Exploremetics
Journal of Innovative
Engineering and Technology

Volume: 02 No: 01 | March -2018

ISSN (Online) 2636 – 590
ISSN (Print) 2636 - 591X

AN ONLINE PATIENT DIAGNOSTIC LABORATORY APPOINTMENT BOOKING MANAGEMENT SYSTEM

*Nduanya, U. I.[1] , Agbo T. R.[2], Okoye F. A.[3]

1,2,3 Department of Computer Engineering, Enugu State University of Science and Technology (ESUT). Enugu State, Nigeria.

*Author for Correspondence: uju.nduanya@esut.edu.ng

Abstract - The online diagnostic laboratory system is a web-based application designed to manage tasks in medical laboratories, in particular, AMBLIN Laboratory Services. This system manages several modules such as patient registration, booking for laboratory tests, generation of appointment evidence, generation of patient test result, and its delivery via email and SMS prompts. It aims at aiding the laboratory staff to manage laboratory operations easily. The system was designed as a client/server web-based system, which was implemented using the two technologies: The Front-end (Graphical User Interface – GUI) was implemented using Asp.net Web form which incorporates HTML, Bootstrap, CSS and JQuery. The Back-end that is the Database was implemented using MSSQL server while the middleware was implemented using C#. An evaluation of the system determined that it achieved the set objectives. The developed system is an efficient, usable and reliable diagnosis laboratory management system.

Keywords: ***Web-based system, Asp.net, Diagnostics, Databases***

1. Introduction

Information technology infusion that aids globalization refers to the degree to which various information technology tools integrate into organizational activities (Idowu et al., 2006). The application of information technology in health care is unceasingly evolving as the quality of patient care in contemporary times seems to depend on the timely acquisition and processing of clinical information related to the patient (Brailer, 2005). Cholewka (2006) asserted that a significant paradigm shift has occurred in health care service delivery from an era of physician centeredness to emphasis on quality of patient care; from isolationist practices by caregivers to networking in a global world, and from competition to collaboration among practitioners. In tandem with this trend, improvement in technology and advancement in information systems has been adopted in the health care industry as a business strategy to improve the quality of care (Wilcke, 2008). In addition, an operating and robust information system provides the right information to the right person at the right time with the lowest cost (Mehdi et al, 2004). This is why existing laboratory data management needs to be upgraded to a level that is sufficient to improve data quality, reduce the manual interfaces and intervention by laboratory technicians, and aid in timely and routine reporting of disease trends. The emphasis is on reducing the margin of errors made during transcription in the laboratories and provides a single point of entry for all patient and specimen data. According to Jantz (2001), the emergence of computer-based information system has changed the world a great deal; both large and small systems have adopted new

methodologies by the use of personal computer to fulfil several roles in the production of information, therefore, computerizing the documentation of patient record to enable easier manipulation of the input and output processes. Moreover, it improves the quality of data control (Liu and Zhu, 2007). The benefit of using a health care information system or online laboratory management system is to provide a complete patient health record, to make proper diagnosis and prescribe proper treatments; to track crucial medical information, insurance data, consultation history, medications and special conditions.

