by finding the awareness level of E-Prescription, features of E-Prescription, feasibility for adoption and legal possibilities for implementing E-Prescription in India. [3] developed and evaluated the acceptability and use of an integrated electronic prescribing and drug management system for primary care physicians. Thereby improving continuity of care, and they were more likely to use the system for patients with more complex, fragmented care. [4] gave a review according to the PRISMA-SCR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) for Electronic prescription system presenting requirements, standards, and features of an electronic prescription system for its correct and accurate execution, showing that the electronic prescription systems have several functional and technical capabilities that can provide significant benefits to all system's stakeholders, including service providers, drug distributors, patients, and insurance organizations if used correctly [8], [6]. [7] in a paper titled "Routes of Drug Administration: Advantages and Disadvantages" gave a routes of drug administration: Dosage, Design, and Pharmacotherapy Success stating that Various routes of administration play a marked role in the bioavailability of the active drug in the body. [5] developed a safe drug administration assessment instrument for nursing students with the sole objective of determining the content and face validity of a safe drug administration assessment instrument for nursing students using the Architecture of Integrated Information Systems and the Work Breakdown Structure. The paper-based system for prescribing and dispensing medications had widespread problems with safety and efficiency, experts predicted that a shift to Computer-based Physician Order Entry (CPOE) and related technologies such as electronic prescribing (e-prescribing) systems could avoid adverse life-threatening drug events by eliminating common errors. There was also a need for the use of pervasive healthcare. Pervasive healthcare systems are applications that can support patients' needs anytime anywhere Puspitasari, (2011).

2.0 METHODOLOGY

2.1 System Design

To make the e-prescribing experience as successful as possible and reduce development time. More time was dedicated to overall systems design, outlining requirements and modeling the business objects and the relationship that exist using UML diagrams. The entire systems were based on the MVC (Model View Controller) and MVVM (Model View-View Model) architecture.

2.2 System Architectural Framework

The developed e-prescription system is intended for out-patient health care delivery and it is heavily dependent on internet services as compared to the in-patient which uses Intranet based setup. The e-prescription system consists of several computers designated to the physicians and pharmacists, servers and database systems, firewalls and patient mobile application packages for service access. Figure 1 represents the interconnection of these computer components to form a working system. The server hosts the systems' software package and centralized system database. It is responsible for the processing of service requests such as login authentication and authorization, prescription updates, patient information storage and retrieval via the Internet. Prescriber and pharmacy computers can optionally be connected to their respective remote servers which are connected to the internet. These remote servers are used when multiple systems are used by the care centers, all service requests and response are queued on these servers. The pharmacy remote server functions as the pharmacy benefit manager by providing the hub with information on patient eligibility, formulary, and medication history. The remote physician/pharmacy communication or transaction hub is a dedicated system that provides a common link between all actors (prescribe and pharmacy). It stores and maintains a master patient index for quick access to their medical information as well as a list of prescription detals, alerts and notification from physicians and the pharmacy which make this development system distinct from other prescription system.

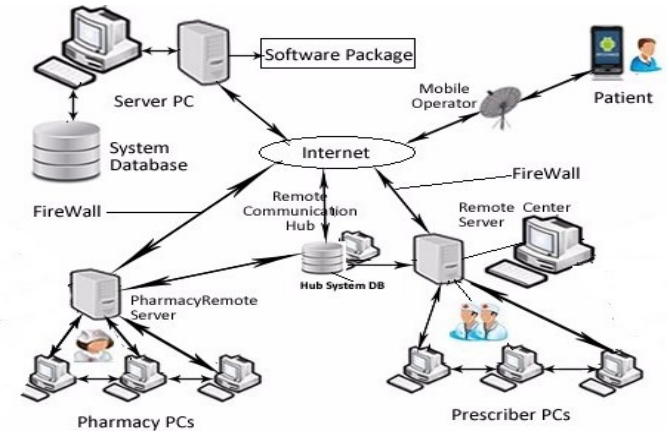


Figure 1: System architecture of a standalone e-prescription system

The Use-Case Diagram for the e-prescription system

The use case diagram shows the functional relationships between the functional entities of the system. The complex interaction contributes to the overall outcome of the system. Each module interacts with the other in sequence of activities to achieve the overall objective of getting the prescription to the patient, monitors the usage, get feedback to enforce compliance with the therapy regime. The role of each player in the prescription is clearly spelt out.

2.3 System Prescription Process Sequence Diagram

The activities occurring in the system includes a lot of important sub-functions and functionalities making the e-prescription experience much more efficient. Figure 3 demonstrate the behaviour of objects in the use case by describing the system objects and the messages they pass during the prescription process. The diagrams are read left to right and descending.

