



Design a Framework of a web-based Thalassemia Management System: Akre - Gulan hospital as a case study

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ABSTRACT

Large volumes of data are generated in contemporary medicine. However, there is always a gap between what they gather and what they perceive and interpret. Minimal data sets are created in this manner. The collecting of a significant amount of different data, which makes the conventional paper-based method difficult, is at the heart of the complex continuous care process of thalassemia patients. Adoption of electronic medical records (EMR) system is the best solution in this situation because of the documented benefits in previous studies. Thalassemia is a chronic genetic disorder of the blood and the most common genetic disorder in the world. Technology can enhance the management of thalassemia. The aim of this study is to produce a design and framework of a web-based Thalassemia Management System. This system will perform all operations related to Thalassemia patient starting from registration, to provide patient-related details, such as reports, medical records

history, diagnosis, medicines and support the lifelong healthcare of patients. The technology acted as an appointment reminder, which resulted in fewer appointments being missed. In addition, the system can assist clinicians by proposing appropriate therapy depending on the results of patients' tests. Patients with thalassemia can access their medical records, which makes communication and information available to other doctors and healthcare professionals upon request. The system booked outpatient visits and issued medical appointment reminders. The SUS results confirmed that the rate of overall satisfaction was high nearly 85%, which is above average and good acceptable.

1. Introduction

With the increase of population again in our country, the number of patients with chronic disease is increasing rapidly. Chronic diseases are ailments that endure for a long time and have a long-term impact. People's quality of life may be impacted by their economic and social implications (Reynolds et al., 2018). Chronic diseases are growing more widespread, and they are a top focus for health-care reform. Many persons with chronic diseases don't have a single, dominating ailment; instead, they have multi-morbidity, which is defined as the occurrence of two or more chronic disorders in the same person at the same time (Fernandez-Lazaro et al., 2019).

Thalassemia is abnormal hemoglobin production and is a symptom of hereditary blood diseases. The severity of the symptoms varies depending on the type. Often there is mild to severe anemia (low red blood cells). Tiredness and pale complexion are common symptoms of anemia. Bone issues, an enlarged spleen, yellowish skin, black urine, and sluggish development in youngsters are all possible symptoms (Noori et al., 2019). Thalassemia is a hereditary condition that is passed down from one's parents (Raja et al., 2020). There are two main types, alpha thalassemia, and beta-thalassemia. The severity of alpha and beta-thalassemia depends on how many of the four genes for alpha globin or two genes for beta-globin are missing. Diagnosis is typically by blood tests including a complete blood count, special hemoglobin tests, and genetic tests (Chopra, et al., 2022). Diagnosis may occur before birth through prenatal testing (Amin et al., 2020) (Kosaryan et al., 2019). The main problem for



patients with thalassemia major is severe and progressive anemia that usually begins a few months after birth and may cause the death of the struggling individual (Lal & Bansal, 2020). Most patients are given recurrent blood transfusions since stem cell transplantation is a final therapy that is not viable for all people (Agarwal et al., 2019). The treatment's purpose is to maintain enough hemoglobin levels to maintain life and avoid bone abnormalities, as well as to allow the patient to develop normally (M, 2021). Other treatments include iron-chelating medicines, splenomegaly therapy, treatment of delayed development, and treatment of cardiac and endocrine issues, in addition to blood transfusion (Shah et al., 2019) (Soni, 2020).

The treatment of thalassemia is long and ongoing, and it entails numerous steps, similar to the treatment of other chronic disorders. As a result, having IT tools to support the process, such as an electronic medical record (EMR), may increase the quality of healthcare services. The electronic medical record (EMR) delivers more accurate and timely information about patient treatment. It has also been discovered to increase healthcare service efficiency, particularly in terms of patient data management (Saimanoj et al., 2020). Nevertheless, medical records in the Thalassemia center in Akre Gulan Hospital (TCAGH) despite well-documented deficiencies in terms of accuracy, completeness, availability, and legibility, are still mostly paper-based. Incomplete, illegible, or unavailable. Hospitals have a lot of obligations surrounding patients daily (Abdulrahman, Hawezi, MR, Kareem, & Ahmed, 2022). Following a patient's visit, the doctor will frequently schedule a follow-up consultation to examine the situation further. Text reminders are a low-cost, simple-to-implement, and automated method of increasing medical compliance and appointment attendance (Schwebel & Larimer, 2018).