2. Related Works

Monu (2010) developed a laboratory information system for resource-limited settings, Basic Laboratory Information System (BLIS). In this system, test samples and results related data are largely managed in non-standardized paper-based systems and manual entry method. The system is designed to work in *resource-constrained* laboratories with limited IT equipment and across sites with good, intermittent or no internet availability. There might be periods where power supply is not available in the laboratories. In such situations, it becomes important to ensure that the data in BLIS is consistent with paper records used in the absence of power supply. In spite of the inherent inefficiencies of paper-based methods, flexibility in data entry can be relatively easy to attain while working with logbooks than on an electronic information system. The system had its downside in that it is not automated (the patients must be physically present to register) and appointment booking had to be done physically. This then increases patient waiting time. Thereby, deteriorating the quality of service in health care. *Al-Khawlani (2009)* designed a Web-Based Integrated Health Care Management System. The system contains the main modules such as patient module, doctor schedule module and appointment module. This manages the patient information history (personal information, medical information, treatment information, payment information, and appointment information). It is a flexible integrated web based system to keep track of all patient information, payment and appointments. In addition, tracking the doctor schedules. This integrated web-based system gives the patient the opportunity to use the system online and confirm their own appointments by themselves, a matter that saves time and effort of both the patient and the nurse. Moreover, by this integrated web-based system, patient will be able to check the status of their appointment and doctor availability online. This provides a full view of previous visit history of the patient and the previous diagnosis, investigation, treatments and medications. Moreover, it supports the user to put their tasks in priority such as Urgent, High, Medium and Low. However, its limitation was that the patient cannot book appointments online or change the date of appointments. The system only kept track of manual records which can only be collected if the patient is physically present. *Kopach et al., (2007)* developed a system which concentrated on patient's appointment; where the appointment can be made many months in advance. Once the patient wants to have an appointment to see the physician, they just have to call the health care informing them of the preferred date and time. If the appointment slot is available within a day or two of the preferred date, the patient appointment is then scheduled. If not the patient has to call back later. This has improved patient access to physicians and reduced uncertainty in the health care operations by eliminating no-shows, resulting from long appointment times. In addition, in static appointment, all decisions about appointment times are made prior to the start of a session, but in the dynamic case, the appointment times are adjusted as patients arrive. There are three parameters in the appointment system - the "block," which is the number of patients arriving at the beginning of an appointment period; the "initial block," which is the number of patients arriving for the initial appointment; and the "interval," which is the length of the appointment. *Lim et al (2006)* developed a web-based healthcare system that integrates components such as patient management,

patient accounting, appointment, house call and communications into one complete package solution. These components are developed using portal technology. A healthcare web portal serves as the integrated gateway in a healthcare center website and provides to the users a single point of access for the healthcare services delivery. This portal technology supports single point of access and different access levels to prevent patients' records from unauthorized access while maintaining one simple gateway for all user levels. This provides a strong and secure system. The limitation is that only one point of access is allowed. Also, method of sample collection from patients is not indicated. *Porta-Sales et al. (2005)* built a system whose main concept is contacting, screening and scheduling appointment with the health care center initially by an expert nurse and the patient initiating contacting with the health care center using the telephone. Moreover, the health care center can be accessible from different places. So, there should be PC resources and PC consultations to be accessed from different sources, from other hospitals, from general practitioners, or even from the patients themselves. *Mustafa (2004)* developed a system which allows a registered patient, having user name and password, to access and explore the list of physicians alphabetically and select a physician, whose email contact and profile are also provided. A patient can also view the physician working calendar to find out his/her working and non-working day to make an appointment. On the calendar, which is part of the developed system, the patient can then choose any valid day in any month to make an appointment. After that, the patient will receive an e-mail from the system to confirm the appointment time or to inform the patient that the selected time is already taken by another patient or blocked by the physician. In general, the patient appointment system provides all the choices and the capabilities to the patients, such as selecting a physician, selecting the time of appointment, and allows them to access the health care system day or night and schedule their own appointments using the Internet without spending time holding for a nurse or having lengthy phone calls.

3. System Design

This study proposes a web-based system that enables a patient/doctor to register for AMBLIN diagnostic laboratory services remotely. The system provides the means of specimen collection and when to do so. It delivers results of tests via e-mail and SMS prompts. It provides bookings and records management and prompt response to queries.

Fig 1: The system structure

The ODLMS is structured as shown in Fig 1. There is a front-end or the graphical user interface (GUI), the middleware or the processing subsystem and the back-end or database.