Firstly, a patient consults a doctor, lodging complaints and requesting for treatment, the patient can visit the hospital or make use of the system; next, the doctor diagnoses the patient and is ready to prescribe or make recommendations. The doctor then requests internet service from the internet service provider, when a positive response is received, the doctor then proceeds to log into the system, the login authentication is performed by a joint effort of the application server and the database. After successfully being granted access, prescriptions are made by selecting the drugs and patient for whom it is intended (in no particular order) then sends it to the patient's pharmacy. The prescription details are uploaded to the

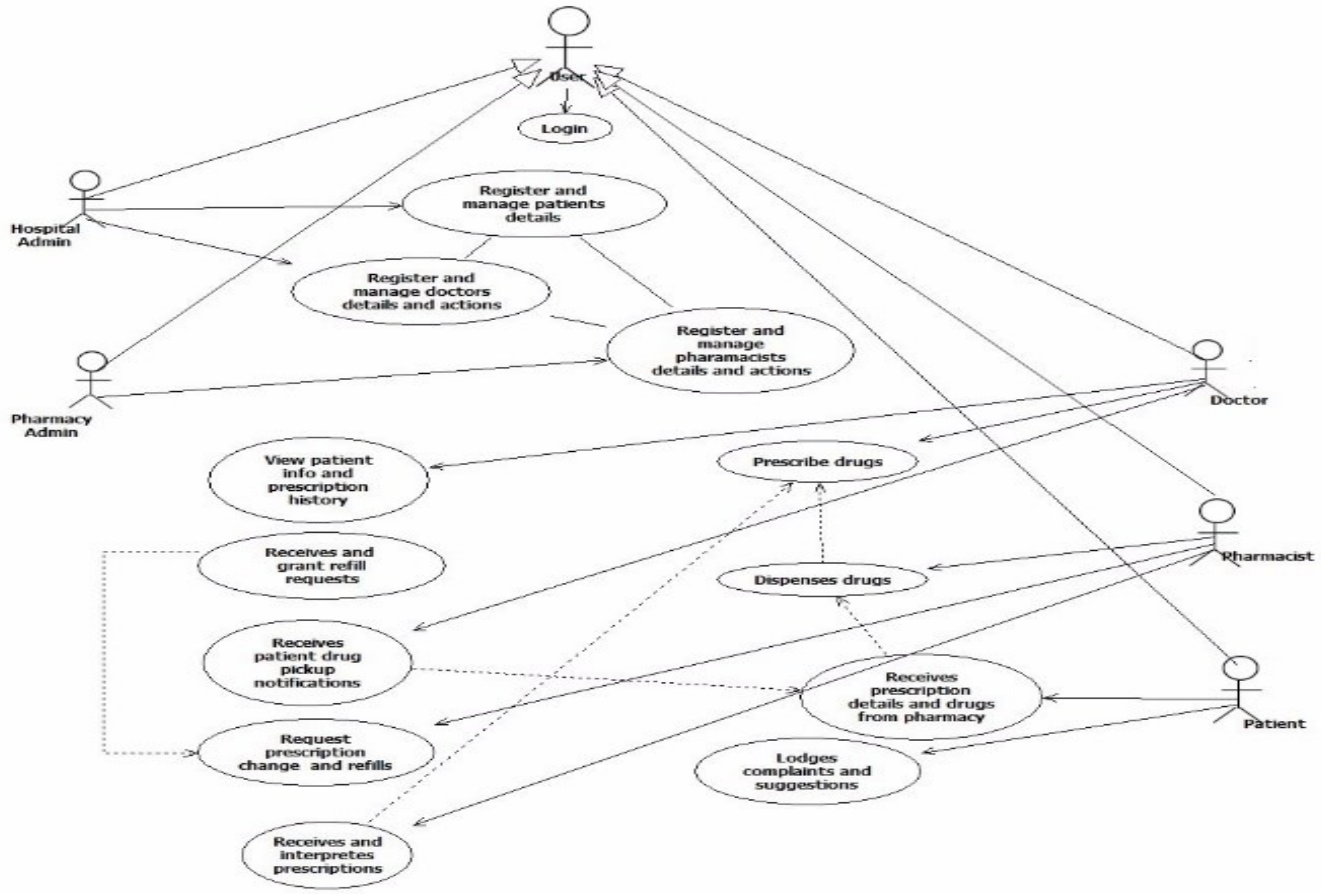


Figure 2: Use-case Diagram Showing the System Actors and their Roles

server's database and are tracked. The patients then go to the pharmacy to acquire his/her prescribed drugs; the

pharmacist dispenses the drug to the patient who later notifies the doctor when the prescription detail medication might have been dispensed. The user starts medication and a notification is sent to the doctor by the system, the system subsequently notifies the patient for his scheduled drug intake

