Decision Support System for Dengue Detection based on Vital Signs and Blood Profile

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2020

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Dissertation submitted to the Faculty of Information Technology, University of Moratuwa, Sri Lanka for the fulfillment of the requirements of Degree of Master of Science in Information Technology.

June 2020

Declaration

I hereby declare that this project report entitled "Decision Support System for Dengue Detection based on Vital Signs and Blood Profile" contains my own work and has not been submitted and will not be submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

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Mr. Saminda Premarathna

Signature of Supervisor

Acknowledgments

I wish to express my sincere thanks to my supervisor Mr. Saminda Premarathna for guiding me to have a successful outcome in this project work.

I would also like to thank Pro. Harendra Desilva who helped me a lot on providing the data which which was used and helped to develop the cases on the study.

I would like to acknowledge and extend my heartfelt gratitude to the following people who have made the completion of this project possible.

My father mother and sister for the help given to proof read all the project documents by spending their valuable time,

Instructors of Faculty of Information Technology at University of Moratuwa who have supported me to find resources and requirements for the project.

Academic, non-academic staff members who helped me throughout this project,

Batch mates who motivated in doing the project, and friends.

ABSTRACT

The primary focus of this research study goes to the decision support system for dengue detection based on vital signs and blood profile using data mining techniques. This study sought to analyze the best data mining techniques which can be used to detect the dengue stage and suggest the decisions according to the situation.

This research based on research paradigm, Cased-Based Reasoning (CBR) to develop a web application to manage dengue illness. Identified the essential cases related to Dengue and recognised the rules which are related to those cases. This system generated suggestions will help doctors to quickly identify the current situation of the patient and do proper treatments to the patient. The system will help to reduce the number of Dengue death in Sri Lanka.

Keywords: Dengue management, Case based reasoning, Dengue shock syndrome

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CHAPTER ONE

INTRODUCTION

1.1 Chapter Introduction

This chapter mainly discusses the research problem, research questions, background of the study, and objectives of the study.

1.2 Background of the Study

Dengue is a viral infection mostly spread through tropical and subtropical areas of the world. The disease is spread by Aedes aegypti and Aedes albopictus, female mosquitos' species out of 3500 of mosquito species [1]. Mosquitos follow a life cycle of four stages, which are known as egg, larvae, pupae and adult. To survive through this life cycle mosquito's, need two main elements. One is vertebrate blood, and the other one is water. None of these mosquito species are bone with the virus. They only transmit the disease. Once a mosquito of the species mentioned above bit a dengue infected person that mosquito becomes the conveyor of dengue virus. When it bit another person, the virus will be affected to that person.

During the year 2017 a total of 186,101 suspected dengue cases were reported and as at 24 May 2018 a total of 19,459 suspected dengue cases were reported to the Epidemiology Unit of the Ministry of Health (MoH) of Sri Lanka with over 320 deaths in 2017 and 202 deaths in 2018. Over 40 percent of dengue cases were reported from the Western province. [2]

50 year ago, Dengue cases were only reported in 9 countries. Now it has been an endemic which has spread throughout more than 100 countries in the WHO regions of Africa, the Americas, the Eastern Mediterranean, South-East Asia and the Western Pacific. The America, South-East Asia and Western Pacific regions are the most seriously affected, with Asia representing ~70% of the global burden of disease.[7] The number of cases and the disease is