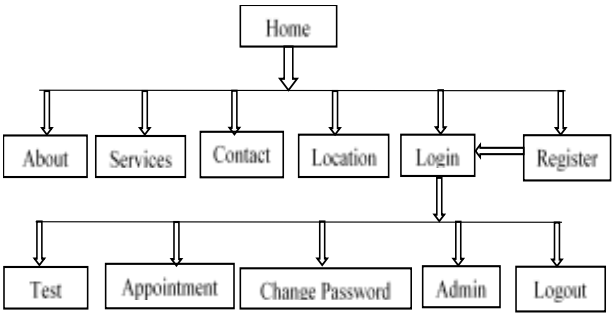


Fig 2: System Front-End Structure

The Front end also known as the graphical user interface (GUI) of the system was designed using Asp.Net webform which incorporates Html, Bootstrap, CSS, JQuery and Javascript.

The Home tab has the following linked pages: About Us, Service, Contact Us, Location, Login and Register sub modules. Any user (registered or not) can access these functions.

About Us contains general information about the company (i.e. Amblin), and how the company operates. The *Service Module* contains the services the company renders; the tests, the diagnosis, etc. while *Contact Us Module* contains the contact addresses, phone numbers and email of the company. *Location Module* lists the various locations of the physical offices (or branches) of the company.

3.1 ***Admin and User/Patient Registration Module:*** Patient Registration requires the entry of the following data: Name, Age, Email, Phone Number, Address, Sex, Blood Group, Genotype, Username and Password. The registration module (Fig. 3) is designed for both Administrators and Users (patients). The information required from the user such as Username and Password will be crucial during the process of logging in as it specifies what privileges the system user should and should not have.

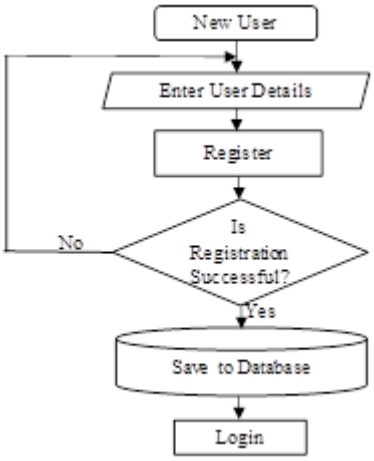


Fig 3: Registration module

3.2 ***Login Control Module:*** Login Control module is the path through which User can access certain system resources depending on privileges set by the Admin. If the user is not successfully logged in, access to these system resources will be denied. For a user to login, they must key in username and password used during registration.

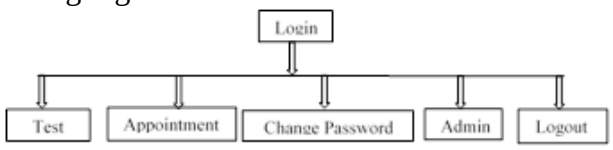


Fig 4: The Login structure

When logged in, the user is allowed access to the following sub-modules: Test, Appointment, and Change Password (see Fig. 4). Figure 5 depicts this process.

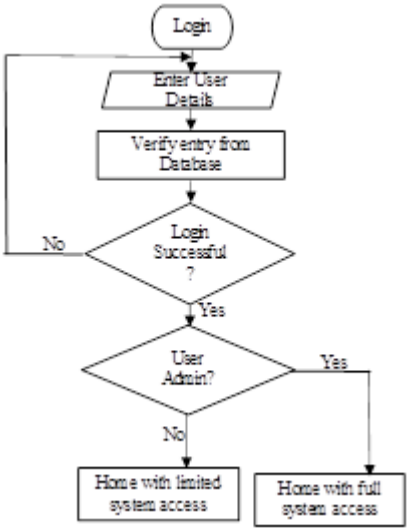


Fig 5: Login module

3.3 ***Test Module:*** The Test module closely follows the algorithm expressed in Fig. 6.

