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ORIGINAL STUDY

Integrative Software Design for Hospital Information Systems

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Abstract

The Hospital Information System is a huge, integrated system that meets these needs. The primary objective of any hospital information system is to produce high-quality and timely reporting for evidence-based decisions and interventions. The electronic health record is essential in creating uniform data formats and terminology for both corporate and public sector reporting needs.

In this study, we design a hospital information system that focuses on the tools, and techniques necessary to improve the gathering, archiving, retrieval, and application of information in biomedicine and the healthcare industry. With the intention of bringing about progress, the idea of a paperless hospital is presented as the embodiment of future health information systems. The outcomes of this study succeeded in proposing an integrative system for hospital information, that has the ability to enhance the capability of medical professionals to coordinate patient care.

Keywords: Electronic health record, Health informatics, Hospital information systems, Integrative system

1. Introduction

Hundreds of patients visit healthcare institutions every day, making it challenging for the administration to keep things running properly. The staff members are responsible for managing and integrating clinical, financial, and operational information as the practice evolves (Aghajani, 2002). A health information system (HIS) or hospital information system of a country is a comprehensive software and database for the integration of service records, statistical data, personal records, facility surveys, population surveys, and official records for the effective management of healthcare services (Nengomasha. et al., 2018). This patient information integration program intends to share thorough patient data between wards and other medical facilities in order to expedite the care and treatment process, raise patient satisfaction, and reduce costs (Hoxha et al., 2020). The necessity of correcting the shortcomings in present health information system practices has been highlighted by the accelerated development of information technology in healthcare settings.

In hospitals and other types of healthcare organizations, HIS is seen as a significant aspect of the healthcare system. In general, we can define HIS as comprehensive patient information integration software for sending and sharing detailed patient data between wards and other medical facilities to expedite the delivery of care, raise patient satisfaction, boost quality, and lower costs (Aghajani, 2002). The expanding complexity of health management procedures, the growing need for HIS, and the supply system's outstanding diversity and innovation are all factors that raise concerns in the health industry.

Health organizations now more than ever understand the value of making investments in

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information technologies to raise the quality of healthcare services and lower their costs. It is evident that the health sector needs to adopt a reliable and high-quality information system in order to increase productivity, efficiency, and patient satisfaction (Abbas et al., 2020). The benefit of HIS is that it raises the standard of patient care, promotes education, makes data available, protects and quickly recovers patient experience, integrates the system of covering centers, and accelerates hospital-related issues (Khalifa, 2014).

The ineffectiveness of manual processes, the expansion of clinical research in the id, the development of the insurance industry, the evolution of payment methods to centers of contracts, new approaches to medical education, the great achievements of medical facilities, the rise of professionalism among employees, the development of hospital catering and management, rising health costs, rising patient expectations, the association for HIS, etc (Qazisaeed et al., 2006).

Today, many professional hospitals and clinics rely on HIS, which can manage all the information and help healthcare professionals accomplish their tasks efficiently. Canada, Singapore, and Australia are a few examples of nations that have implemented HIS. In March 2009 (Nabil and Anshari, 2011). In order to improve waiting times, medication management, and diabetes management, Canada developed e-health Ontario. The healthcare sector is diverse in that it collects a lot of information and data from various sources, including patients, hospitals, pharmacies, labs, ambulances, trauma centers, doctors, patients' families, insurance providers, etc (Gürsel et al., 2014). Putting everything on an automated platform and online is a very large and complex domain. As a result, this industry requires a comprehensive software framework that accounts for all processes (Gürsel et al., 2014).

The Health Information Technology Affairs (Khalifa and Alswailem, 2015) developed and approved a questionnaire at Research Center in Saudi Arabia and King Faisal Specialist Hospital to collect objective, numerical data from various categories of HIS users. Many users expressed great enthusiasm for this study's and survey's performance, and they all suggested that it be repeated frequently to track and raise users' acceptance and contentment of HIS while concentrating on pressing problems and high-priority concerns. In hospitals, over the years, a variety of models and schemes for hospital interventions and development have been deployed.