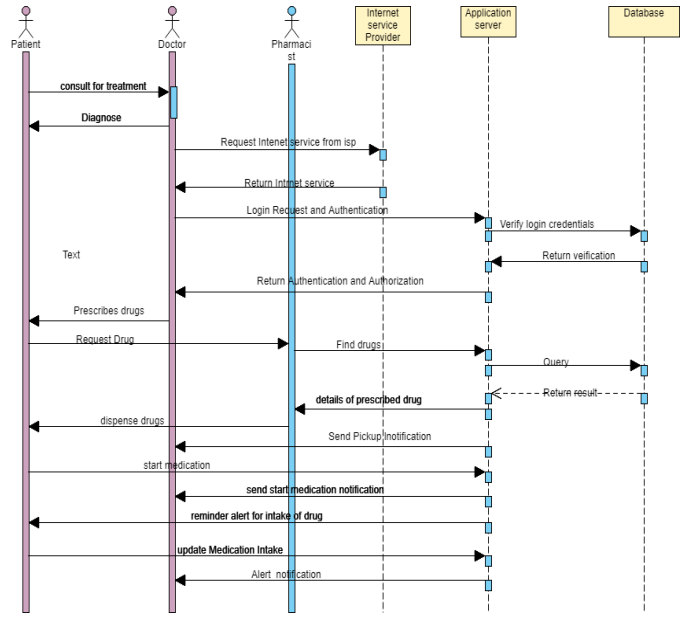


Figure 3: Sequence diagram of a simple prescription process.

Entities include but are not limited to User type, Users patients, hospital actor, pharmacy actors, hospital list, pharmacy list, prescription, drugs, dosages, consultations, the attributes from Figure 4 depicts a user has a one to one relationship with user type, User entity has a one to one relationship with hospital actor, pharmacy actor, patients respectively, Patient Entity have a one to many relationships with Consultation Entity, Prescription's Entity, respectively. Pharmacy actor Entity have a one to many relationships with Consultation Entity, Prescriptions Entity, respectively. Drug Entity have a one to many relationships with Prescriptions Entity. Prescriptions Entity have a one to many relationships with Consultation Entity. Dosage Entity have a one to many relationships with Prescriptions Entity.

3.0 RESULTS AND DISCUSSION

The mobile e-prescription system was developed in three modules which are the hospital and pharmacy administrators, the pharmacist, the patient and doctor modules. The administrators and pharmacist modules are web based using HTML5, Javascript, PHP and MySQL while the patient modules are deployed and packaged into mobile operating system executable file format using React Native. The modules in the implementation is presented in the sections that follows

