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Intensive Care Unit (ICU) Management System for Dengue Ward

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Abstract: Intensive care units(ICU) in Sri Lankan hospital systems are generally managed manually. Using a manual system for the ICU can cause many difficulties as the ICU is the main department in a hospital. After analysing the current procedure at Kalubowila Teaching Hospital we observed that it normally takes 24 hours to identify and direct a seriously ill dengue patient to the ICU from the High Dependency Unit(HDU). Patients with the Dengue virus will have similar symptoms. Thereby the next patient who needs to be admitted into the ICU has to be more ailing than the rest of the patients in the HDU. If the correct patient to be admitted is not identified, another patient in the unit could fall into a more severe case. ICU Management System is a web based system that has the ability to identify the next most critical Dengue patient that should be treated in the ICU using a specific score. The score is calculated by monitoring the symptoms of the patient and giving a separate value to each symptom. The calculated score depends on the severity of the patient. This paper presents the design and implementation of this ICU Management System and offers a comparative study about existing Hospital Management Systems.

Keywords: ICU, HDU, Score, Dengue, Hospital

Introduction

Current hospital management system in Sri Lanka is not properly managed and most of the procedures and tasks are done manually using man power. When a patient is admitted to the hospital with symptoms of dengue fever it is hard to check whether the admitted patient's situation is critical. The patient must go through several check-ups and tests in order to clarify whether he/she is in a severe condition (Soni et al., 2001). The process of directing patients to the ICU (Intensive Care Unit) is done manually by a doctor. The next patient to be selected has to be chosen from the HDU (High dependency Unit) which is also a manual process (Calvo Herranz et al., 2011). The current ICU management system faces many difficulties as it is done manually. Some of the difficulties, hospitals have to face are difficulties in finding the most rightful patient who should be treated in the ICU with better treatments, monitoring each and every patient's health situation and unable to find the most critical patient (Ward and Levy, 2001). After analysing the current situation on which the Intensive Care Unit (ICU) is being managed, a system was planned. With this system we plan to minimize the work of the 24 hour attendants in the ICU and to maximize the efficiency in taking them.

The intended system in an online, web-based system, which can show the next most suitable patient to be transferred to the ICU without any difficulties. Each patient will be given a specific score and using that score the severity of the patient is identified. Doctors and nurses will be able to manage this system conveniently, as it is easy to use.

A. Problem in brief

The traditional method of directing a critically ill patient to the Intensive Care Unit (ICU) is performed on the recommendation of a physician. Manual examination of each patient is an exhausting procedure("(7)

(PDF) Challenges encountered by critical care unit managers in the large intensive care units," n.d.). Some of the outcomes of dengue patients' infections requiring ICU admissions remain unclear. Therefore, it is difficult to identify critically ill patients who need to be treated in the ICU with specialized treatment (Chen et al., 2016). In the current system patients' records are stored manually in files, papers and bills. If a patient recovers from the disease and is discharged, but later is admitted again for the same disease and the records are not to be found it could be fatal as the disease could be more severe and without the right information and data of the patient. Treating the patient will not be an easy task. After storing the current records of the patient, to view them the doctor has to come and assess the patient regularly. While checking on the patient with the disease if the doctor realizes the disease has become fatal for the patient in an irregular tie period it could be a disaster. To avoid this matter would be the mission("(7) (PDF) Management of dengue fever in ICU," n.d.).

B. Solution

As a solution to the above mentioned problems, an online web based system which can show the next most suitable patient that needs to be transferred to the ICU can be built using firebase. This system will be able to help physicians and nurses to monitor the severity of patients.

C. Aim and Objectives

The main aim of this project is to provide Kalubowila Hospital or any other general hospital an automated system to efficiently record dengue patients' data and find the most critical patient to be admitted to the ICU from HDU considering their health records.

In Sri Lanka, general hospitals do not have an automated system in the Intensive care unit. The proposed system's aim is to automate all the manual work done by the hospital staff and to gather the data and analyze important information regarding patients. By considering the analysed data severity of the patient is identified and sorted in order to be treated in the ICU. Since there are two wards for serious patients, namely the HDU (High Dependency Unit) and the ICU (Intensive Care Unit) the system proposed will be used only between these two wards and also the patients switching is also done only in these two wards.

The method of evaluating the most critical patient in a very short period will be the main aim of this system. Within a short time period, using the recorded data of the patient, the system will be able to identify the next most critical patient to be admitted to the ICU.

The rest of the paper is organized as follows; section 2 contains related work by other pioneers and their views in this avenue of automating this system as well as information on the current manual system. Furthermore, section 3 provides a detailed description on the design and the implementation of the system along with its modules and methodology. Thereafter section 4 gives the general results. Last but not least the conclusion is described and discussed in section 5.