In the work that is being presented, we design HIS that can quickly and accurately access information about patients, pharmacies, laboratories, and blood banks by displaying data where it is needed and obtaining data when it is produced using secure networked electronic data processing. There won't be any delays in the system's communication because the start and end times of every action will be noted and followed in the system.

2. Materials and methods

One of the critical parts of HIS is an electronic health record (EHR) (Fisher, 1999). Past medical history diagnoses vital signs, prescriptions, progress notes, dates of immunizations, allergies, lab results, and imaging reports could all be included (Shortliffe and Cimino, 2014). EHR is described as "a repository of patient data in digital form, maintained and exchanged securely, and accessible by multiple authorized users," by the International Organization for Standardization (ISO). Its main objective is to supply ongoing, effective, and high-quality integrated health. It contains concurrent, retrospective, and prospective information (Health Informatic-Electronic Health Record, 2005).

A restrictive rule called the Health Insurance Portability and Accountability Act (HIPAA) mandates that healthcare providers keep patient information private and secure or face severe federal fines. To prevent unauthorized to a patient's medical record, EHRs must be equipped with comprehensive security features (Seymour et al., 2012). The primary "modules" or "components" of the suggested system are shown in Fig. 1.

2.1. Registration

At the point of care, the system records patient demographics and visits using an EHR. On screens in the clinical system, registration data will be automatically and consistently displayed. The patient is given a special patient ID number by the registration system, which is exclusively utilized by that specific healthcare provider. We created the system such that only doctors and receptionists could access it in order to protect the confidentiality of the data.

2.2. Order entry and results

Reporting there will be a list of all clinical orders with notes on what has been finished and what is still waiting. Enabling doctors to place test orders electronically rather than needing to do it on paper forms. When there are duplicate or incorrect orders, electronic notifications will display and provide

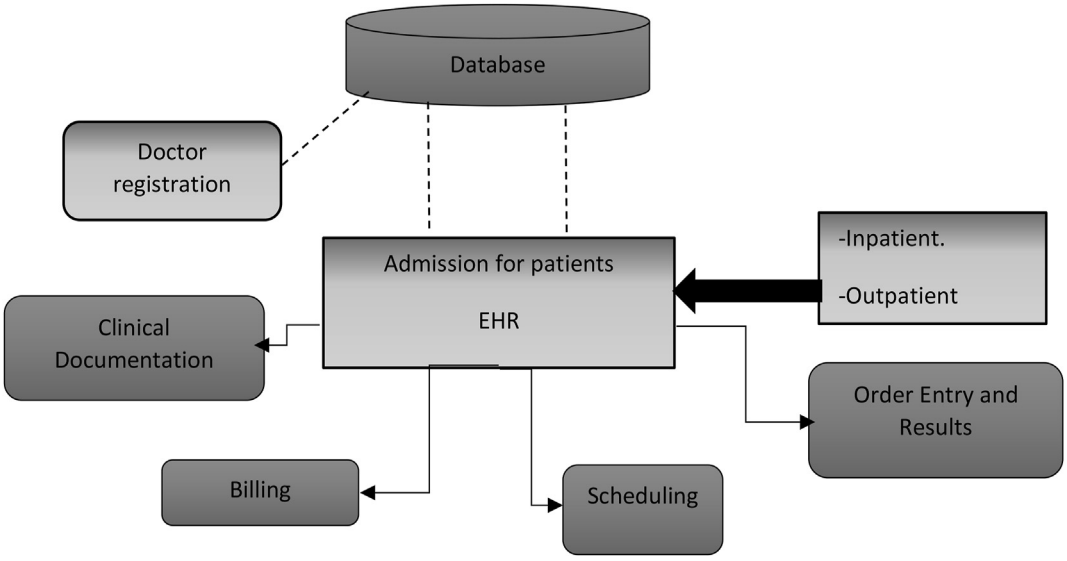

Fig. 1. The main component of suggested system.

information to aid clinical decision-making. All test results will be filed with notifications for abnormal outcomes in the patient's electronic chart. It also informs medical practitioners of the tests that must be run.

2.3. Clinical documentation

This module provides online flowcharts and structured notes for recording therapeutic experiences. This data will eventually be shared throughout Manitoban healthcare facilities.

2.4. Patient billing

This system will handle and provide access to all billable health services. Examples include private rooms and international coverage.