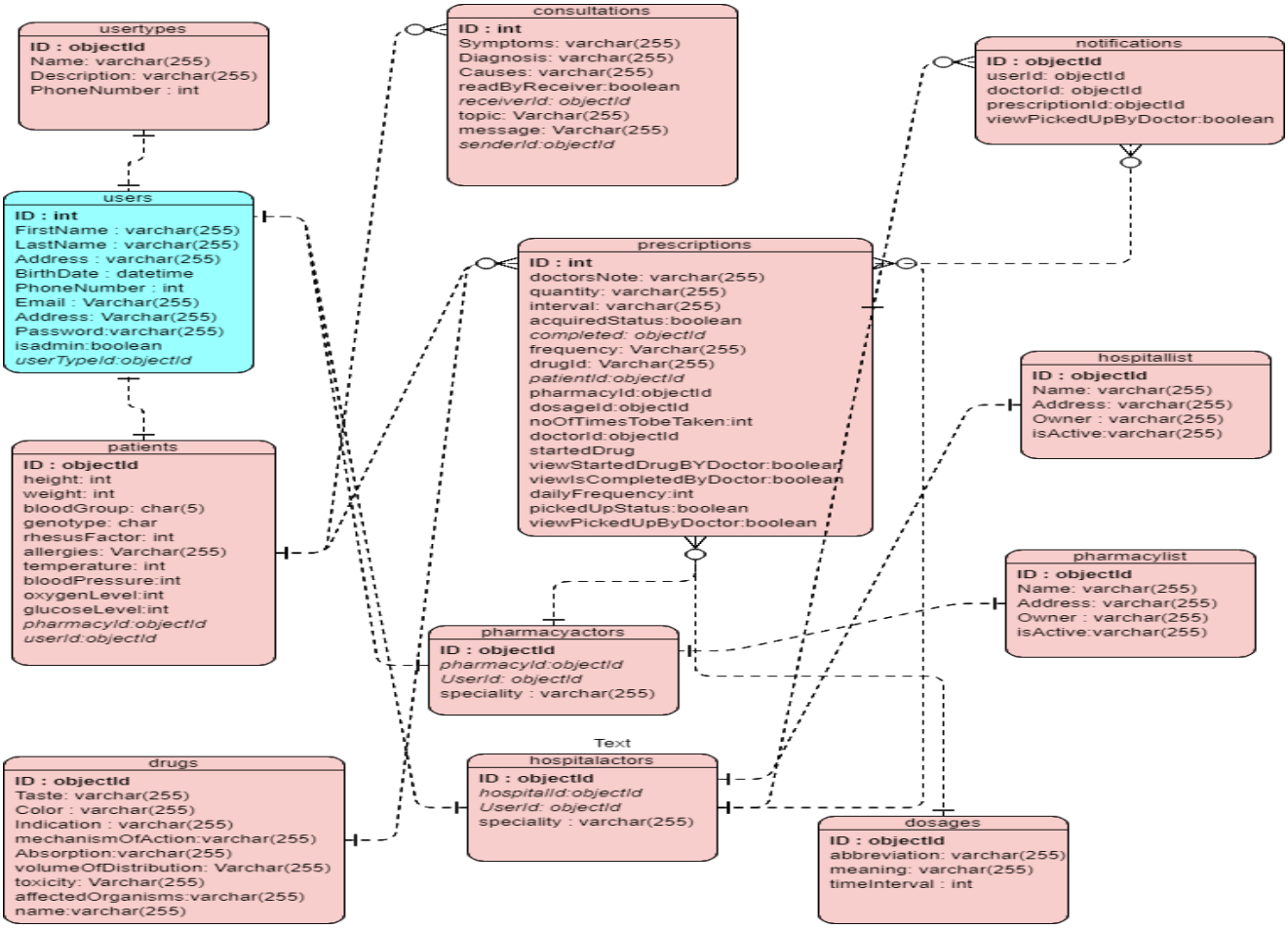


Figure 4: Entity Relationship Diagram Showing the System Models and their Relationship

2.4 Entity Relatio

Figure 4: Entity Relationship diagram showing the system models and their relationship

3.1 Hospital Administrator Module (web based aspect)

This module houses the hospital administrative tasks such as but not limited to the registration and the management of doctors and patients. The tasks include creating, viewing, editing and deleting doctor, patient and. These are shown in Figure 5 which allows the administrator to login into the system providing his username and a matching password, Figure 6 shows the dashboard page with a side bar for the hospital administrator where he can navigate to tasks or operations to be performed while logged on to the system, Figure 7 is used for the registration of doctors in the system by the administrator, and Figure 8 Confirmation Registered pharmacists, Figure 9 Confirmation of Successful Registration of Patient, Figure 10 for registration of a Drug and Figure 11 for managing Registered Drug

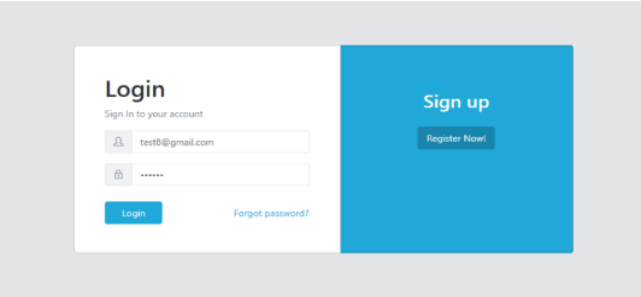


Figure 5: Login Page for Hospital Administrator.

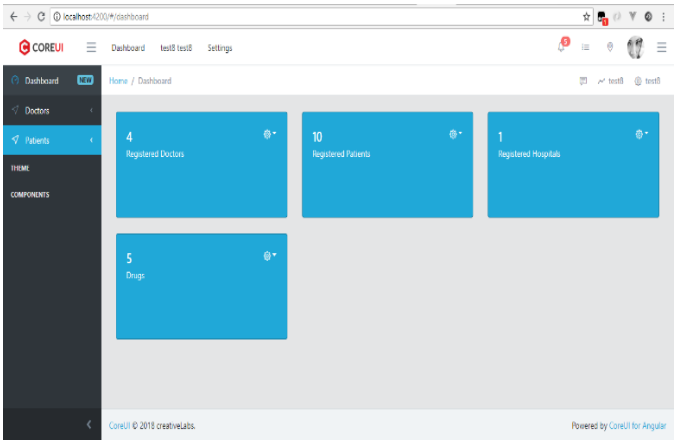
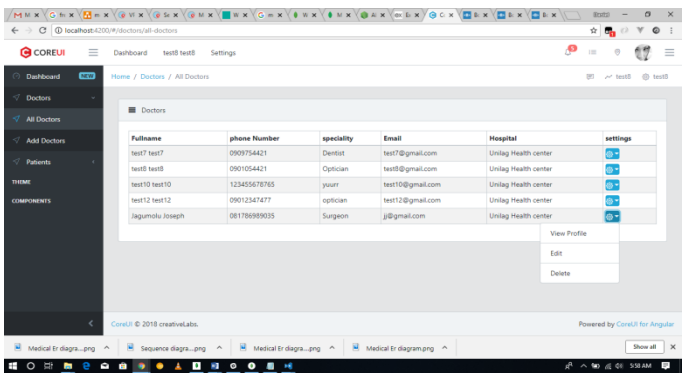


Figure 6: Hospital Administrator Dashboard Page.