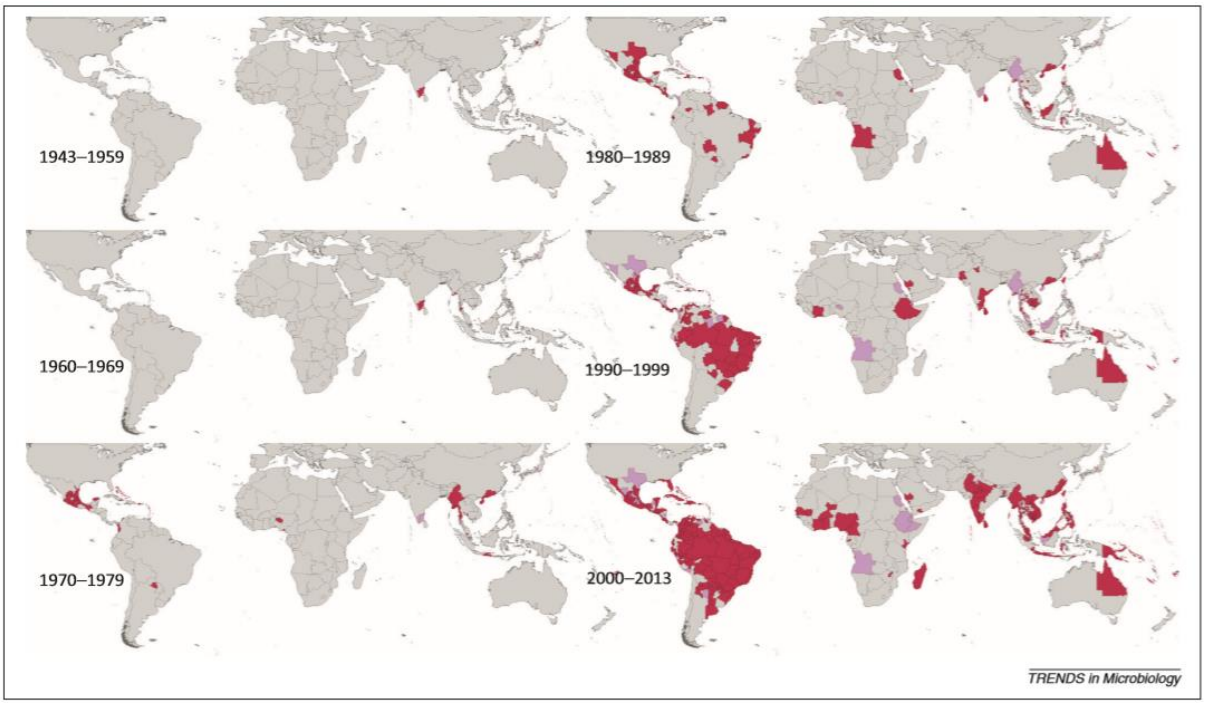


Figure 1.1 Dengue spread across around world.

spreading to new countries and areas, including Europe. Dengue virus has not still announced as a pandemic, but this is an epidemic which is risking much humankind around the world.

Figure one shows the spread of the dengue virus throughout all these years.[13]

Dengue has four closely related serotypes named DENV-1, DENV-2, DENV-3, DENV-4 which lead to classic dengue fever (DF), to the severe forms of the disease, dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS). Early clinical recognition of dengue infection and anticipatory treatment for those who develop DHF or DSS can save lives. In that case detecting dengue at its early stages, is very important.

Dengue disease appears seasonally in every rainy season, and on that season's waves of infectors are recorded. Gradually the number of infected patients decreases with climate change. During this spreading period, there may be thousands of infectors, and most of them will not grow into severe cases, few but a significant number of patients will grow on to critical dengue stages such as dengue shock syndrome and other fatal sages.

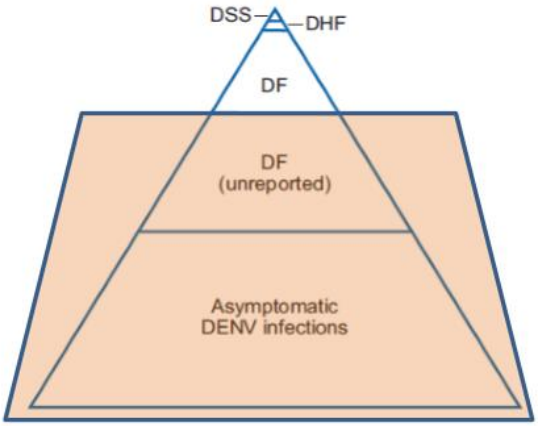


Figure 1.2 : Dengue distribution

90% of dengue patients are asymptomatic. They did not show any symptoms and will not grow into severe cases. Even though they do not have any symptoms, they have the virus in their blood. Hence, they take part in spreading the virus to others. Another 5% will undergo viral fever, but they will be recovering very soon. Their white blood cell count will be decreasing, but the platelet count will not affect. From the rest of 5%, 4% will have dengue fever, but no leaking. Their platelets and white blood cells will be affected by the virus. The rest of 1% will grow into severe dengue stages such as gangue hemorrhagic fever and dengue shock syndrome with leaking and bleeding.

There is number of symptoms where dengue can be identified, but somebody may confuse with other illness which causes fever. The system will appear by 3-4 days after the infected mosquito bite and will last for 9- 10 days. The main symptoms are shown below.

- Headache
- Muscle, bone, and joint pain
- Nausea
- Vomiting
- Pain behind the eyes
- Swollen glands
- Rash

In this study, various blood profile parameters and some other parameters such as urine outputs are used. All the parameters which are used are mention below with the ranges of an average, healthy person.