2.5. Framework of the proposed HIS modules

Once the doctor's or receptionist's identity has been confirmed, they will log in to the EHR page and have the option to enter the patient's diagnosis or the doctor's or patient's profile as shown in Figs. 2 and 3.

3. The proposed modules of HIS

A sophisticated, integrated computer system is the HIS. There are numerous subsystems in medical disciplines that fall under this umbrella structure, like.

3.1. Doctor's module form

The doctor's form is where the doctor's ID, name, password, specialty, years of experience, and contact information is being filled in. If there are any empty fields a "No empty fill accepted" message will be shown that refuses to complete the process. In case there is a duplication of information between two different ID's the data will be accepted as the ID is the only primary key that cannot be duplicated. Duplication sets hospitals and health information technologies in threat and costs money. The form also contains a grid view that shows the data from the database to ease the addition and deletion of data. As an example, see Fig. 4.

4. Patient module form

When a patient visits the hospital for the first time, the receptionist adds the patient's information to the system database, such as ID, name, gender, age, blood type, disease, and contact info. If there are any empty fields a "No empty fill accepted" message will be shown that refuses to complete the process. In case there is identical information of two different ID's the data will be accepted as the ID is the only primary key that cannot be duplicated.

4.1. Pharmacy module

Large hospitals have highly automated pharmacies that use med carts with computerized integration and robots to write prescriptions. Since drug interactions and drug allergies are monitored within

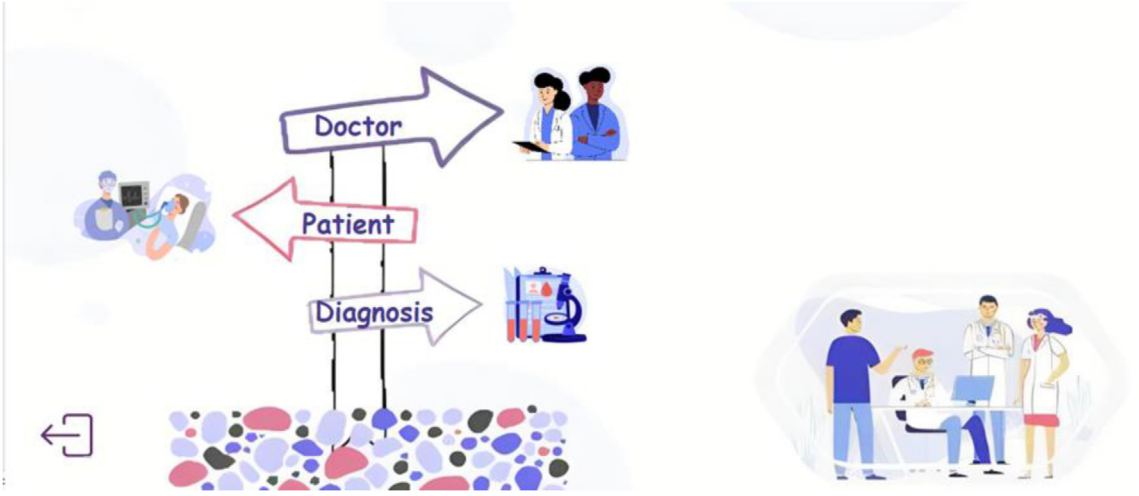

Fig. 2. The home page of HIS proposed system.

an EHR, it is essential that pharmacy systems connect with EHRs (Helton et al., 2012). Shown in Fig. 5 is the home page of the pharmacy.

4.1.1. Medicine stock form

Medicine stock is where medicine name, quantity, expiry date, and buying and selling prices are added to the database in order to store and a "data successfully added" is shown, the grid view is to show the data from the database. In case any field is missing, a "no empty fill accepted" message is shown. Fig. 6.

4.2. Medicine order form

To make a medicine order, you need to search the patient ID from the combo box, select the desired medicine name from the combo box and insert the quantity needed. The grand total of the purchase will be shown in the box and remove medicine or add more medicines before printing the receipt. Once the purchase is done, you can print the receipt.