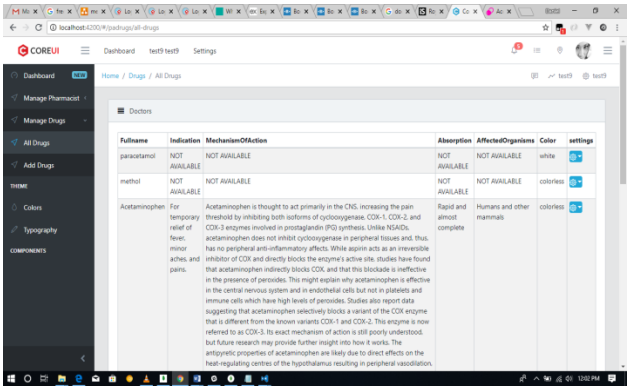


Figure 8: Registered pharmacists

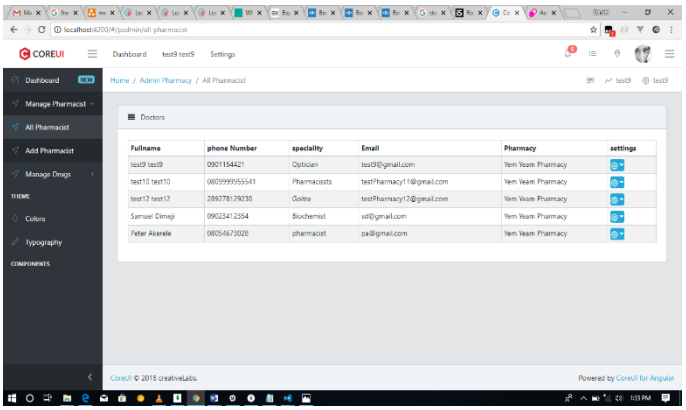
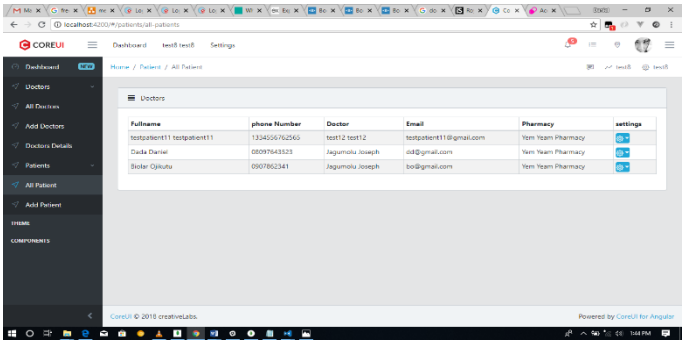