Related Works

There are many concepts developed which are used to automate ICU systems in hospitals but unfortunately, a working system as we proposed hasn't been developed progressively in the current world. As we proposed, we mentioned about the automatic score calculating technique and predicting the most suitable patient to admit to the ICU from the HDU unit and to compare the scores. However, there are some ICU management systems as mentioned below which comes under the existing techniques.

A. Therapeutic Intervention Scoring System (TISS)- A method for measuring workload and calculating costs in the ICU.

J. Malstam and L.Lind proposed the therapeutic intervention scoring system, which is an easily applicable method for measuring workload in the ICU. In the present day modified 'TISS' was performed during 1989-1998 on 2693 patients in a general ICU. From them only 900 could be treated in the ICU. The average workload was then calculated. The workload isn't related to age or type of admission from these calculations; patients categorized into respiratory and infectious diseases showed the greatest average workload. This workload index was developed relating the actual workload to the ICU personnel. This supports the potential cost saving managing patients in ICU(Kaufmann and Briegel, 2000).

Compared to the above stated system, the system we describe does not have a workload index. Instead, our system will be using algorithms to calculate accurately and precisely the next eligible and critical patient. In addition, this system will be able to assign and update the patient's medicine and hold the records (Kaufmann and Briegel, 2000).

B. Utilizing findings from the APACHE III research to develop an operational information system for the ICU-- the APACHE III ICU Management System.

The APACHE III database reflects the disease, physiologic status, and outcome data from 17,400 ICU patients at 40 hospitals. This provides a nationally representative standard for measuring several important aspects of ICU performance. Results from the study have now been used to develop an automated information system to provide real time information about expected ICU patient outcome, length of stay, production cost, and ICU performance. APACHE III has the capability to electronically interface with and utilize data already captured in existing hospital information systems, automated laboratory information systems, and patient monitoring systems (Solutions, n.d.).

However, in our system we have used algorithms to predict and help to get the most important decisions. As we monitor the patients, the Sensors attached to the body track heart rate, blood pressure, and other vital signs, while bedside monitors graph the data in undulating lines. The ICU of the future will make far better use of its machines and the continuous streams of data they generate. Instead will pool their information to present a comprehensive picture of the patient's health to doctors. In addition, that information will flow to artificial intelligence (AI) like systems to predict the next most critical person in the ICU (Knaus et al., 1991).

C. ICU Care

ICU Care is built for Intensive Care Units as an information system. It was made for adults, neonatal, pediatric, and specialty intensive care. ICU Care is a domain specific, modularly oriented unit management and point of care information framework. The system is a solution to the software and hardware. In terms of applications, the framework provides Intensive Care Units with a forum for controlling clinical, administrative. This system gives the capacity to draw inferences and performance patterns of an ICU.

ICU Care functions as a bedside point of care system. Doctors use ICU Care to prescribe their patient's clinical process and care plan. This application is flexible to allow doctors to access patient's clinical reports from a different place. This system also communicates with other systems such as hospital information systems and PAC systems ("ICU Manager," n.d.).

The above stated system is built for adults, neonatal, pediatric and specialty intensive

care but the system we propose is built only for dengue patients.

D. Current Manual System

Most of the things in the hospital are done manually. Therefore, we have to compare our system with the manual existing process, which is undergoing in each hospital in Sri Lanka. As we mentioned earlier we are proposing our automated ICU managing system to the dengue unit of the Kalubowila Teaching Hospital

The initial step of the manual process starts with entering the patient's data when admitting to the hospital, from then on patients are being monitored, and data is being added daily to the patients' records. In case if the patient's condition gets serious then only the patient will transfer to the high dependency unit and at that time also the data is being gathered and no any score or prediction is taking place. If the situation is getting worse, there is no chance to transfer the patient to the ICU unless there is an available bed because we can't compare the patient and select the most suitable patient to be admitted or to remain in the ICU. A survey was conducted to acquire information about the current manual system that is being commonly used.15 medical personals were selected from the Kalubowila Teaching Hospital.

The medical personnel were initially asked about their opinion on the development of the IT field in the current hospital system.