4.3. Blood bank module

After logging in, the doctor had to choose whether the patient came as a donor or wanted a transfer or check the donation stock. The home button is used to return to the main hospital system page. Fig. 7.

4.3.1. Donor form

The donor form is where the donor information is recorded, such as ID, first and last names, age,

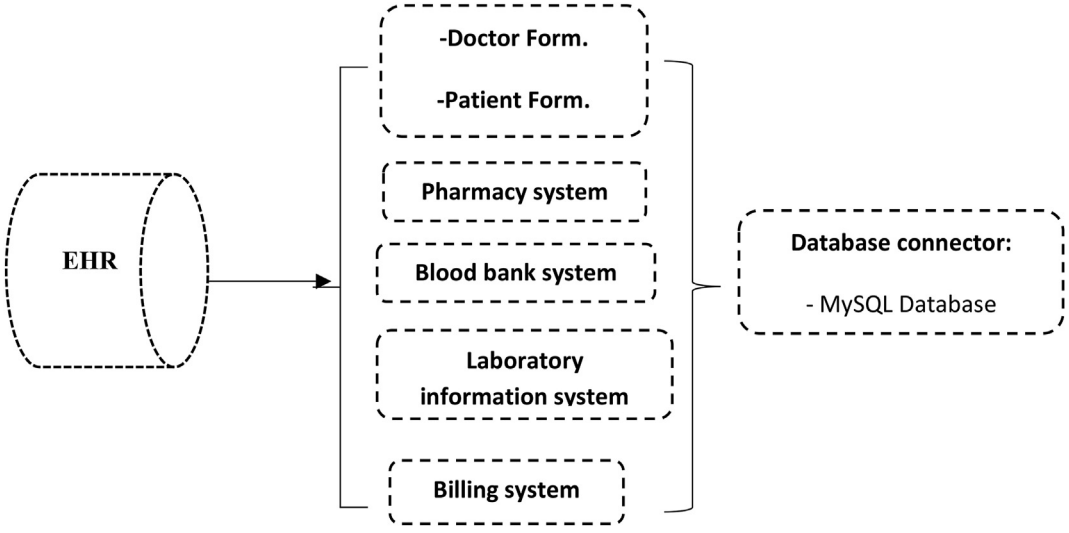

Fig. 3. Proposed subsystems for HIS.

Fig. 4. Doctor form home page.

gender, phone number, and blood type to be donated. In order to update/delete a profile all you need is to click on the donor from the grid data view and press the button to process and a "data successfully updated" or "data successfully deleted" will be shown.

4.3.2. Donation form

The donation form is to check the blood availability in stock for blood transfer. Then write the name of the blood donor, and the blood type to be donated.

4.3.3. Transfer form

The transfer form is to write the information of the patient to be donated. First, the transfer ID which is a primary key to the form. Choose the patient ID from the combo box and the patient's name and blood type will be automatically filled in from the database. The grid shows the stock availability of blood bags.

4.4. Laboratory information system (LIS) module

The majority of laboratories already use lab information systems (LIS) in healthcare settings,

Fig. 5. Pharmacy home page.

Fig. 6. The medicines stock page.

which are typically interfaced with the EHR for the interchange of patient data and test results (Electronic Health Records Overview National, 2006). Fig. 8 shows the home page of LIS.

4.4.1. Lab doctor

Lab doctor form is where the doctor's information is recorded, such as ID, name, age, gender, phone number, and specialization.