Table 1.1 : Heathly persons blood profile ranges

Parameter	**Range**
Platelet	150,000 – 450,000
White Blood Cell Count	4,000 – 11,000
PVC %	40 – 54
Pulse Pressure	40 – 60
Capillary refilling	Less than 2 seconds
SGOT	5 – 40
SGPT	7 – 56

There are several phases which dengue positive patient will undergo. The first one is dengue fever phase, which is the most preliminary stage of dengue. Then early dengue hemorrhagic fever. After that critical phase which is also known as leakage phase. Then the bleeding phase, finally, the recovery phase. By examine the vital signs and blood profile for roughly three days, phase can be identified. There are two main methods of identifying dengue virus in laboratory diagnosis. One is detecting the virus itself, and the second method is identifying anti-dengue antibodies. If the patient is positive with dengue virus, phase identification is essential to treat the patient.

1.3 Research Problem

This disease may spread into a new country in which there was no previous case of dengue, and most of the medical personals will not know what the necessary actions that must take immediately. Dengue can be even managed at home up to some extent. Dengue may appear in rural areas, and it will take time to get medical assistance. There may be doctors, but they may not be aware of the disease and the treatments.

There may be an incident such as some people got infected with dengue virus and flew to another country where dengue virus is not reported before. Doctors and nurses may not be families enough to deliver treatments accordingly. If there were a system to support their decisions, it will be helpful and may save lives from this deadly virus.

And there are several stages that patients will be when they have dengue virus, and the main problem here is to identify which stage is the patient is and give the medications and do the dengue management practices accordingly. Here we have the main six stages as follows.

1. Viral Fever Picture

2. Dengue Fever (DF)

3. Check Possibility of leaking (DHF)

4. DHF

5. Bleeding Phase

6. Recovery Phase

There are more minor cases in between these cases. “Decision Support System for Dengue Management Based on Vital Signs and Blood Profile” is a project which is done by S.H.U.Briyatis. The system is good but could improve by adding more minor cases to the main six cases will add more advantage, and it will help anyone who is using the system. Furthermore, the previous system had many errors in the algorithms when it was converted from text to code. So, if those were corrected, the system will be more reliable.

1.4 Scope of the research

This research only gives suggestions for doctors and nurses. This research will only look into the blood profile and the symptoms which will occur due to Dengue virus. If the patient has any other illness such as diabetes and cholesterol, the doctor should be aware of that and should consider if the given suggestions will affect the patient in another way.

1.5 Aim of the research

To enhance the accuracy and speed of the dengue decision support system for dengue management.

1.6 Research Objectives

- Identify the nature of the Dengue based on vital signs and blood profiles
- Explore and choose data mining techniques to experiment with vital signs and blood profiles of Dengue patients
- Find more attributes that make it easy to identify dengue phases and severity of dengue.
- Add those attributes to increase the accuracy of the system. Increase the accuracy by fine-tuning the cases.
- Verify the different cases and the stages for prediction.

1.7 ~~Include the~~ Proposed Solution.

The solution for this scenario is to implement a system which can be access from anywhere. In the system, blood profile and other details should be able to insert to the system and after that system will decide in which phase dengue patient is and suggestions of treatments which has

to be given to the patient. Some parameters should be inserted hourly and some are daily. All these data will be saved on a database. In each insert or any other time user can check the status according to the given previous data of the patient and the treatments which should given according to the condition. In this case these treatments are only suggestion until the medical advices are received.

1.8 Structure of the Thesis.

Structure of the thesis is as follows. First chapter addresses the introduction of dengue epidemic; how it causes, how it has been spreaded, what are the countries which has been effected. It also address the research problem, research questions and objectives,

scope of the study and proposed solution. Second chapter is devoted for critically reviewed literature related to dengue virus, case base reasoning methods on other reachers, and on other related studies. Third chapter was about technology adupted. It address the what are the datamining techniques are used and langues used in implementing this system. Fourth chapter is about methology of the project. In fifth chapter the design phase is addressed. Users guide line are included here. Chapter six is evaluation and chapter seven express the future work of this project. This is the structure of the thesis.

CHAPTER TWO

LITERATURE REVIEW

2.1 Chapter Introduction

This chapter is about the literature which was supported to this research. Dengue is a significant problem in Sri Lanka and as well as all tropical and sub-tropical regions around the world. Data mining techniques have been started to use for Dengue diagnosis.