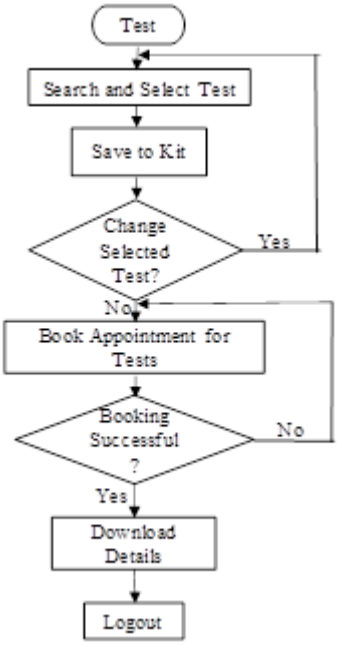


Fig 6: Test module design

The Test module allows logged in User to search and select test such as Full blood count, Liver function tests, Typhoid, Lipid profile, Malaria profile. Selected test is saved to kit.

The user can go back to test page and change selected test or add more tests depending on choice. Each selected test and the cost will be displayed in two text boxes in the appointment page if the User clicks on book appointment.

3.4 ***Appointment:*** The appointment sub-module allows logged in User to book appointment for laboratory tests. The user is required to key in appointment time, date,

referral test, service, doctors and hospital names. On clicking 'book appointment' button, the user is redirected to Appointment details which supports download, save or print (see Fig. 7).

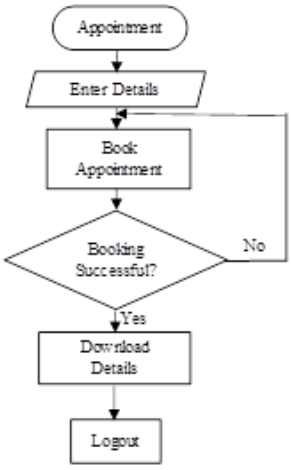


Fig 7: Appointment module of ODLMS

platform that is used in the design of this system is MySQL server. Tables 1 to 4 show the database structure adapted for registered users.**3.5** ***Back-End Designs:*** The database

Table 1: Database structure for user registration

Column Name	Data Type	Allow Nulls
Id	Int	Primary key Unchecked
Name	nvarchar(50)	Unchecked
Age	nvarchar(2)	Unchecked
Address	nvarchar(max)	Unchecked
Contact	nvarchar(11)	Unchecked
SexId	Int	Checked
BloodId	Int	Checked
Genotypeid	Int	Checked
Username	nvarchar(10)	Unchecked
Password	nvarchar(10)	Unchecked

Table 1 shows the database structure for user registration. The *Id* stores unique numbers of every registered user. No two users can have the same Id. It is a primary key in this table and can be referenced in another table (foreign key). *Name* stores registered user's name while *Age* stores registered users age. *Address* stores user's address. *Contact* is used to store user's phone number. *SexId* is used to store user's sex type Id selected by user from a dropdown list. *BloodId* stores user's blood type Id selected by user from a dropdown list. *GenotypeId* is used to store user's genotype type Id selected by user from a dropdown list. *Username* is used to store information that will be used to authenticate user during login while *Password* stores information that will be used to authenticate user during login.

Table 2 shows the database structure for diseases.

Table 2: Database structure for Diseases

Column Name	Data Type	Allow Nulls
Id	Int	Unchecked
Disease	nvarchar(50)	Unchecked
DiseaseExplanation	nvarchar(max)	Unchecked
Drug1	nvarchar(50)	Checked
Drug2	nvarchar(50)	Checked
Drug3	nvarchar(50)	Checked
Drug4	nvarchar(50)	Checked
Drug5	nvarchar(50)	Checked

Disease stores suspected disease name while *DiseaseExplanation* stores a short explanation of the disease name. *Drug1, Drug2, Drug3, Drug4, Drug5* store the prescription of drugs for the suspected disease.

Table 3 shows the database structure for tests. *TestName* stores all the tests in the system while *Price* stores the different prices of the tests.

Table 3: Database structure for Tests

Column Name	Data Type	Allow Nulls
Id	Int	Unchecked
TestName	nvarchar(max)	Unchecked
Price	nvarchar(15)	Unchecked

Table 4 shows the database structure for symptoms. *SymptomName* stores all the symptoms in the system; *Gender* stores the gender of the patient and *AgeGroup* stores the age group of the patient.