Patient data may lead to unnecessary or ineffective consultations, diagnostic and screening procedures, and therapies. If discussions must concentrate on recreating clinical data, preventive treatment and patient education may be missed. Using a process called information extraction; technology can help in entering report data into the hospital system. Methods to convert data from unstructured health reports into a uniform format, for example, have been created. Instead of relying on printed reports or repeating tests, healthcare practitioners may now access a patient's medical history utilizing automated data. This study aims to design and implement a

web-based Thalassemia Management System for (TCAGH). This system will perform all operations related to Thalassemia patient registration and provides patient-related details, such as medical history, medicines, appointments, and appointment reminders in real-time (Sharma, Miran, & Ahmed, 2022).

The other sections of this article are organized as follows. Section 2, mentions the related work. Section 3, describes the methodology. Section 4, describes evaluation. Section 5, presents the conclusion.

2. Related Work

It is important to manage the process of the thalassemia section in Gulan hospital of Akre to digitalize the system. Many systems are constructed and designed to manage the thalassemia process in terms of detection based on patient data, classification of the thalassemia, and so on. Manual management is difficult and causes many problems such as delay and accuracy of the process. However, there is a need for a digital system to manage and track the thalassemia process for dealing with the patient when he/she gets the treatment.

(Banjar et al., 2021) Proposed an expert system based on the web that offers patient information such as reports, medical data, diagnoses, medications, and appointments. Based on the findings of patients' testing, the system can aid physicians by proposing suitable therapy. Patients with -thalassemia may use a QR code to view their medical data, which also allows communication and information to be shared with other doctors and healthcare professionals on demand. Physicians can adjust treatment plans and make suitable decisions based on the expert system's recommendations by accessing the website following routine assessments. Physicians can also interact with their patients and create tailored treatment plans to ensure that they receive the best care possible. When compared to a group of medical experts, the web-based expert system has a weakness in identifying proper treatment for various health disorders. Furthermore, rather than presenting conclusions that clinicians must follow, the validation case serves as a preliminary indication of what the program can achieve. The expert system will be developed in the future to cover all probable medical problems of -thalassemia, such as splenomegaly, to provide the entire spectrum of care that these patients demand.



(Muhammad & Garba, 2019) created and constructed a clinical management system to automate Sule Lamido University Clinic's manual system and eliminate the manual technique of record/file keeping. This solution will benefit both practitioners and patients in their computerization efforts. As a result, the system will encourage the delivery of effective, efficient, and high-quality services. The system will make it simple for doctors and patients to access electronic records, reducing the expense, difficulty, and inefficiency of manually interacting with patients' records and increasing the advantages and revenues of clinic services.

(Alfiansyah et al., 2021) created a web-based patient registration information system. The waterfall methodology was chosen as the study method. The waterfall process includes processes such as planning, system design, programming, testing, implementation, and maintenance. The outcomes of their work up to the system design stage are presented in the form of system flow design, database design, and web-based interface design in their article. HTML5, CSS3, JavaScript, and the Bootstrap framework are used to create the user interface. To make building the back-end system easier, this interface design was implemented in the CodeIgniter 4 framework. The user interface is responsive, which means it can be used on a smartphone screen. So, the patients may quickly register, whether on a desktop or their smartphone.

Real-time communication is a new industry standard that extends the online surfing model by giving access to information in areas such as social networking, chat, video conferencing, and television through the internet.

WebRTC is a cutting-edge open standard that enables real time video, audio and data transfer over web browsers. many researcher worked on WebRTC such as (Shin, 2020) created a robot that can control a medical counseling robot from a doctor's office to move to a hospital room where patients are hospitalized and consult a patient in the room. A real-time heart sound transmission system using a remote medical imaging stethoscope is demonstrated. The suggested system is a type of peer-to-peer communication that transmits video, audio, and control signals individually using the webRTC platform, ensuring that no data is lost. It is more successful than traditional approaches for patient security since it consults and sees



doctors in real-time. The device will be able to provide distant medical care in areas where disease transmission is a concern.

