

ETU Management and Patient Tracking System

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Abstract - The Emergency Treatment Unit (ETU) in Sri Lankan Hospitals runs based on paper-based manual process and results in delays in delivering patient reports, losing them and delay in the treatments. In addition, due to the limited number of beds inside the Coronary Care Unit (CCU), it has become more important to identify the most severe patients to be admitted into the CCU. So, if the correct patient to be admitted is not identified properly, another patient in the unit could fall into a more critical condition. ETU Management System is a web-based system, which automates the current manual process inside the ETU and is capable of identifying the most suitable patient that should be treated inside the CCU, using a specific scoring system calculated by monitoring the symptoms of the patient at ETU assessment. Patient tracking system is a mobile application provided for patients and their guardians, which gives patients the facility to contact his/her guardian and doctor in any case of emergency, as well as enables Guardians to track the patient's location and notifies them via the mobile application, if the location of the patient is changed in any case. The proposed ETU management system helps to take the Sri Lankan medical field into another era by eliminating traditional paper-based manual processes.

Keywords: *ETU, CCU, score, hospital, automate*

I. INTRODUCTION

Accident and Emergency Treatment Unit (ETU) is considered as a clinical treatment department that specializes in the intense considerations of who arrive at the hospital without prior appointments or arrangements either by their own or by ambulance ("Emergency Unit - Asiri Health," n.d.). In such situation ETU department must be fully prepared to provide initial

treatments for broad range of diseases and wounds some of may be perilous and require immediate consideration ("Emergency departments | health direct," n.d.). If anyone end up requiring the services of an ETU, the first thought will be the efficiency as well as the professionalism of the department since in an emergency every second count and each decision has potentially life-changing outcomes. In Sri Lanka, the department will provide initial medical treatments for the patients who arrive at the tirage area of the Accident and Emergency Treatment Unit and will be directed to CCU (Coronary Care Unit), ETU (Emergency Treatment Unit) and PCU (Preventive Care Unit) based on their severity ("Ministry of Health - HOME," n.d.). The most severe patients will be admitted to the CCU, and least severe patients will be admitted to PCU wards and the patients with medium severity will be admitted to the ETU, respectively. All the above processes inside the ETU are done manually. As a result, there are so many difficulties in finding the most severe patient and most rightful patient who should be treated inside CCU. All the patient's records, past records are stored in manually using papers, files, records, and bills. Hence, these documents were most likely to be lost or misplaced when moved around by various hospital personnel who handle them. Consultants must wait for an extended period to treat his patient until the hospital attendant carry out his reports from a certain laboratory which may find far off from the A-E department. Consequently, the patient's condition may get worsen and his life may be threatened. So, it is quite conspicuous that the Accident and Emergency Treatment Unit in Sri Lanka should be handled efficiently as well as precisely to provide a maximum service to the patients who require emergency treatments. In addition to the above problems when focuses on the side of the patient, there is no proper facility

for the patient to view his medical report when necessary other than go through all the report papers stored in his personal medical file. It is also difficult for the patient to find facilities to contact his caregiver or doctor in an emergency as well as there is no proper facility to notify the guardian of the patient if the location of the patient such as, ward or hospital is change due to an emergency happens to his patient.

The intended ETU management system will be a web application implemented to help the prevailing circumstances of the manual system utilized in current general hospitals in Sri Lanka by finding the next most suitable patient to be admitted to the CCU and guarantees more security, speed and information storing techniques to show high quality of the AE Department. The aim of the web application is to automate the current accident and Emergency treating unit to assist doctors and staff by kicking off the traditional paper-based process and find the most critical patient to be admitted to the CCU and the mobile application to make the daily lives of patients and their caregivers easier by maintaining social well-being of the patient as well. The main objectives of the ETU Management and Patient Tracking system is as follows.

1. Study the existing manual system and identify major stakeholders.
2. Interview the specialists and identify major requirements.
3. Study the existing system's documentation and identify pros and cons.
4. identify suitable software process model (e.g.- waterfall, spiral etc.) and technologies for the development.
5. Design the system.
6. Implement the system.
7. Evaluate the results.