Table 4: Database structure for Symptoms

Column Name	Data Type	Allow Nulls
Id	Int	Unchecked
SymptomName	nvarchar(max)	Unchecked
Gender	nvarchar(15)	Unchecked
AgeGroup	nvarchar(15)	Unchecked

4. IMPLEMENTATION AND RESULTS

The middle ware is coded in C# to perform the processes previously discussed in the last section, and process queries and requests related to the database. The graphical user interface (GUI) of the system was implemented using ASP.NET. ASP.NET is a server-side web application framework developed by Microsoft that incorporates HTML, CSS, BOOTSTRAP, JQUERY and JAVASCRIPT. The middleware

is coded in C# to perform the processes previously discussed in the last section and process queries and requests related to the database. The result is a robust, scalable, and fast web development experience with great flexibility and little coding. The Back-End that is the Database was implemented using MySQL server. Its main functionality is storing and retrieving data in a secure manner as requested by applications.

4.1 ***Home Page:*** The home page allows unhindered access to About us, Contact Us, Location, Login, Register and Service pages. A click on the login link, opens the login page. However, if the user has not signed up, he/she is directed to the registration page. When the user registers and successfully logs into the system, then the pages are displayed on the home page (Fig. 8).

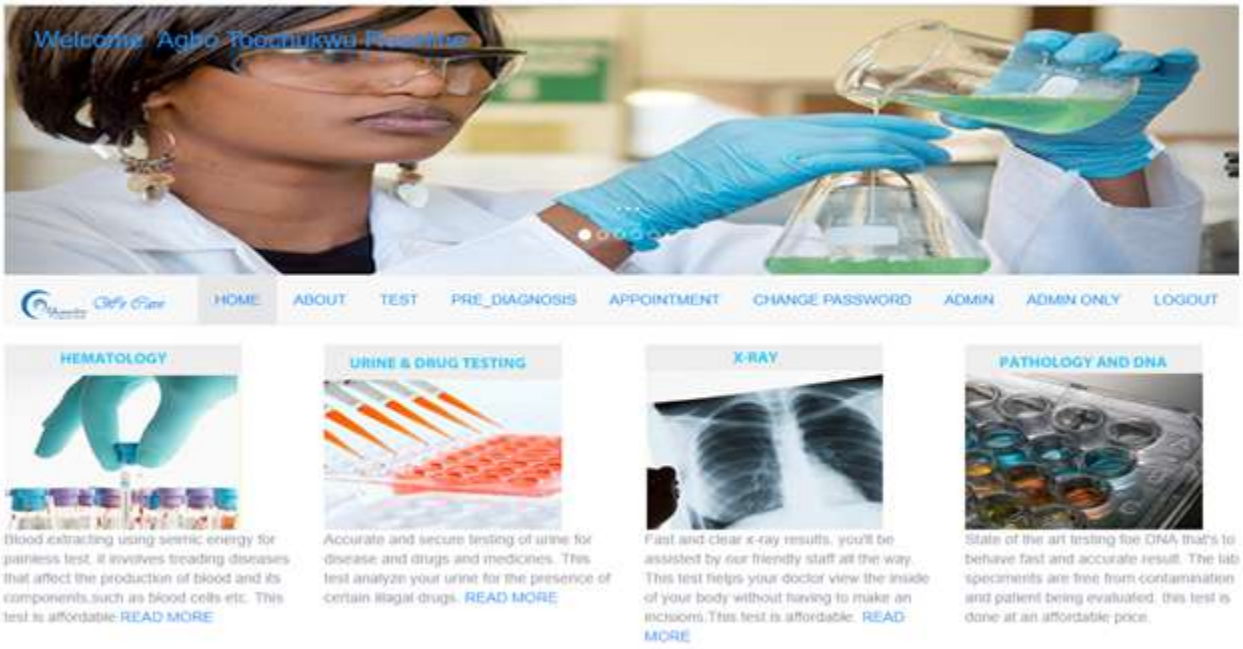
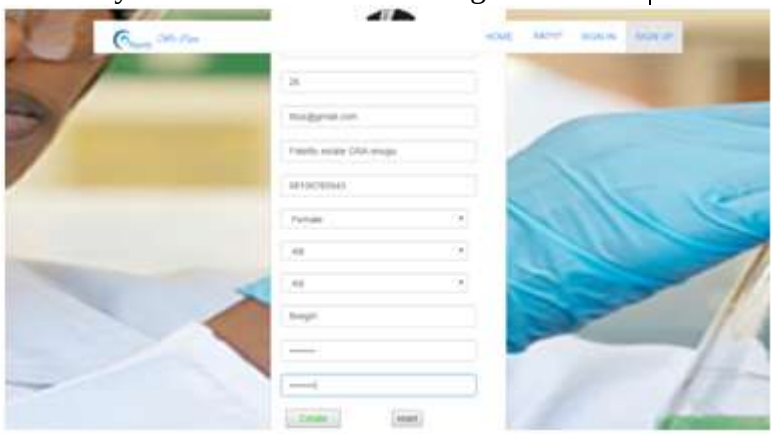