(Teo et al., 2021) presented a smart e-health system. It's a cutting-edge Telemedicine technology that allows patients to consult with doctors from the comfort of their own homes. The web part of the system is built with Django-Rest Framework, HTML, CSS, JavaScript, and Bootstrap4. WebRTC and Twillo were all used to test video calling APIs. Patient contact and prescription are the major characteristics of this real-time online doctor. Distance individuals will readily take advantage of the growing popularity of online platforms to avoid wasting time. The doctors are experts in their fields and are highly qualified. The website also includes a blog and a shop where doctors may publish various health issues to raise public awareness and patients can purchase medications.

Appointment cancellations are a typical occurrence in medical offices around the world. Adherence to visits and medicines is critical in the healthcare setting, especially for chronic conditions. Several studies have demonstrated that the use of an automatic short messaging reminder system can be utilized to reduce non-adherence to medical appointments. (Sallow et al., n.d.) proposed a solution to remind the child's parents to schedule the next immunization visit. According to the immunization schedule advised in the Kurdistan area, the proposed system sends a reminder SMS and an email message to the child's parents. The suggested system aims to improve newborn primary immunization completion by providing automatic vaccine updates, free reminders, and the ability to manage vaccines for numerous babies from a health-care clinical facility.

(Anthony et al., 2019) evaluated the effectiveness of a text-based reminder system with conventional care in boosting clinic and social work appointment attendance at a Ryan White-funded clinic housed in an academic institution. The convenience sample approach was used in their study, which looked at two time periods: six months before text message initiation and six months after text message initiation. After a 6-month post-intervention period, they discovered a statistically significant drop in no-show rates (individuals failing to keep booked appointments) of 24.8 percent against 17.7 percent, P-value. 05. They were able to drastically reduce no-

show rates in a largely youthful, low-income, and uninsured population by using an affordable internet text message system.

(Boone et al., 2022) demonstrated a text message appointment reminder tool for chronic disease patients in Chile, which was implemented at primary care clinics. They discovered that the program did not affect the frequency of visits by chronic patients who were eligible for reminders, but that visits from other patients who were not eligible for reminders increased by 5.0 percent in the first year and 7.4 percent in the second. Clinics with a higher number of chronic patients and a younger patient group benefited the most from the program. Due to timely cancellations and rescheduling, scheduling systems with automatic appointment reminders were effective in enhancing clinics' ability to care for more patients.

3. Methodology

The TCAGH has been chosen for this research. A questionnaire and interview were completed with the doctor, employee, and staff nurses. The interview focused on a few key questions about their daily routine at the center, as well as an issue or difficulty they are having, and their solution to the problem. The department's perspective and acceptability of deploying the web-based management system were also evaluated. The thalassemia center is responsible for thalassemia patient management, and it still uses a paper-based medical record system. System overview, system architecture and case diagram, Database diagram, and system requirement are all explored in this research.

3.1. System structure

The system is a web-based electronic medical record that healthcare professionals, such as doctors, nurses, and system administrators, can utilize. Patients' clinical and non-clinical information, laboratory and radiological tests, prescription information, transfusion information, and appointment scheduling are all recorded and stored in the system. The system will send patients reminders for their appointments by using Twilio which is a communication API as shown in Fig.1, also the patient will be able to communicate with a doctor via video by using Web-RTC protocol.



Figure (1) text SMS reminder

3.2. Architecture and Case diagram of the system

The overall structure of this thalassemia website management system is illustrated in Fig.2 and Fig.3. The website and database are two components of the system. In order to effectively aid the patient management process, the suggested system should be accessible from any internet-connected client workstation. The system may be accessed using any Internet-enabled device, such as a computer, tablet, or smartphone.