2.2 Case-Based reasoning for diagnosis

Case-based reasoning has been used widely in resolving many problems. For example, a case-based expert system prototype for supporting the diagnosis of heart diseases is a system which was developed by the Computer Science Department, Faculty of Computer & Information Sciences, Ain Shams University in 2005. In this research, 110 cases were examined on four types of heart diseases, which are mitral stenosis, left-sided heart failure, stable angina pectoris and essential hypertension.[12]

CBR is a proper method for all medical domain approaches. The reasons for that fact are cognitive adequateness, explicit experience, the duality of objective and subjective knowledge, automatic acquisition of subjective knowledge, and system integration. “CBR presents an essential technology of building intelligent CBR systems for medical diagnoses that can aid significantly in improving the decision making of the physicians.” [13]

2.3 Current methods for Dengue detection

The main vital signs and blood profiles which are related to the dengue patients are blood pressure (BP), Pulse pressure, heart rate (HR), body temperature (BT), Packed Cell Volume (PCV), platelet (PLT), urine output and fluid intake rate, Hematocrit (HCT), platelet (PLT) and white blood cell (WBC) are the components of the full blood count test. The virus that is caused to dengue fever is in blood. After infection, the patient may suffer from high fever. Dengue can cause diagnosis by detection of dengue virus NS1 antigen and immunoglobulin M (IgM)/IgG antibodies. Wi-Mo [3] system is a monitoring system which is used of dengue patients. It’s just and monitoring system that monitors and records several parameters such as temperature,

blood pressure, pulse rate, Spo2, and ECG. The system is implemented with sensors which can get the above-mentioned parameters from the patient. It records the parameters every 10 minutes. In this system, there is no data mining method used to identify or analyses the severity or any phase of dengue. The main advantage of this system is, doctors can access remotely to patients' details and give instructions to nurse or anyone nearby. Furthermore, this system is not considering the PCV, PLT and WBC.

2.4 More related work.

Another research is done on, Performance Comparison of Artificial Neural Network Models for Dengue Fever Disease Detection [4]. Variables considered in this research are, Fever, Nausea, Vomiting, Diarrhea, Black Fesses, Headache, Pain Abdomen, Muscular Pain, Red Spots, Spontaneous Bleeding. The study compares five neural network models which named Gradient Descent, BFGS Quasi-Newton, Conjugate Gradient Descend, Resilient Backpropagation, and Levenberg Marquardt. The comparison has done in terms of Mean Square Error (MSE), Training Speed Based CPU Time, Accuracy Based Accuracy, Sensitivity, and Specificity, Training Speed Based Epoch. From all five, Levenberg Marquardt has gained the most successful results. Even in this research, main factors such as platelet count, Packed Cell Volume and white blood cell count have not addressed.

A preliminary dengue fever prediction model based on vital signs and blood profiles [5]; research was used to find the severity of the dengue infection. Decision tree, Discriminant analyses, support vector machine, nearest neighbor classification, ensemble classifier are the model types that has been used. This system has used wide range of attributes and the result of three categories. Blood pressure (BP), heart rate (HR) and body temperature (BT), hematocrit (HCT), platelet (PLT) and white blood cell (WBC) are the variables. Except fluid in and out, all the main parameters were used in the system. But the accurate of the system was roughly 50%. The main reason for the lower accuracy was the smaller number of cases and missing data in the dataset.

Decision Support System for Malaria and Dengue Disease Diagnosis (DSSMD)[10] is a study that has done by ITM University, which has used the fuzzy logic method to differentiate dengue and malaria by using non-clinical symptoms. The following are the non-clinical symptoms, which has taken in analysis.

- Fever
- Joint pain
- Muscle pain
- Pain behind eyes
- Skin rash
- Loss of appetite
- Nausea and vomiting
- Headache
- Convulsion
- Bleeding
- Sleepiness
- Temperature
- Yellowish
- Cold hot and sweating

In the study, the graphical user interface has built to enter the symptoms, and the results will show as to whether the patient is a dengue patient, malaria patient or how much bias to dengue or malaria. The accuracy of this system was 91.3%, and in this, nothing has specifically discussed on dengue severity or dengue phases.

The spectrum of liver dysfunction in patients with dengue infection and the markers of severe disease [8] is a study which has done using 281 dengue patients. The main focus of this study was to analyze the liver enzymes, which are released from the liver when the liver cells are damaged. SGOT (serum glutamic oxaloacetic transaminase), SGPT(serum glutamic pyruvic transaminase), Albumin, Bilirubin, and INR(international normalized ratio) are the parameters taken to undergo the analysis. According to this study found that 100% of patients had an elevated SGOT, and 91% had elevated SGPT among patients with dengue.