For the development of the intended system iterative and incremental development model (Nguyen-Cong and TranCao, 2013) is utilized. Node.js is used in server-side development of the web application and MySQL is used as the database. For the mobile application development Java is used as the programming language and Google APIs (Application

Programming Interfaces) for the location tracing.

This web application will be of acceptable use to the overall general hospitals hectic circumstances may arise when a pandemic happens in the country as well as mobile application will be helpful in real-time tracking of the patient as well as this ensures eliminating mental burden of the patients and their caregivers.

II. RELATED WORKS

This section will illustrate the review of existing systems and technologies related to hospital management and with score prediction as well as mobile application developed for patients.

A. Severity Prediction Systems

A comparison of risk scoring systems in predicting clinical outcome at upper gastrointestinal bleeding patients in an emergency unit. They compare Admission Rockall score (RS), full RS, and Glasgow-Blatchford Bleeding Score (GBS) which were gathered and calculated during patient's ED assessment to identify the most accurate score on order to predict the outcomes at upper gastrointestinal bleeding patients in Romanian ED (Dicu et al., 2013) Authors have mentioned that this comparison permitted them a more accurate and effective confirmation patients in ICU, ordinary wards, or ambulatory management of the patients.

A combination of a Smart Priority Recommendation and Patient Control System as well as a Hospital Emergency Smart Band was introduced in which the smart band was placed in each patient's hand permitting to detect changes in the fundamental indications of patients who are waiting that may demonstrate that they require immediate attention and care (Lima and Faria, 2018). Their system has addressed the issues that happen in medical clinics when there is a peak in the quantity of individuals utilizing the emergency service, increasing the time of waiting. By obtaining the advantages of Hospital Emergency Smart Band (HESB) which consists of sensors for measuring body temperature, heart rate, blood oxygen level and blood pressure the system continuously

stores and analyzes the patient's information on crucial data being ready to generate real-time alerts for the responsible nurse in the triage process.

B. Patient registration and hospital management Fist in First Out Algorithm where patient who came first to the first is the one who enrolled first in patient registration was utilized in Management Information Systems Development for Veterinary Hospital. Authors have mentioned that this information system is considered as extremely helpful since it reduces the time when processing the data of the patients (Hapsari et al., 2016). And the data storage can be validated properly to decrease the utilization of paper. However, authors also have mentioned that there are some drawbacks where the sub-system registration information are unable to offer priority for the patients with emergency cases.

Leitos which is a Web-based Information System for the Management of ICU Beds During the Coronavirus Outbreak was carried out (de Morais Barroca Filho et al., 2020) which does effective management of ICU beds as well as semi-ICU beds which are assigned to Covid-19 patients. Agile scrum was used as the development methodology they have used Java platform as well as Spring framework as technologies for the implementation process. They have carried out unit tests and acceptance tests as the testing techniques.

Comparatively the ETU management web application will be using a special algorithm to calculate and predict the severity of the patients and compare each score of the patients to find most accurate patient who must be admitted inside the CCU and automate the current manual process inside A-E department which increases the efficiency and security of the processing of patient's medical information. Figure 1.1 illustrates the comparison of the sample related work when compared to functionalities of the proposed system.

Research work	Patient Registration	Score calculation	Severity Prediction	Update records	Severity alerts
Comparison of risk scoring systems in predicting clinical outcome at upper gastrointestinal bleeding patients in an emergency unit	✗	✓	✗	✗	✗
Towards Real-Time Patient Prioritization in Hospital Emergency Services	✓	✗	✓ Initial Severity prediction	✗	✓
Management Information Systems Development for Veterinary Hospital Patient Registration	✓	✗	✗	✓	✗
A Web-based Information System for the Management of ICU Beds During the Coronavirus Outbreak	✓	✗	✗	✓	✗

Figure 1.1 – Comparison Table

C. Mobile Health Record Systems

Mobile app and a web GIS-based health care system in Ampang district in Malaysia assist people with disabilities to reach nearest health care centers. This is a Web-GIS based system consists of two main components which are PWD Monitoring system which is a GIS – web system and PWDsupport2U which a mobile application (Rasam et al., 2018). The mobile application proposed was expected assist the people with disabilities and their guardians by providing functions like, requesting a doctor home visit, requesting an ambulance or medical delivery depending on their existing circumstances and requirements. www.data.gov.my and Google Map were utilized to collect data related to health care facilities. For the creation of the web mapping system ArcGIS online with its app function is utilized.