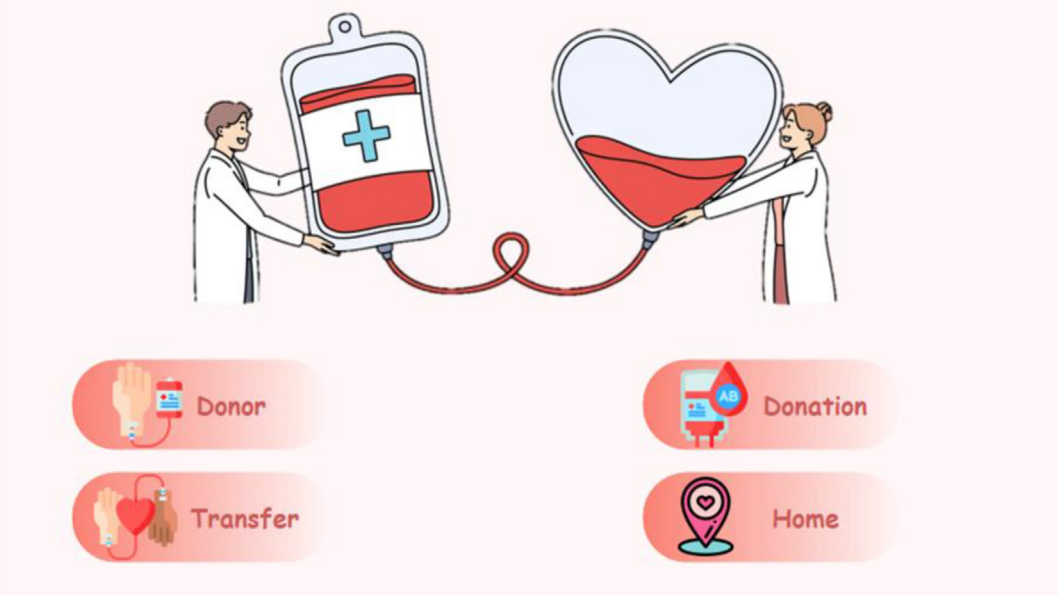

Fig. 7. The home page of the blood bank system.

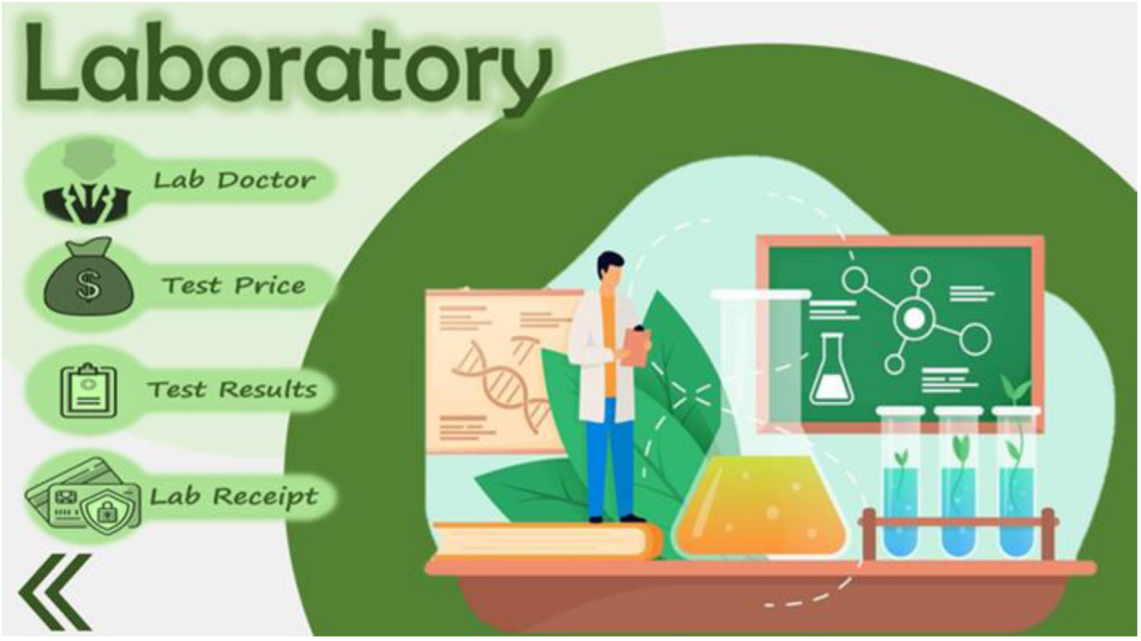

Fig. 8. The home page of LIS.

4.4.2. Tests cost

In this form, we add the prices of the available tests to know the cost of each test.

4.4.3. Test results

The test results form gives us the complete patient information, the name, and specialization of the doctor who ordered the test, the name of the test, the name of the lab where the test was performed, and the final test results.

4.4.4. Lap receipt

Lab receipt helps us to get the total amount of tests.