Figure 9: Registered Patients



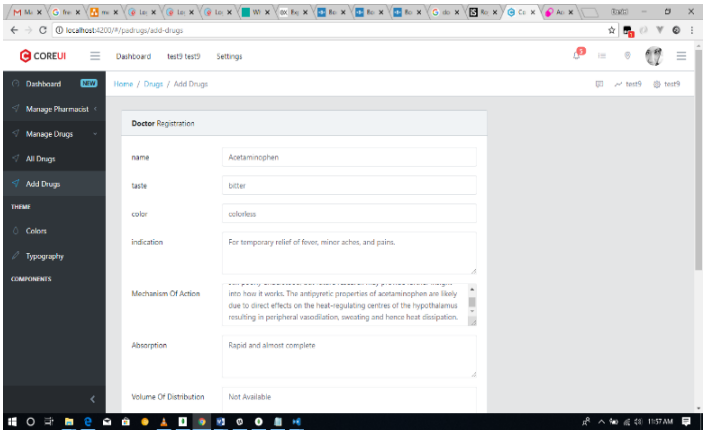


Figure 10: Registration of a Drug

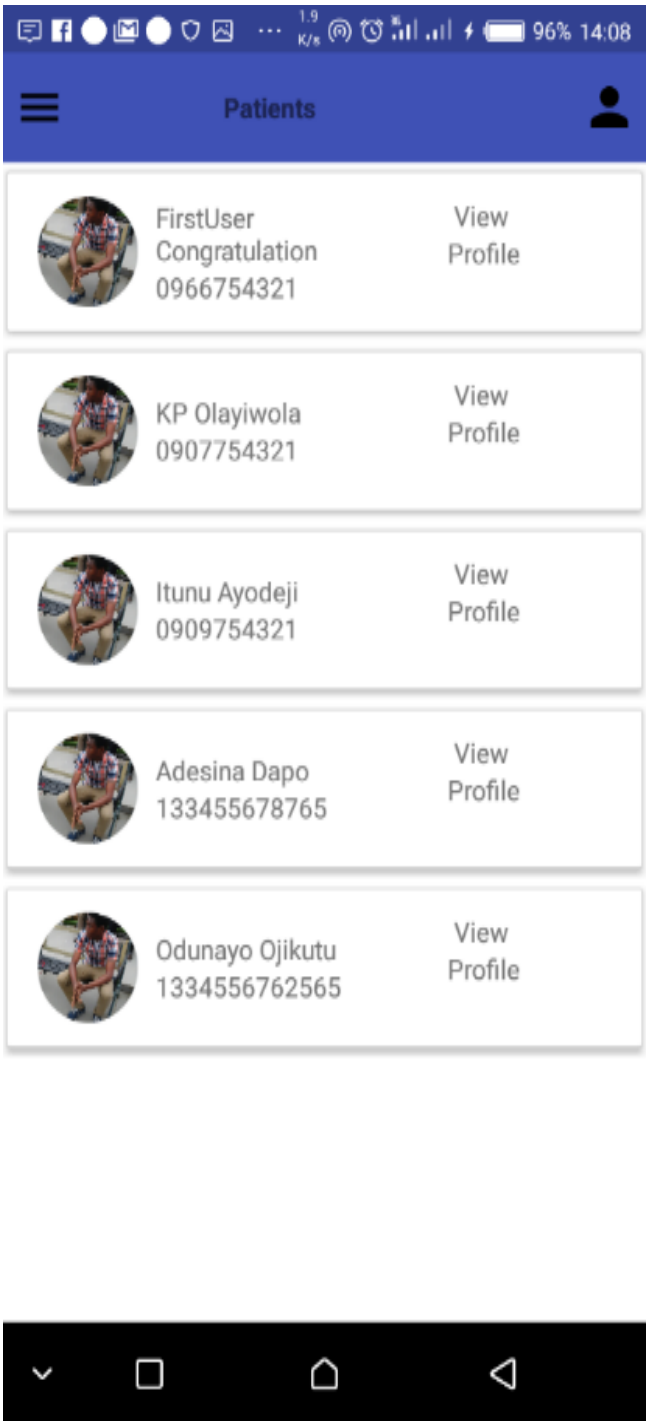


Figure: 11 Managing Registered Drug.

3.2 Mobile Based Module

Figure 12 shows the list of patients assigned to the doctor, Figure depicts 13 Doctor viewing Patient Details, Figure 14 shows Doctor consulting with a patient, Figure 15 shows a Doctor prescribing to a patient. Figure 16: Doctor Viewing a patient complaint, Figure 17 shows Login page for Patient, Figure 18 Doctor Viewing a Drug chart, Figure 19 Patient Viewing Details acquired prescription. Figure 20: Drug reminder counter and alarm.