An analysis about Mobile applications for Alzheimer patients and caregivers (Gupta et al., 2018) stated that the smartphone well assisting the care giver of the patient to take a proper care of patient like receiving the GPS (Global Positioning System) location of the patient by utilization of Geotagging and the requirement of building a relatively simple cross-platform mobile application with an interactive graphical user interface will helps in increasement of the cognitive abilities of the patients. The research work has stated that the Mapigate feature empowers the real-time tracking of the patients This component shares the current location of a patient with the safe zone contacts and produces an alert, in instance of wrong way choice.

The intended mobile application which will be provided to the patient's and their guardians is capable of viewing patient's medical reports, contact his guardian or doctor in any emergency and sending relevant medical information to the

guardian. The guardian will be using this application to detect his patient's current location (Kumar and M., 2018) as well as to keep proper communication process with his patient.

III. DESIGN AND IMPLEMENTATION

By considering about the main problem existing and reviewing the technologies used, the proposed solution is an automated ETU management web application which will be able to predict the severity of the patients. Figure 1.2 below represents the referral system and Accident and Emergency Department setup in Sri Lanka and Figure 1.3 describes the triage categories represented in the figure 1.2.

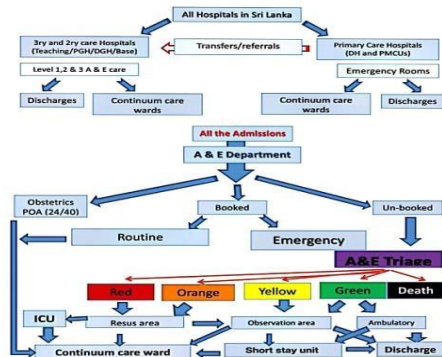


Figure 1.2 – Operational Structure and Patient Care model

TRIAGE CATEGORY	SEVERITY	ACUITY (Maximum waiting time)
Category 1 (Red) Immediate (Resuscitation)	Life threatening	Immediate
Category 2 (orange) Emergency	Imminently Life threatening	10 minutes
Category 3 (Yellow) Urgent	Potentially Life threatening	20 minutes
Category 4 (green) Semi urgent (standard)	Potentially serious	30 minutes

Figure 1.3- Triage Categories

The mobile application which will assist patients and their guardians to which will ease their daily routines. The intended web application will be built using node.js (Chhetri, n.d.) and MySQL will be used for the database

and java will be using for the development and Google API(Aldabbagh and Mohsen, 2014) will be used for location detection of the intended mobile application.

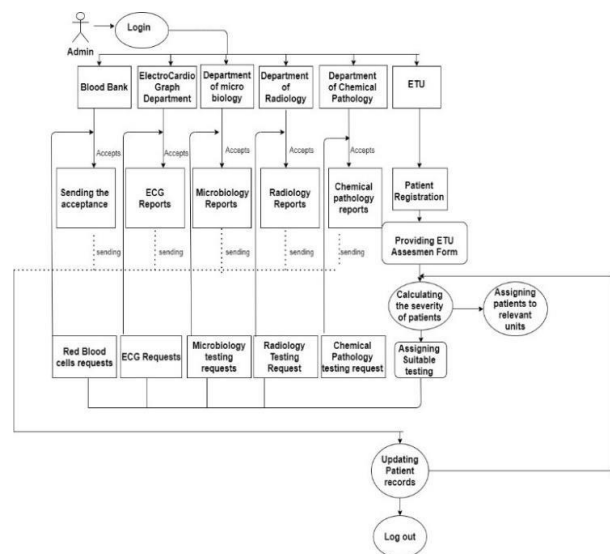


Figure 1.4 – Flow diagram -Web app

To understand the major purposes of the web application in depth main functionalities of the ETU management system is listed below.