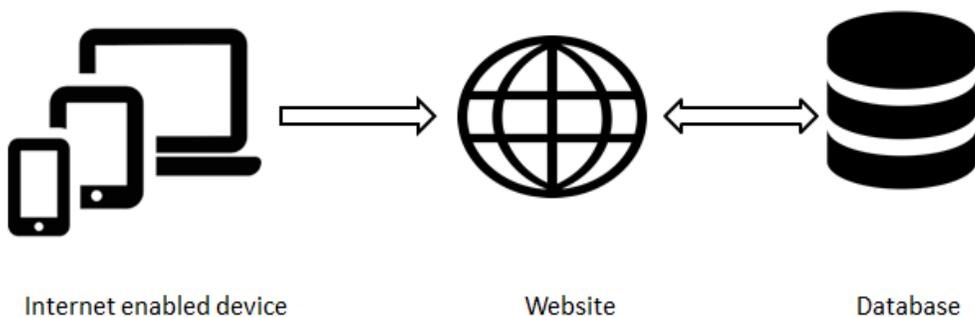


Figure (2) System architecture

The predictability functionality of the system is defined using a case diagram. It describes how users and the system interact with one another. The doctor, nurse, administrator, and patient are the four users in the case diagram of the system shown

in Fig.2. This platform uses a login system, which means that before using the system, the user must have a username and password, which is critical for system authentication and security.

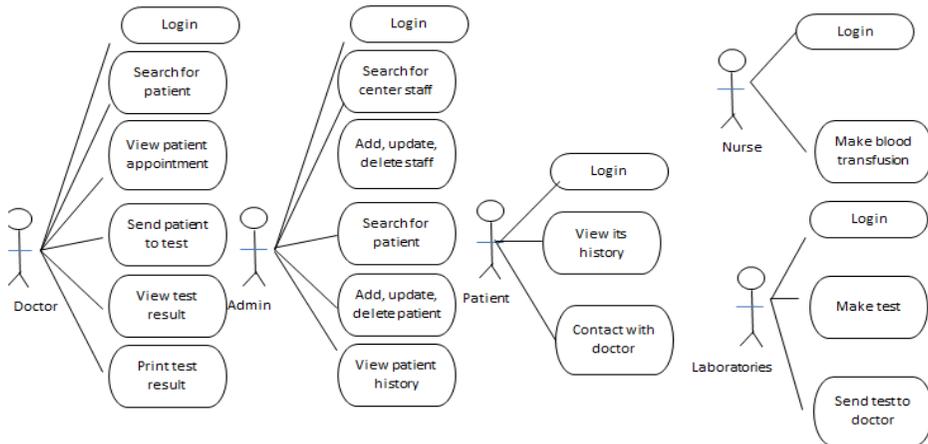


Figure (3) User case diagram

Table (1): System Users and their Roles

User	Role
Admin	Search for staff
	Update staff
	Delete staff
	Add new staff
	Search for patient
	Update patient
	Delete patient
	Add new patient
Doctor	Search for patient
	View patient appointment
	View patient history
	Send patient to tests
	View patient test result
	Export patient test as excel, copy patient test, print patient test
Nurse	Make patient appointment
	Make blood transfusion process for patient

Laboratories	Make test for patient and send test result to doctor
Patients	View its history
	Print, export and copy its information and tests
	Contact with doctor

3.3. Database Diagram

A database is required for every interactive website. Database design is the most crucial component of development. Only relevant data and essential information are stored in a properly built database. As a consequence, due to the table's arrangement, the data is in a uniform format. The database diagram for the system is shown in Fig.4. The diagram depicts the database's structure as well as the relationships between tables. Staff and patient tables have one to many relationships with other tables via IDs.