Figure 12 : List of Patients Assigned to the Doctor

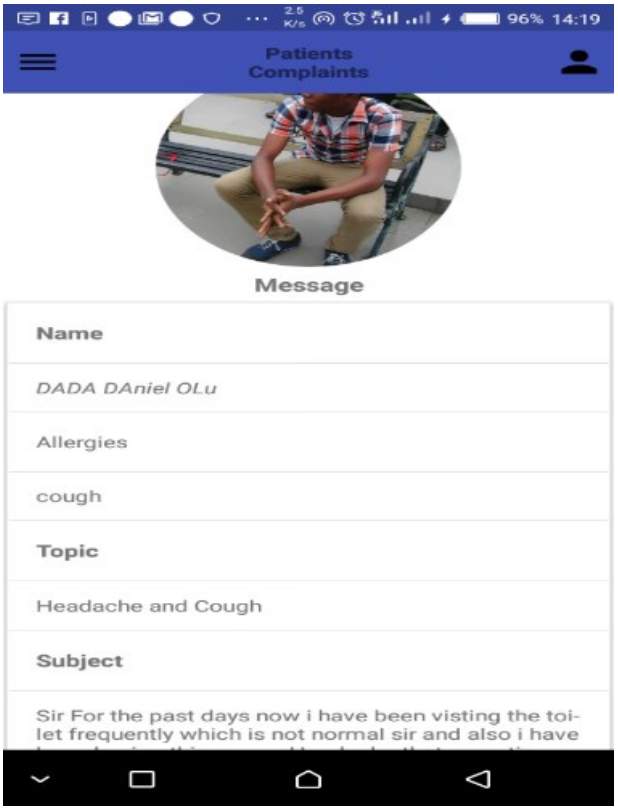


Figure 13: Doctor viewing Patient Details

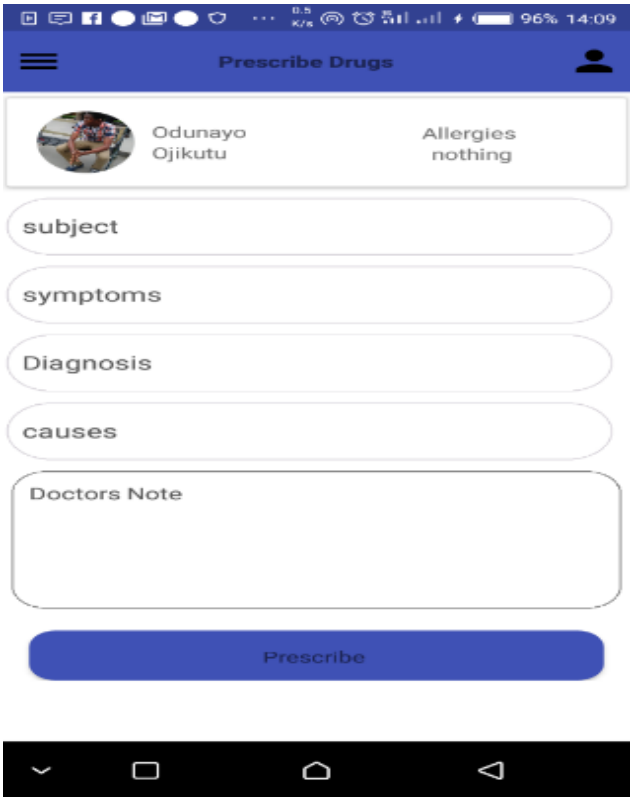


Figure 14: Doctor Consulting with a Patient

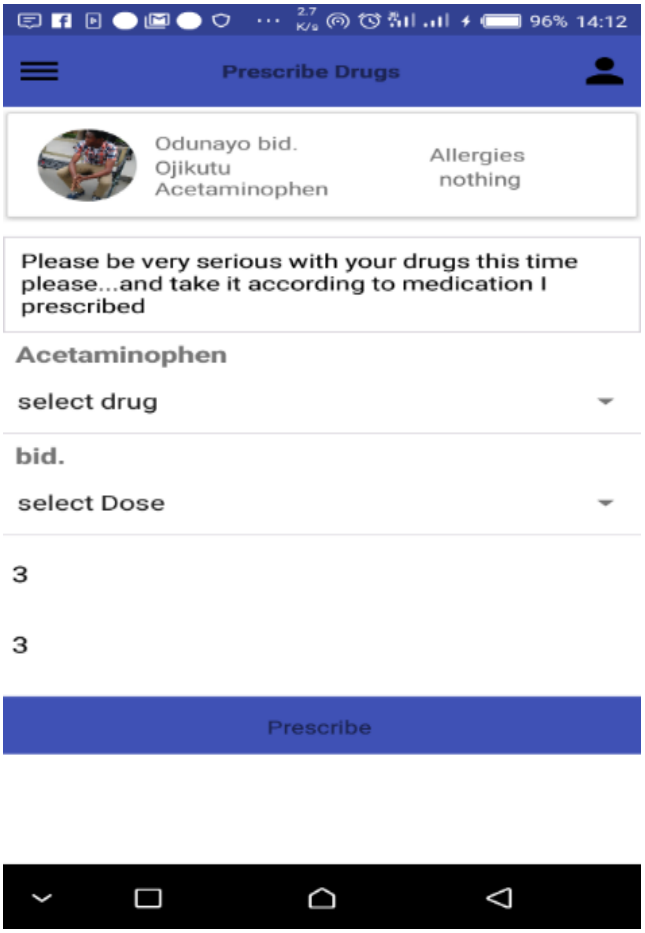


Figure 15: Doctor prescribing to a patient.

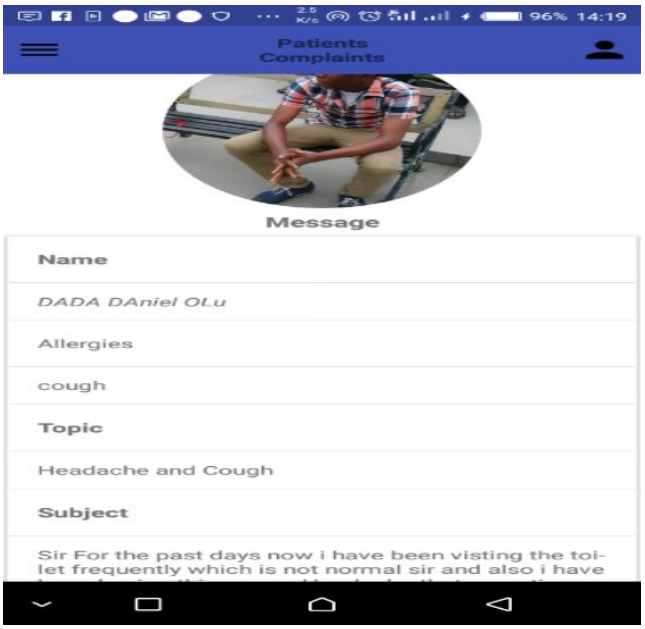


Figure 16: Doctor Viewing a Patient Complaint.

Figure 17 : Login page for Patient.