A. Score Calculation

Specific score is calculated to identify the severity of each patient who arrives at A-E department by using a special algorithm which is constructed by using data values in the ETU assessment which is done by the ETU doctor. For the algorithm, the values given to the Blood pressure, Respiratory rate, Pulse rate, Oxygen saturation and GCS scale which is calculated from scores given to eyes, verbal and motor will be considered. After examination of the medical reports which are retrieved from the laboratories doctors will be able to add a score based on the experience and physically visible symptoms and this score will be added to the current score and after all the final scores will be calculated for each patient. The scores will be calculated as percentages and the percentage values of the patients will be compared to find most accurate patient to be admitted to the CCU or ETU respectively.

B. Update Records

This system will provide facilities for the chemical pathology, radiology, microbiology, and Electrocardiograph departments as well as the

blood bank and keeps updated records of the patient’s medical information. The overall scores of the patients will be updated every once in the while, the doctor examines the new reports received from the laboratory testing. So, at each update the scores will be compared and send a notification to the doctor about the patient with the highest score who should be transferred to the CCU. If the score of a patient inside the CCU is lesser than the score of the patient inside the ETU the patients should be interchanged.

C. Alerts

The system keeps alerting the responsible medical officer about the severity of the patients. When the severity of the patient in the ETU gets higher than the patient in the CCU system alerts about the critical condition as well as when the severity of the patient inside the CCU lower than the patient inside the ETU systems sends the alerts about the availability inside the CCU.

Figure 1.5 and figure 1.6 below represents the main interface of the ETU nurse and complete checkup interface of the nurse’s module, respectively. The main interface of the ETU nurse represents the details about patients who have been registered and admitted inside ETU as well as the patients who have been discharged from A-E department within a single day. Each patient’s severity level is also stated in front of the patients’ details. Initial checkup form is filled by the nurse in-charge. These details along with the details filled by the ETU doctor in the ETU assessment form after the initial checkup will help in predicting the initial severity level of the patient who registered.



Figure 1.5 – Interface of the Nurse

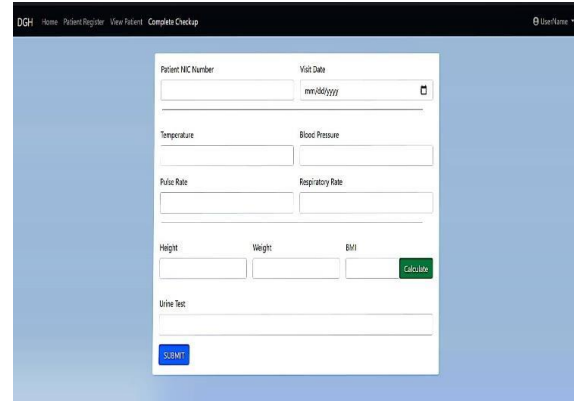


Figure 1.6 – Interface of the checkup form

Figure 1.7 represents the general flow the web application.

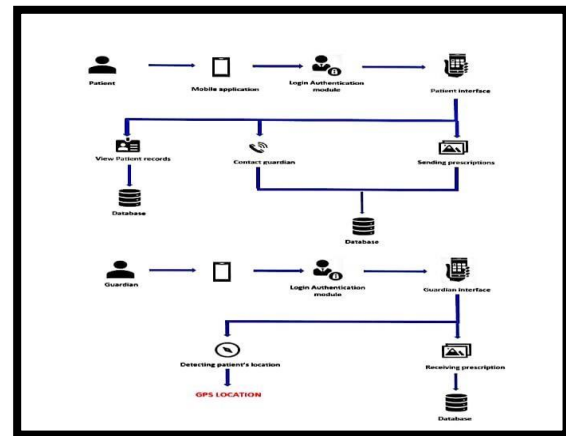


Figure 1.7 -flow diagram-mobile app

Features which need to be incorporated in the mobile application are shown below.