4.5. Billing module

A billing form is a checkout form that contains the patient id, name, phone number, and checkout date. By using patient ID, we can retrieve all the patient's payments from the time he entered the hospital until he left and the most prominent services, the patient consumed (Shortliffe and Cimino, 2014). Fig. 9, show the home page of billing system.

4.6. Implementation

This work is implemented by C#, it is a software program that may be employed to carry out a variety of tasks and goals across a number of professions. While C# is remarkably versatile. C# is commonly applied in the design of desktop and web apps. It is one of the widely used languages that is used in professional desktop applications (Shortliffe and Cimino, 2014).

For databases, we use SQL Server Management Studio (SSMS). It is allowed to communicate with the underlying MySQL Database. Oracle Corporation produces, distributes, and supports MySQL. MySQL is a database system used on the web it runs on a server. MySQL is ideal for both small and large applications. It is exceptionally efficient, dependable, and simple to use. It supports standard SQL. A variety of platforms can be used to compile MySQL (https://www.mysql.com/.).

5. Results and discussions

Finding standard software engineering solutions for medical care challenges is difficult because they are highly complex. It is crucial to acquire relevant data from reliable sources in a proactive manner, without having to expend effort and time searching for, analyzing, evaluating, and filtering it. The existence of a duplicate record can lead to unnecessary repetition of lab orders and tests without a need for them, raising the expense of a patient's care. Importance Duplicated text is a well-known risk factor for medical errors, lost clinician time, and exhaustion.

HISs are necessary for providing high-quality medical care. Additionally, telecommunication between a satellite clinic and a central hospital has grown more and more important, particularly when

Fig. 9. The home page of the billing system.

a doctor consults with other hospitals concerning his/her patients' care. One of the most engaging parts of HIS is how to manage the relationship between patients and healthcare providers. Additionally, a positive relationship will encourage the patient's participation in decision-making.

Phase two of the proposed work is to apply the proposed system to hospital and implement a survey: for patient, doctor, and employee. To evaluate the proposed HIS acceptance and satisfaction. The questionnaire had different parts; a demographic information section about the users, the accessibility of EHR and a general HIS assessment section, a section about availability of systems, a section about HIS and patient care and a section about satisfaction with HIS. By implementing a comparative study with other systems (Nabil and Anshari, 2011; Gürsel et al., 2014; Khalifa and Alswailem, 2015; Mohammadpour et al., 2021; Ummers et al., 2021), Because patients play a significant role in Clinical Quality Assurance (CQA) programs, it is crucial to investigate the relationship between patient satisfaction and the caliber of medical services (Mabrouk et al., 2019).

6. Conclusions

Public healthcare information systems were created because of the incorporation of contemporary information technologies into healthcare with the intention of assisting the medical profession by enabling less error-prone illness diagnosis and treatment. Every medical staff member in a hospital now works practically every day at a computer terminal, which has become increasingly necessary.

HIS's objective is to support hospital activities on the levels of strategic, tactical, and practical. Also, the purpose of HIS is to use communications equipment and computers to, readout store, gather, process, and communication between patient care with administrative data on all hospital activities in order to meet consumer compliance requirements. In the end, the system will communicate therapeutic patient data more quickly and broadly between workstations of various treatment workstations and therapeutic factors, taking care to prevent patient data from entering from overlap. By introducing blind spots into its treatment process, the system's efficiency is, able to shorten the amount of time that patients must wait for treatment. This decrease in overall lead time decrease the costs of treating patients and or the nation's health system and will increase healthcare quality and patient satisfaction.

A paperless hospital is envisioned as the embodiment of future HISs, with the goal that it will provide an improvement and the promise of being more dependable, effective, and efficient. We offer our conceptual framework for a paperless hospital and HIS. The suggested system improves the ability

of medical staff to coordinate care by making a patient's medical information and visit history available when and when it is needed, without duplicating electronic health records.

Author credit statement

E.M and M.F, implemented all the practical work that have been done and analyzed the results, and was responsible for the proposed algorithm. M.S and S.M supervised and revised the work, shared in the discussion, and obtained the results. E.M was a major contributor in writing the manuscript, helped in point selection of study, and supported the data framework. All authors read and approved the final manuscript to be published.

Conflicts of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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