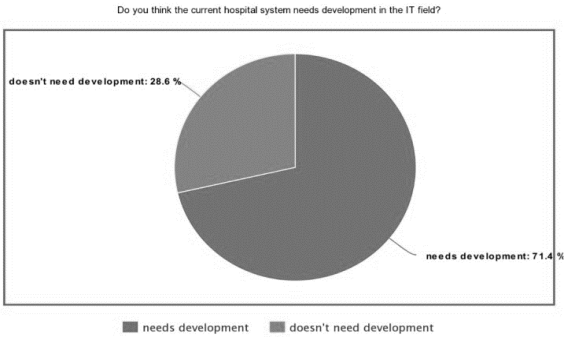

Figure 1 – Question 1 statistical results

According to the above pie chart it clearly shows how the medical personnel think of the current system in which the IT department may use. The positive response of the participants is mainly due to the human error that could occur under immense pressure when rash decisions have to be made. When decisions are made, statistics should be analysed and taken care of, therefore an effective system to output continuous data for the medical team would be of immense help. Thereby the It department of the hospital has to be point and the algorithm has to be effective. The minority which would be the negative response is due to the participants thinking that the human brain can judge better than a computerized algorithm. Since the AI field is still being developed all over the world the concept in this field is not famous. Thereby the participants believed that the human judgment should overrule the algorithm when necessary and this moment is not specified (Gholami et al., 2018). It could be whenever or through the continuous path. Hence, after reviewing existing technologies the proposed system was designed and developed

Design & Implementation

Addressing the main problem and reviewing the current technologies, the proposed solution is an automated ICU management system. ICU management system is a web based system which is built using Java and uses firebase as the database connector.

This web page can be considered as the "user-interface" of the system and hence used to interact with the system. To capture changes and to keep the system synchronized with the web page, Firebase platform is used. To understand the system purpose in depth, main functionalities of the system are listed below.

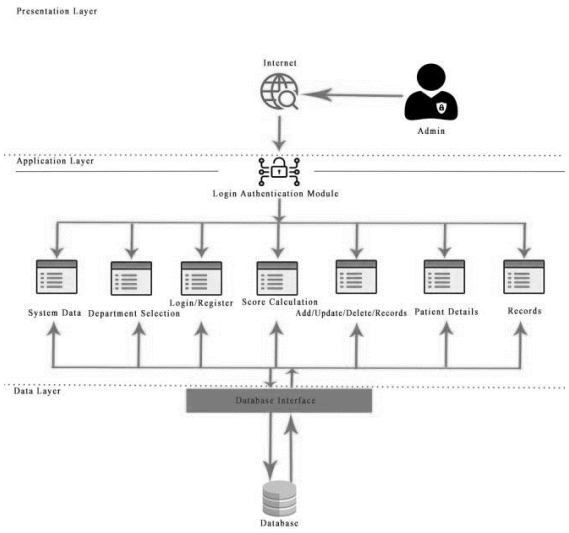

Figure 2 – Overall System Architecture

A. Calculate the score

To identify the severity of each patient individually, a specific score is calculated using an algorithm. By monitoring and giving a score to each and every patient in the ICU and HDU, ICU Management System gives the ability to find the most severe patient and direct him/her to the rightful unit.

B. Doctors score

There's a special section only for doctors, so that the doctors could give a score to all the patients separately. The doctor's score will also be added to the final score of the patient. This score is given according to the doctor's experience on the patients and physically visible symptoms are considered when giving this score. And also other medical conditions of the patient and the facts which cannot be included in the system are considered here. x`A separate percentage from the final score is calculated with this doctor's score.

C. Real time status module

Firebase database system is capable of capturing real time changes that occur in the application. Therefore, when a new patient is admitted to the hospital and when the nurse inputs his details to the system, the real time status of the specific patient will be displayed. Also when a patient's condition changes from one state to another it will also be displayed in the system.

D. Update records

Keep an updated detailed record of the doctors' comments, tests, scans and most importantly the patients score. Here according to the data collected the patients score gets updated and again gets sorted according to the highest score.so that the doctors gets an alert saying the patient with the highest score needs to be transferred to the ICU.If the any patient in the ICU gets a score which is below than a patient in the HDU, then both the patients should be interchange. Likewise, when a new patient or a new data is added to the system it gets updated and sorted accordingly by always displaying the most critical person.

E. Alerts

When a patient's score gets higher than expected which means that the patient should be immediately transferred into the ICU, so in that kind of a situation an alert is sent to all medical personals which are responsible for the patient. And also when a patient from ICU gets a lower score than a Patient in the HDU, then another alert is sent by mentioning the availability of the ICU.

The proposed system will be the most suitable and efficient model to be used in hospitals as it is necessary. Hospital personnel such as doctors and ward attendants will use the system only. Since there are two wards of focus namely the HDU (High Dependency Unit) and the ICU (Intensive Care Unit) the system proposed will be used only between these two wards.