A. Tracking Patient’s location

Guardian will be able to track patient’s current location and get notified if the location of the patient is changed in any emergency case (Tang et al., 2016). This feature will be provided by the guardian interface of the mobile application. This feature will be especially useful for the guardians whose patients are suffering from diseases like dementia.

B. View Medical reports and contact doctor or Guardian.

Patients will be able to view his own medical reports whenever he wants other than go through the bunches of paper reports. Patients will be able to contact his guardian or doctor

through the speed dial option and send prescriptions or other medical information for the guardian in any case.

The proposed system will be utilized by medical staff, such as, doctors, nurses, and the laboratory staff of department of chemical pathology, Radiology, Microbiology, ECG unit as well as the Blood bank. The ETU nurse logs in to enter the new patients details and personal information. After that the information with respect to the symptoms and indications of the case is recorded (Abraham et al., 2015). These data recorded and put away in such a way would be helpful in this industry as it's time to create has come. Each strategy will be done online very soon; thusly, this system will be of acceptable use to the overall general hospitals hectic circumstances may arise when a pandemic happens in the country. The strategy for assessing the most critical patient in a brief timeframe and automate the laboratory report exchanges within other departments and the A-E department will be the objective of this system. Quickly with the recorded data of the patient the system will be able to make out the following most severe patient who is reasonable to be admitted to the CCU.

Along with the web application, the proposed Patient Tracking system is an android mobile application intended to assist patients and their care givers. The mobile application will be able to View his/her own medical reports, Contact the guardian or doctors in any case of emergency and Sending prescriptions and medical information for the care givers. As well as care givers of the patient will be able to detect his/her patient's location by utilizing this mobile application. This mobile application will be an uncomplicated simple application with a user-friendly interface which will solve most common problems encountered to the helpless, weak and incapable patients and their care givers since the situation of a patient inside the A-E department can be in any point of time.

IV. DISCUSSION & CONCLUSION

In Sri Lanka, the general hospitals do not have an automated system to be used in an A-E Department. When a patient arrives at the A-E department is severe having many symptoms

and side effects, it is hard to find the most eligible patient for the CCU. The next patient to be selected must be chosen from the ETU which is a manual process as well. All the patient's records, past records are stored in manually using papers, files, records, and bills. As a result, these documents were most likely to be lost or misplaced when moved around by various hospital personnel who handle them. Consequently, the patient's condition may get worsen and his life may be threatened. The proposed ETU Management system is a web-based system which can demonstrate the next most appropriate patient to be transferred to the CCU without any hesitation. Doctors and nurses will be able to manage this system conveniently as it is easy to use, and the system will help in collecting and updating all the patients records efficiently and effectively. The intended system will be an efficient solution for the proper management of CCU beds which are limited in the hospital by deciding most suitable patient to be treated inside the CCU. The proposed ETU management system will be more efficient than the manual system since it guarantees more security, speed and data/information storing techniques to show high quality of the A-E Department. Since the intended web application is designed for the health sector, the accuracy of the system is mandatory So, variety of variables such as Respiratory rate, Sat% on air, SBP value, Pulse and GCS values were considered when predicting the severity of the patients. In addition to these variables a specific score which is based on the experience of the doctor and physically visible symptoms were also taken into consideration when calculating the final severity score. These scores will be updated and compared with the existing scores of the other patients continuously in each testing which will affirm and verify the accuracy of the system, and the system can be improved by using image processing to analyze x-rays and CT scan images to identify the condition of the patient. As well as, as the use of smart phones continues to grow it can be used to aid the daily lives of the patient and their care givers. Patient tracking system will be able to track the patient's location, storing medical records and contact doctor guardian in any emergency which will be essential in any critical situation. So, the patient

tracking system will provide a good support to critical situations by guardians of the patients as well as it can be further improved to as a mobile application which will be capable of enhancing the cognitive capabilities of the patients.