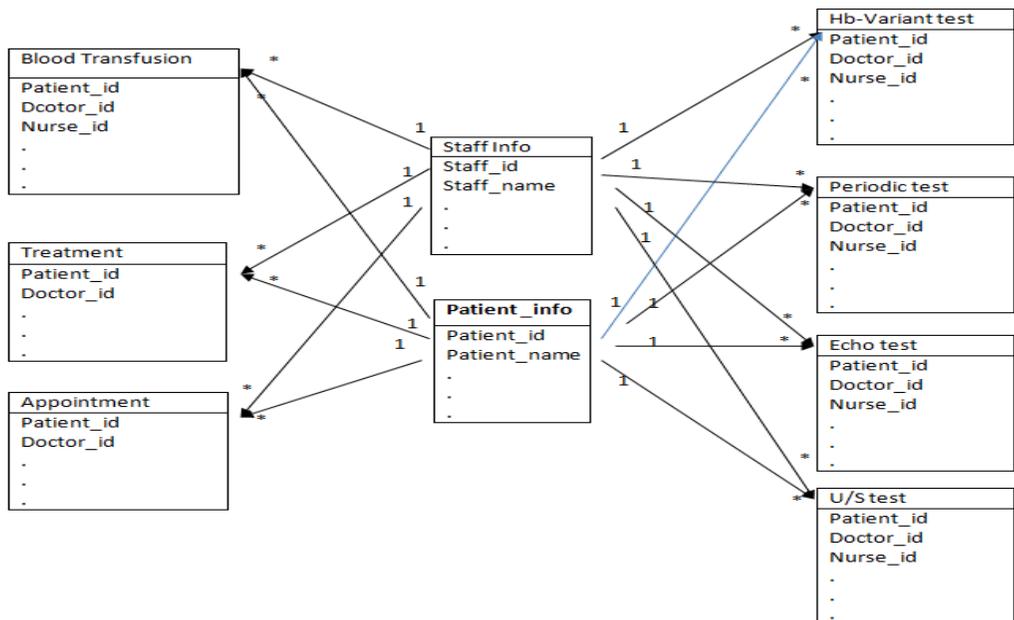


Figure (4) Database Diagram

3.4. System Requirement

Except for a special program called "web server," which is responsible for communication with the browser, practically all of the work of web applications takes place on the server. A relational database server keeps track of whatever data is needed. PHP is a simple language that may be used to manage requests between a web server and a database server. All the used tools should be supported by OS; that means the Web server, programming languages and Database server must be familiar with the selected OS. MySQL is an excellent database management system implementation tool. PHP XAMPP Local Server is the technology utilized in the proposed system to connect the database to the front-end interface. To implement the suggested system, two separate types of computers (hardware and software) are required; the server-side computer must be more powerful than the client-side computer (due to the rule of networking and data communication). Table 2 describes all software and applications used for designing a proposed system.

Table (2): Software and Application used for proposed system

Software Requirement	
Development server: XAMPP	
X	X-OS
A	Apache
M	MySQL
P	PHP
P	Perl
Backend: (database) MySQL	
Frontend: HTML, CSS, JavaScript, JQuery, Ajax	
Serve Side Scripting Language: PHP	
Application: Text-Editor Sublime, Almost any web browser	

3.5 System Implementation

The proposed system includes five users admin, doctor, nurse, laboratory, and patient as mentioned in the above section. The system starts with an index Fig.5 shows the index page in which each user has its unique username and password.

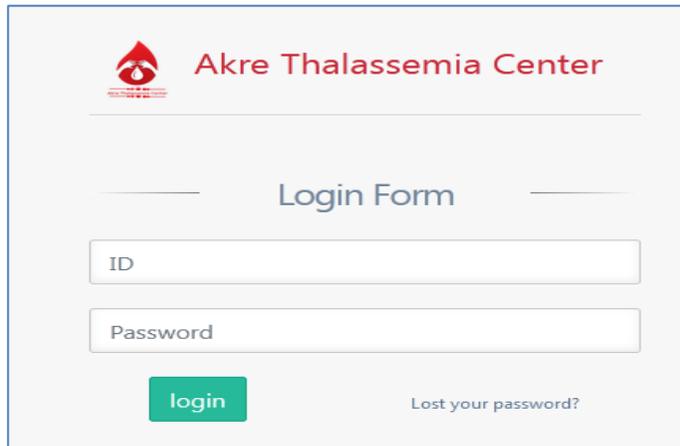
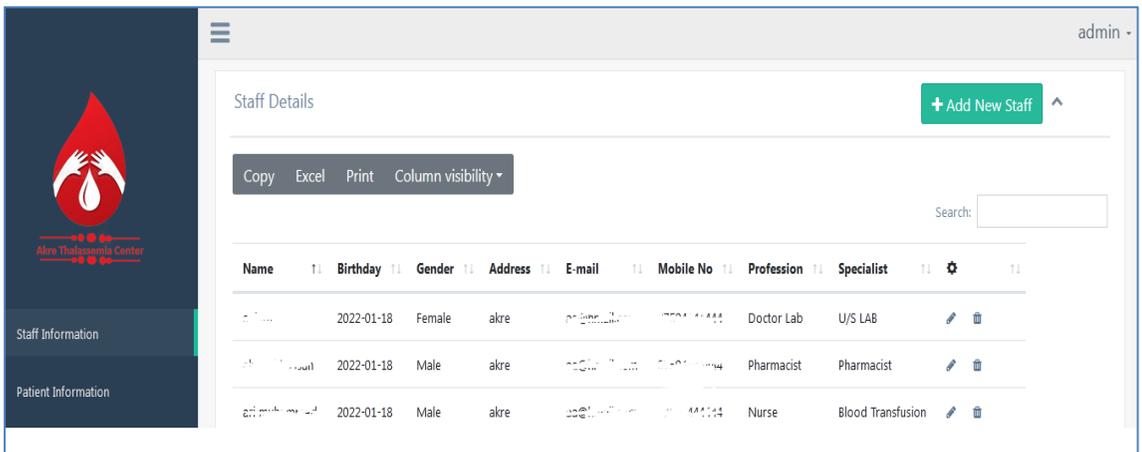