The patients were classified as dengue fever, dengue hemorrhagic fever and dengue shock syndrome and then compared the parameters. Conclusions of the study were all patients with a rise in SGOT significantly more than SGPT. Preferentially high SGOT may serve as an early indicator of dengue infection. In contrast, high values of bilirubin, SGOT, SGPT, ALP and INR may be an indicator of severe disease and poor prognosis.

Primarily what is essential in this study is, SGPT and SGOT values can be taken as measurements of dengue severity.

Case-Based Reasoning for Diagnosis of Disease Caused by Dengue Virus [11] is study which has built a system to diagnosis of the disease caused by the dengue virus using CBR. Here they have used two case-based reasoning methods, Bayesian model for the process of indexing and Nearest neighbor to the similarity. At the end of the study, they have obtained results as by using a Bayesian model of value sensitivity 88.89 % and 95.56 % accuracy and result by using a Nearest Neighbor of value sensitivity 98.14 % and 99.25 %. In this study, no interest has been put to any clinical or non-clinical parameters.

2.5 Chapter Summary

This chapter discusses the previous researcher's, which has been done on the Dengue diagnosis and other research's which has been done on Dengue virus. There are more studies which have been related to this study directly.

CHAPTER THREE

TECHNOLOGY ADAPTED

3.1 Chapter Introduction

Chapter three included technology used to implement the system. Also, this chapter will address all the software's and software tools which were used to build the application.

3.2 Case Base Reasoning

Case-based reasoning (CBR) is an experience-based approach to solving new problems by adapting previously successful solutions to similar issues. It is an automated decision-making process whereby we solve issues through the experiences we have accumulated in solving previous ones. Case-based reasoning is an excellent method to apply when a situation that requires diagnosis, prediction, classification or recommendations.

This is achieved by accumulating data to build a model of understanding of a problem we are trying to solve. By storing the conditions of problems and the actions taken at that time, we establish a collection of rules that dictates, when in each -situation, we have one or more actions to resolve it. The system then focused on recognizing the similarity of new problems to existing ones, but also how to manage that collection of accumulated data. Case-based reasoning is structured as a four-step process, sometimes referred to as the 4R's.

- Retrieval
- Reuse
- Revision
- Retention

Each of these phases either interacted with the collection of cases, either editing this collection or retrieving actions from it to make. This means that the case collections are continually being revised as the system is being searched for appropriate actions based on the current situation. The system will be updating it to highlight whether a particular case proved useful in a given context as well as adding a new case when it seems clear that the current situation has minimal relation to anything we have already stored.

Retrieval is the process of finding a case that like our current situation or state. This relies on an ability to access any two states based on their applicability.

Reuse is when we retrieve a case and propose it as a proper action to apply in our current states.

Revision is when we evaluate through a series of metrics or simulation how well the proposed action will perform and whether it is practical to apply in the particular case were in.

The last retention is applied after a successful execution by storing the result of this experience in memory.

This 4R methods provide a decision-making system that can generalize its previous experiences, allowing you to apply decisions make in similar but not identical circumstances to new situations.

3.2.1 Comparison to other techniques

Case-based reasoning has several differences from other AI approaches, such as knowledge-based systems (KBS). Rather than relying entirely on general knowledge of a problem domain or making associations along with generalized relationships between problem descriptors and conclusions, CBR employs the specific knowledge of previously experienced, concrete problem situations. CBR also offers incremental, sustained learning in that each time a problem is solved a new experience is retained and can be applied for future issues.

3.2.2 Advantages and disadvantages of CBR

Scientists cite both advantages and disadvantages to CBR. On the plus side, remembering past experiences help learners avoid repeating previous mistakes, and the reasoner can discern what features of a problem are significant and focus on them.

Further, CBR is intuitive because it reflects how people work. Because no knowledge must be elicited to create rules or methods, development is more manageable. Another benefit is that systems learn by acquiring new cases through use, and this makes maintenance easier.

CBR also enables the reasoner to propose solutions to problems quickly. The reasoner can offer solutions in areas that he or she does not fully understand, evaluate solutions when no algorithmic method is available and interpret open-ended and ill-defined concepts.

On the negative side, critics claim that the main premise of CBR is based on anecdotal evidence and that adapting the elements of one case to another may be complex and potentially lead to inaccuracies. However, recent work has enhanced CBR by using a statistical framework. This makes it possible to produce case-based predictions with a higher level of confidence.