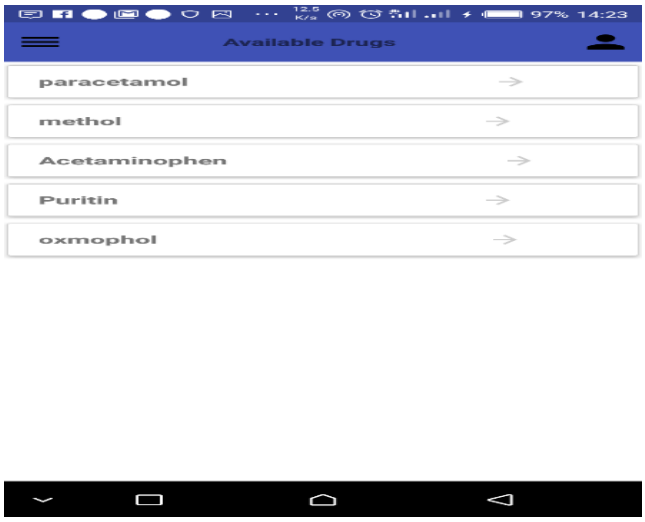


Figure 18: Doctor Viewing a Drug chart.

Figure 19: Patient Viewing Details Acquired Prescription

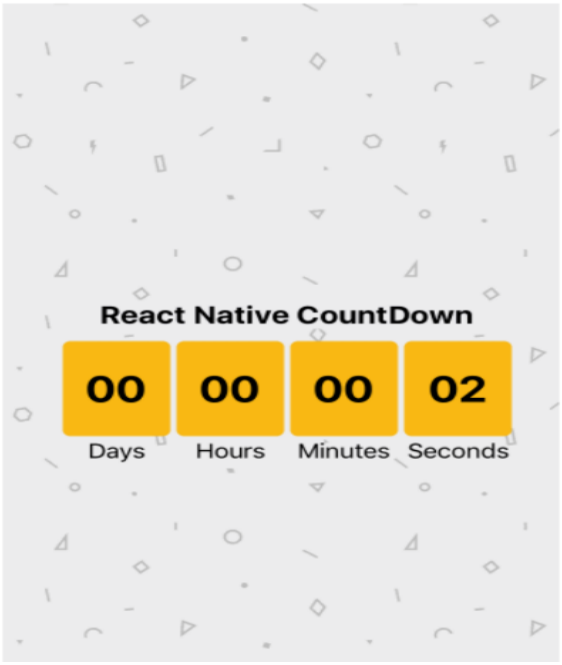


Figure 20: Drug Reminder Counter Alarm

The e-prescription system developed in this research demonstrates how technology can be adopted to solve a major issue in the medical field. This aspect of medicine is known as telemedicine and e-health. The system was developed in parts: Administrators part, whose duty is to register the users that should interact with the system, the administrator cares for the security and the network interaction of the whole integrated system. The Administrators modules is a web based application; therefore, it is hosted in the hospital coordinating the e-prescription system. The other participants are the Doctors, pharmacist and the patients. These individuals are registered by the Administrator in the initial state, but are subsequently attached to be registered by the consulting physician as the system goes into operation. The pharmacist is responsible for populating the drug database and for dispensing prescribed medications by the doctors. The doctors consult for patients registers under him/her, look up the patient history, biodata, vital signs and other testes that would have been conducted in time past. The prescription is done on the platform of the e-prescription system. This eliminated the errors associated with the writing prescription on a paper. This is stored in the database and can be accessed by both the patient and the pharmacist. The prescription states how the drug is to be administered and other peculiarities with the patient's health conditions. The patient is directed to the pharmacist to get the prescribed drugs. The pharmacist, the doctors and the patients have a mobile platform from which the can work for remote consultations, communication and coordination of drugs dispensation and authorisation. The patient picks up prescription from the pharmacist, the pharmacist sets all the drug dosage as recommended by the doctor, set the duration and triggers reminder parameter on his platform. This is updated and can be seen on the hospitals database for remote monitoring of then patient for conformity to the drug regiment and its effective administration. The patient logs on to his mobile interface, sees the regiment of the drugs prescription, duration of administration and the remainder is synchronised with the patient phone's calendar to remind him/her in a timely manner when the drug is to be taken. Once the dosage is taken, the patient clicks taken and the record is updated for the whole system. This feature is important for tele-monitoring and evaluation of the patient's recovery trajectory. All these features are depicted in figures 5-19 in the previous section. The developed system was set up where a number of medical practitioners and some patients were asked to access the functionality of the system. The degree of ease of use, interactive interface, network connectivity and preference for the developed system over the tradition methods of drug administration was tested. The feedback shows that the participants rate the interface very high and the fact that they use the application remotely on their mobile phones was an added advantage. They found it easy to use, and the data requirements was minimal.

4.0 CONCLUSION

An e-prescription system is very useful modern software whose advantage outnumbers its disadvantages. It is highly recommended for all categories of healthcare practitioners and people due to its ease of use and pervasiveness. E-prescription system can be developed according to client requirements. The developed system was tested with some psudo-data. By using this application, patients can consult doctor without visiting the hospital and gets feedback in form of advice or prescription which is sent by doctors with convenience using their mobile devices. It provides extendibility also such that each of the modules can be equipped with more features whenever there is a change in the department or requirements. This reduces the physical work, prescription errors, stress in prescription history maintenance, time as well as financial costs.

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