Figure (5) Log in Form

After the user enters the correct username and password it will enter its web page the web page for each user is different from each others the admin can search for patient/staff, add new patient/staff, update and delete patient/staff info, or register new patient/staff. Fig.6 shows the admin web page.



Name	Birthday	Gender	Address	E-mail	Mobile No	Profession	Specialist	
...	2022-01-18	Female	akre	...	...	Doctor Lab	U/S LAB	
...	2022-01-18	Male	akre	...	...	Pharmacist	Pharmacist	
...	2022-01-18	Male	akre	...	...	Nurse	Blood Transfusion	

Figure 6 Admin Web page

On a doctor web page, the doctor can view patient info, send the patient to a test, and after the test is finished in the lab the test result will be resent from the

laboratories web page to the doctor's web page, also the doctor can decide the treatment and next appointment to patient. Fig.7 shows the doctor web page.

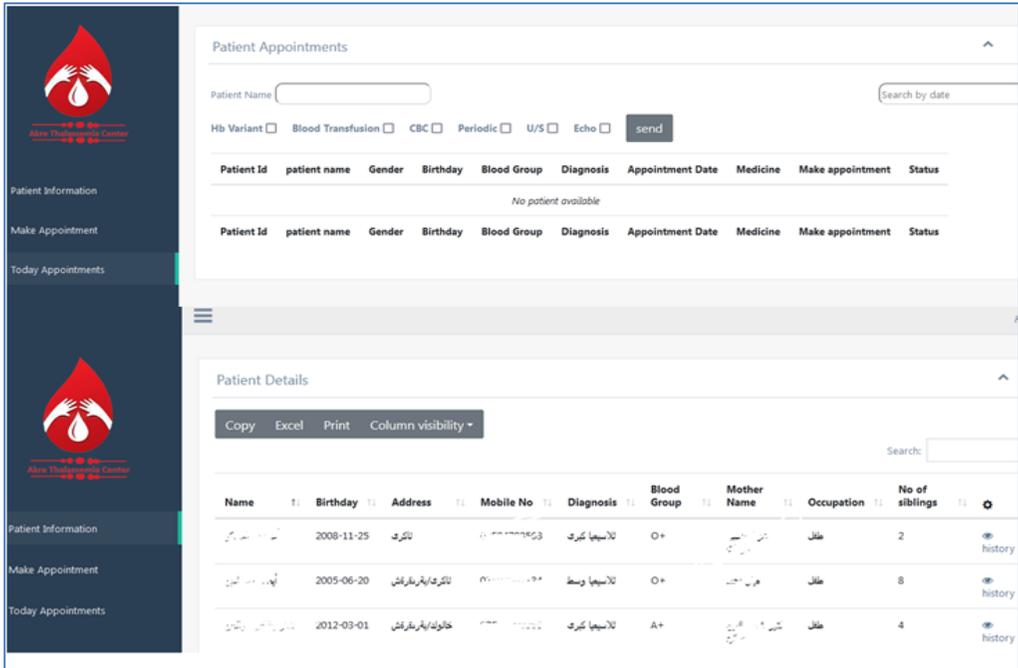


Figure (7) Doctor Web page

On the nurse and Laboratories web page, the user can make a test and blood transfusion to the patient and then sent the patient result to the doctor page. Fig.8 shows nurse and laboratories web pages