Fig 8: Home page after successful login

4.2 ***Registration Page:*** This module allows new user/patient to key in personal profile details. Fig 9(a) shows the Registration Page. By default, new user/patient is registered as a User. A user can later be converted to an Admin by the Administrator if the registered user is a staff. System validation is used in this module to validate user's credentials. The personal profile data are saved in the database and the profile page that follows allows user to view entered data (Fig. 9(b)



(a)

(b)

Fig 9: (a) Registration page showing user details/information

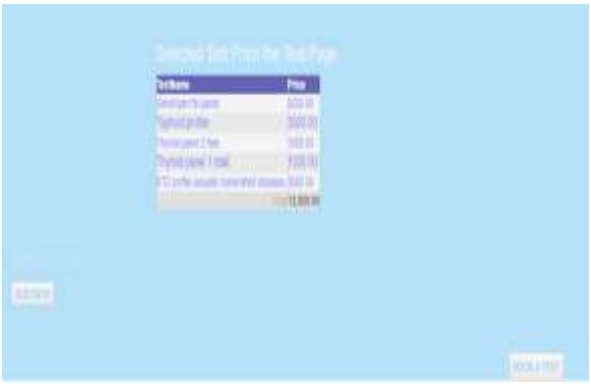
(b) Profile page showing registered users profile

.

4.3 *Login Page:* Clicking on Login causes the system to respond as shown in Fig. 10. This module uses Asp.Net "Form authentication and membership provider module" objects for user authentication and validation. Hence it is not needed to recheck the patient validation from the database every time the patient is redirected to a different page.

Fig 10: Login page

4.4 *Test Page:* The Test page displays several tests with costs (Fig. 11(a)). Logged-in patient can select the tests that they want to go for and click on "add to kit" to save. The system allows changing and editing of selected and calculates total cost of tests as shown in Fig. 11(b). On clicking book test, the system redirects to appointment page where user can book appointment for the selected test.



(a)

Fig 11(a): Test page implementation

(b)

(b): Test selected and total cost

4.5 *Appointment Page:* The GUI for this module is shown as Figs.12(a) and 14(a). It can be accessed from Test page; after booking (Fig. 12(a)), the evidence of booking and the account number where the patient will pay for the test will be displayed for the patient to print, download or save it as shown in Fig. 13(b). It can also be accessed directly from the Home page. The patient can book appointment for consultation (Fig. 14(a)) and download appointment details slip like that shown in Fig. 14(b). There is also a search utility that allows patient to search for test, etc. The system responds with "no such data in the database" if the test is not supported.

Note that the user can opt for the laboratory specimen to be collected at their home or office. Softcopy of the laboratory result is usually sent via SMS and to the client's email address specified here. Fig. 14(b) shows the appointment slip.