The relevant administrator logs in to enter the new patients details and personal information. After that, the data regarding the symptoms and phases of the dengue disease is recorded and stored. The method of evaluating the most critical patient in a very short period will be the goal of this

system. After discussing with the doctors of Kalubowila teaching hospital each symptom is given a specific score accordingly, so by that calculation within a short period of time with the recorded information of the patient, the system will be able to select the next most suitable patient to the ICU.

ICU Management System is developed to improve the efficiency of intensive care unit which will provide services with in and out of the hospital environment uplifting a better health care system with lesser maintain cost and manpower, mainly and easier to use system that's user friendly in order to make the hospital staff less stressful and to make a happier working environment. Even though the system was initially designed to cover the entire hospital management system but since hospitals have a very large organizational structure, with the time limitations for the development of projects, the system will be initially developed only for the intensive care unit of the dengue ward.

Result & Discussion

In Sri Lanka, the general hospitals do not have an automated system to be used in an Intensive care unit. The proposed system will be the most suitable and efficient model to be used in hospitals as it is necessary. Hospital personnel such as doctors and ward attendants will use the system only. Since there are two wards of focus namely the HDU (High Dependency Unit) and the ICU (Intensive Care Unit) the system proposed will be used only between these two wards.

In order to understand user reaction to the proposed system, the system was presented to few users. Also a questionnaire was presented to them to acquire feedback about the system. Before presenting the system to users we provided a survey to a few selected users to get their opinion.

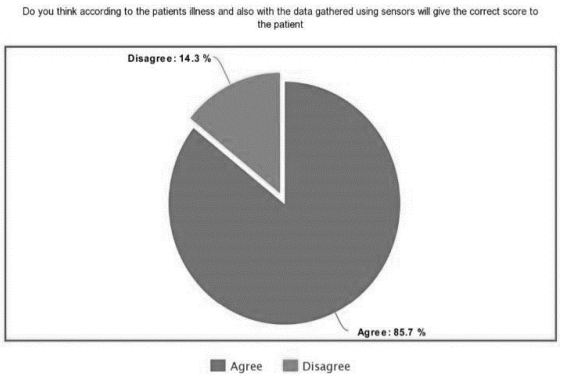

Figure 3 – Question 2 statistical results

According to the above pie chart when the score is calculated with the relevant sensors the accurate score entitled to each patient can be calculated.

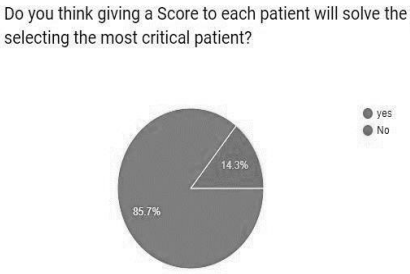

Figure 4 – Question 3 statistical results

According to the feedback users have given, it is proved that our proposed system would be useful for hospitals ("Yoodly ICU Management System," n.d.).

The users were first briefed about the functionality of the system and given to test the system.

The relevant user logs in to enter the new patients details and personal information. After that, the data regarding the symptoms and phases of the dengue disease is recorded. These details recorded and stored in such a manner would be very useful in this industry as it is time to develop has come. Users agreed that since every procedure will be done online very soon, this system will be of good use to the general hospital.

Through this test, it was evident that the functionality of the system fulfils the set-out objectives.

The method of evaluating the most critical patient in a very short period will be the goal of this system. In no time with the recorded information of the patient, the system will be able to make out the next most suitable patient to the ICU.

Conclusion

Intensive care unit(ICU) in the Sri Lankan hospital system is generally managed manually. Using a manual system for the ICU can cause many difficulties. To overcome the problems which have occurred in an intensive care unit (ICU) such as difficulties in finding the next rightful patient who should be treated in the ICU, finding the most critical patient in ICU and difficulties in monitoring the patient's health and treatments. The system to automate the current ICU procedure provides an effective platform to both doctors and nurse to identify the next most suitable patient that should be treated in the ICU using a specific score. Since the process is automated through the system, the main issues of a present ICU system will be fixed. Therefore, our system is basically focusing on dengue patients and monitoring them to get the score and sorting them according to a specific order to transfer patients to the ICU from HDU in the dengue ward. ICU management system is a web based system that uses firebase as the database connector. This paper presents the design and implementation of this ICU Management System and offers a comparative study about existing Hospital Management Systems.

Further Works

Further, the system can be expanded to achieve the scope of the development. Following are identified as the further enhancement to be attached to the implemented system.

- Expanding the system to every high dependency unit in every ward.
- Use the system to predict the most suitable patient to be admitted to the HDU.
- Merging the doctors in every ward to the system so any on duty doctor will monitor the patients in the ICU in any serious case.
- Send automatic calls to doctors in serious situation

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