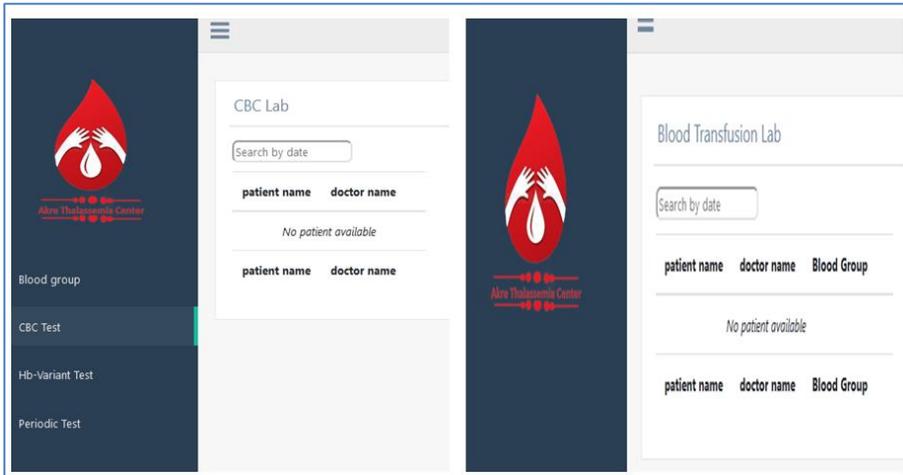


Figure (8) Nurse and Laboratories web pages

4. Evaluation

System Usability Scale (JORDAN, 1996) questionnaire is considered one of the most reliable validation measures to calculate users' perceived usability. The questionnaire contains only ten questions or statements, which respondents assess on a 5-point scale ranging from "strongly disagree" to "strongly agree." A final score is a number between 0 and 100. The usability of the suggested system was examined in this article using the System Usability Scale (SUS) with the help of (20) participants and the findings were analyzed as shown in table (3).

Table (3): SUS Scores by the Participants (#P=20)

Particip ant	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q1 10	SUS Score
P1	4	1	4	2	5	1	3	1	5	1	87.5
P2	4	2	4	1	5	2	4	1	5	2	85
P3	4	1	5	2	4	2	5	1	4	2	85
P4	5	2	4	1	5	2	5	2	4	2	85
P5	4	1	4	2	5	1	4	1	5	1	90
P6	4	1	3	1	5	1	3	1	5	1	87.5
P7	4	1	4	1	4	1	4	1	4	1	87.5
P8	3	2	5	1	4	2	5	2	5	2	82.5
P9	4	1	5	2	4	1	4	3	4	2	80
P10	4	1	5	2	4	1	5	2	4	1	87.5
P11	5	2	4	1	4	1	5	1	4	2	87.5

P12	5	2	4	1	4	1	5	1	4	2	87.5
P13	5	1	4	3	4	1	4	2	5	2	82.5
P14	4	3	5	2	4	1	5	2	4	1	82.5
P15	4	1	5	2	3	1	5	2	4	1	85
P16	4	2	5	1	4	2	4	2	5	1	85
P17	5	2	4	1	3	1	4	2	4	2	80
P18	4	1	5	2	3	2	4	2	5	1	82.5
P19	4	1	5	2	4	2	3	1	4	1	82.5
P20	5	1	4	1	4	2	4	2	5	1	87.5
Average Score											85

(Bangor et al., 2008) produced a scale for an acceptable SUS score. A SUS score of 85 to 100 implies that the system is highly usable. The usability of the system is good when the SUS score is between 70 to about 85. Acceptability is good, with a SUS score from 50 to 70, although the system users experience usability issues. Finally, the usability of the system is not acceptable when the SUS score is below 50.

Results in Table (3) show that the total score of SUS is 85% indicating that The proposed system is generally acceptable under the rules of the SUS tool as a 70%-85% good acceptable ratio.