(a)

(b)

Fig 12(a): Appointment booking for selected tests

(b): Appointment Details

(a)

(b)

Fig. 13: (a) Appointment booking

(b) Appointment Slip

5. CONCLUSION

The developed system provides effective and reliable processing of most tasks performed in a medical laboratory organization. As a web-based system, it affords users the opportunity to book appointments for laboratory tests and also receive test results from remote locations. The graphic user interface is very friendly. Since the system stores patient/user history, it also serves as very helpful data reservoir for the laboratory management and medical practitioners. Mining this data could provide better diagnosis of diseases and conditions as well as aid in planning treatment. It could also help in evaluating response to treatment and in monitoring the course of diseases after a period of time.

REFERENCES

Al-Khawlani, M. A. A. (2009), *A Web-Based Integrated Health Care Management System* (Master's thesis, The University of Malaya, Kuala Lumpur, Malaysia) Retrieved from http://repository.um.edu.my/394 on 22/06/2017

Brailer, D. J. (2005). National Health Information Technology, US Health and Human Services Department, Washington, USA. Economic perspectives on health information technology. The *Journal of the National Association for Business Economics*, *40*(3), 6.

Cholewka, P. A. (2006). Implementation of a health care information system in Lithuania. *International Journal of Economic Development, 8*(3), 716-747. Retrieved from http://www.ijesar.org. on 20/07/2017.

C.Technologies. (2012). *How can I manage data complexity and improve business agility?* Retrieved from: http://erwin.com/content/products/CA-ERwin-r9-ModelingSolution-Brief-na.pdf.on 20/07/2017

Idowu et al (2006) Information technology infusion model for health sector in a developing country: Nigeria as a case. *Journal of Technology and Health Care, 14*(2), 69-77

Jantz, R. (2001) Knowledge management in academic libraries: Special tools and processes to support information professionals. *Reference Services Review 29*(1), 33-39.

Kopach, R., Delaurentis, P.-C., Lawley, M., Muthuraman, K., Ozsen, L., Rardin, R., Wan, H., Intrevado, P., Qu, X. & Willis, D. (2007) Effects of clinical characteristics on successful open access scheduling. *Health Care Management Science, 10***,** 111-124.

Lim, C. C., Yu, M. H., Jin, Y. J. (2006) Web-based Multimedia GP Medical System. *Research and Practice in Information Technology. Pan-Sydney, Australian Computer Society, 36*, 49 – 52.

Liu, L., & Zhu, D. (2007). *Electronic Medical Records: A Vision for Medical Data and Service Grids.* Proceedings of Fourth IEEE Conference on Service Systems and Service Management (pp 1- 6). Chengdu, China.

Mehdi, S., Jorge, P. & Michel, L. (2004) *Information system architectures: where are we?* Proceedings of the International Conference of Information and Communication Technologies: From Theory to Applications (pp 509 – 510). Damascus, Syria.

Monu, R. (2010) *Design and implementation of a basic laboratory information system for resource-limited settings* (Master's Thesis, Georgia Institute of Technology, Atlanta, Georgia, USA). Retrieved from https://smartech.gatech.edu/bitstream/handle/1853/34792/ on 01/06/2017

Mustafa, Y. (2004) E-Health Centre: a web-based tool to empower patients to become proactive customers. *Health Information and Libraries Journal, 21***,** 129-133.

Porta-sales, J., Codorniu, N., Gómez-batiste, X., Alburquerque, E., Serrano-Bermúdez, G., Sánchez-Posadas, D., Pérez-Martin, X., González-Barboteo, J. & Tuca-Rodríguez, A. (2005) Patient Appointment Process, Symptom Control and Prediction of Follow-up Compliance in a Palliative Care Outpatient Clinic. *Pain and Symptom Management, 30***,** 145-153.

Wilcke, B. (2008). *Finding the knowledge in Information.* Clinical laboratory Science, 21(1), 33-34. Retrieved from http://www.ascls.org/leadership/cls/index.asp.on 01/06/2017