REFERENCES

- Abraham, I., Joyce, A., Okpara, M., 2015. Designing A Web Based Hospital Management System for MOUAU Clinic.
- Aldabbagh, O., Mohsen, K., 2014. Design and Implementation an Online Location Based Services Using Google Maps for Android Mobile. *International Journal of Computer Networks and Communications Security* 2, 113–118.
- Chhetri, N., n.d. A Comparative Analysis of Node.js (Server-Side JavaScript) 79.
- de Moraes Barroca Filho, I., Costa Sampaio, S., Cruz, A.P., Freire Ramalho, V.H., Rodrigues de Azevedo, J.A., Caetano da Silveira, Á., 2020. A Web-based Information System for the Management of ICU Beds During the Coronavirus Outbreak, in 2020 IEEE Symposium on Computers and Communications (ISCC). pp. 1–4.
<https://doi.org/10.1109/ISCC50000.2020.9219626>
- Dicu, D., Pop, F., Ionescu, D., Dicu, T., 2013. Comparison of risk scoring systems in predicting clinical outcome at upper gastrointestinal bleeding patients in an emergency unit. *The American Journal of Emergency Medicine* 31, 94–99.
<https://doi.org/10.1016/j.ajem.2012.06.009>
- Emergency departments | healthdirect [WWW Document], n.d. URL <https://www.healthdirect.gov.au/hospitalemergency-departments> (accessed 6.13.21).
- Emergency Unit - Asiri Health [WWW Document], n.d. URL <https://asirihealth.com/services-and-centres/healthybody/emergency-unit> (accessed 6.13.21).
- Gupta, G., Gupta, A., Jaiswal, V., Ansari, M.D., 2018. A Review and Analysis of Mobile Health Applications for Alzheimer Patients and Caregivers, in 2018 Fifth International Conference on Parallel, Distributed and Grid Computing (PDGC). pp. 171–175.
<https://doi.org/10.1109/PDGC.2018.8745995>
- Hapsari, D.A., Permanasari, A.E., Fauziati, S., Fitriana, I., 2016. Management information systems development for veterinary hospital patient registration using first in first out algorithm, in: 2016 1st International Conference on Biomedical Engineering (IBIOMED). pp. 1–5.
<https://doi.org/10.1109/IBIOMED.2016.7869829>
- Kumar, P., M., R., 2018. Location Based Parental Control-Child Tracking App Using Android Mobile Operating System, in 2018 4th International Conference on Computing Communication and Automation (ICCCA). pp. 1–4.
<https://doi.org/10.1109/CCAA.2018.8777612>
- Lima, B., Faria, J.P., 2018. Towards Real-Time Patient Prioritization in Hospital Emergency Services, in: 2018 IEEE 20th International Conference on E-Health Networking, Applications and Services (Healthcom). pp. 1–4.
<https://doi.org/10.1109/HealthCom.2018.8531089>
- Ministry Of Health - HOME [WWW Document], n.d. URL http://www.health.gov.lk/moh_final/english/ (accessed 6.13.21).
- Nguyen-Cong, D., Tran-Cao, D., 2013. A review of effort estimation studies in agile, iterative, and incremental software development, in: The 2013 RIVF International Conference on Computing Communication Technologies - Research, Innovation, and Vision for Future (RIVF). pp. 27–30.
<https://doi.org/10.1109/RIVF.2013.6719861>
- Rasam, A.R.A., Azlin, A.H., Saraf, N.M., 2018. Mobile Apps and Web GIS-Based Accessible Health and Social Care System for People with Disabilities, in 2018 IEEE 8th International Conference on System Engineering and Technology (ICSET). pp. 85–90.
<https://doi.org/10.1109/ICSEngT.2018.8606358>
- Tang, H., Shi, J., Lei, K., 2016. A smart low-consumption IoT (Internet of Things) framework for location tracking and its real application, in 2016 6th International Conference on Electronics Information and Emergency Communication (ICEIEC). pp. 306–309.
<https://doi.org/10.1109/ICEIEC.2016.7589744>

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