5. Conclusion

This article presents a framework to design and implement a Thalassemia web-based system for Gulan hospital – Akre to manage patients with Thalassemia, where the current system is traditional. Design a web-based system to decrease the time of the treatment during the transfusion of the blood and the procedure in general. In addition to the accuracy and the implementation of the system, this system will perform all operations related to Thalassemia patients starting from registration, to provide patient-related details, such as reports, medical records history, diagnosis, medicines, and support for the lifelong healthcare of patients. The system should be implemented and adopted in reality. All the documents of the Thalassemia center are digitalized. By using the SUS tool, the conducted users showed that the overall satisfaction score of the proposed system was good, (85%).

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دیزاینی چوارچیوهیه کی سیستمی بهرپوه بردنی تالاسیما له سهه ر ویب:

نه خوشخانهی ئاکری - گولان: دیراسهی حالهت

پوخته:

له بواری پزیشکی هاوجه رخ دا ژمارهیه کی زور له داتا دروست ده کرین، به لام سهه رهای کۆکردنه وهی ئەم داتایانه کهم و کۆرتی له نیوان کۆکردنه وه و بینین و رونکردنه وه بیان هه به. کۆکردنه وهی داتاگان له سهه ر شیوازی کۆن و که رهسته ی کۆن و ژماره ی زور کاریکی قورسه به تایبه تی له بواری نه خوشی ته لاسیما دا، بویه تۆمارکردنی داتاگان به شیوازی ئەلیکترونی باشترین ریگایه. نه خوشی ته لاسیما نه خوشیه کی بۆماوه یی و درێخایه نه، که تۆشی خوینی مرۆف ده بیئت و یه کیکه له به ربلاوترین نه خوشیه کانی جیهان، بویه ته کنولوجیای نوێ ده توانیئت کونترۆلی لایه نی کارگیری ئەم نه خوشیه بکات. ئامانج له م لیکۆلینه وه یه دروستکردنی سیستمیکی ئەلیکترۆنیه بۆ بهرپوه بردنی نه خوشی ته لاسیما. ئەم سیستمه مه هه لده ستیئت به بهرپوه بردنی ریگاکانی په یوه سهت به م نه خوشیه وه هه ره له سهه رته ی تۆمارکردن و کۆکردنه وهی زانیاریه کانی وه کو راپۆرت و میژووی تۆمارکردن و جۆری ده رمان و شیوازی هاوکاریکردنی نه خوش بۆ هه تا هه تایه. بۆ نموونه: به بیره یئانه وهی پزیشک بۆ هه لبژاردنی ده رمانی راست و دروست ئەمه ش له ریگای ئەم سیستمه مه وه ده بیئت. نه خوشیه کانی ته لاسیما له ریگای ئەم سیستمه مه وه ده توانن بگه ن به تۆماره کانی نوژدارییان و هه روه ها زانیاری ئەم سیستمه مه ئاسانکاریه که بۆ پزیشکه کان و کهسانی تایبه ته مند له م بواره دا، هه روه ها له ریگه ی ئەم سیستمه مه وه نه خوش ناگادار ده کرێته وه له ژوانی نه خوشیه که ی.

تصميم إطار عمل لادارة نظام التالاسيميا على شبكة الإنترنت: مستشفى كولان- عقرة

المخلص:

في الطب المعاصر تسجل أعداد كثيرة من البيانات ، لكن بالرغم من تسجيل الكم الهائل من البيانات دائما هناك فجوة كبيرة. جمع البيانات على الطريقة التقليدية القديمة عملية صعبة بالأخص لمرضى التالاسيميا ، لهذا السبب جمع المعلومات و إدخال البيانات بالطريقة الألكترونية من أحسن الحلول. مرض التالاسيميا مرض مزمن و طويل الأمد الذي يصيب الانسان و تعتبر من أكثر الأمراض المنتشرة، لهذا السبب التكنولوجيا الحديثة يسيطر على النواحي الادارية بشكل جيد. الهدف من هذه الدراسة عمل نظام ألكتروني لادارة هذا المرض. هذا النظام سيكون بإدارة الطرق من بداية التسجيل و جمع المعلومات مثل التقارير و تأريخ التسجيل و نوعية الأدوية و كيفية مساعدة المريض الى الأبد. مرضى هذا المرض بإمكانهم الوصول الى تسجيلات أطبائهم و أيضا معلومات هذا النظام، كما وان هذا النظام يسهل الأطباء وذوى الاختصاص ، هذا بالاضافة انه سينبه المريض لمواعيد الزيارة.