3.3 GUI.

Model view control (MVC) is a commonly used software design pattern to develop a graphical user interface.[15] In this design, programming algorithms, user interface views, and database handling have been separated. The one most important advantage of this design is the easiness of maintenance. Another advantage is most of the popular programming languages are supported with this designing method. Even several languages can be combined.

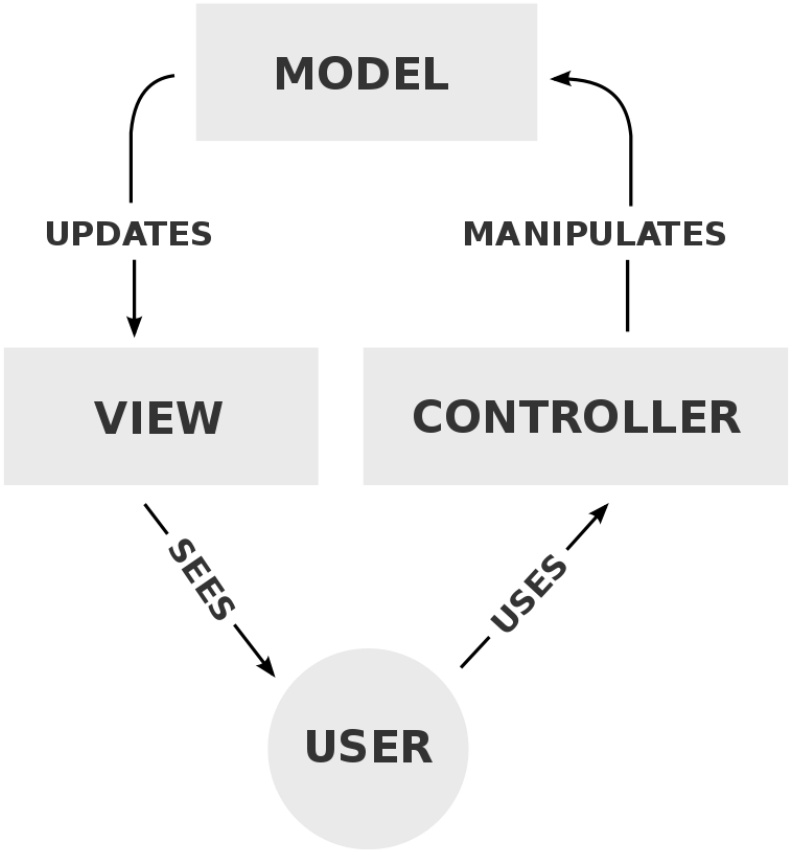


Figure 3.1 : User interactions within the MVC pattern.

3.4 Languages used.

The system is a web-based system. HTML is used as the markup language for each view, and CSS is used to decorate the web pages. C# and Javascrip languages are used for the

algorithms. By using HTML helper tags can reduce the amount of tedious typing of HTML tags that must perform to create a standard HTML page.

3.5 Microsoft SQL Server Database Microsoft

SQL Server is a relational database management system developed by Microsoft as a database server, which is a software product with the primary function of storing and retrieving data, requested by other software applications that may be on the same computer or on different computers, on the same computer or another computer.

3.6 Entity Framework

Entity Framework is an Object Relational Mapper (ORM), a tool to simplify mapping between tables in your software, tables and columns in the relative database.

Enhancing the excess work of the application processing data by increasing the productivity of the Entity Framework. The synthesis framework has a more detailed map template, and you can customize the map, for example, by mapping one unit to multiple single-table aliases or multiple units in a single table. The synthesis of the LINQ engine by the engine generates SQL commands. It remembers the changes in objects for remembering

3.7 Chapter Summary

The main method used here is Case Base Reasoning. The chapter has a detail of Case Base reasoning. How it is done, the steps and advantages and disadvantages are mentioned in the chapter. Also, this chapter explains the software designs and languages used.

CHAPTER FOUR

METHODOLOGY

4.1 Chapter Introduction

In this chapter it discussed, what are the improvements that has been done to the previous system. Previous cases and fine-tuned new instances will be compared with various parameters. There were several errors in the algorithms used in the previous system. Those has been mentioned and corrected. Those also will be addressed here.

4.2. Cases

There were six main cases. And all these has rules which when the relevant case will occur. The cases and rules are mentioned below.

1. Dengue Fever Phase

• WCC is decreasing

• Platelets count is not decreasing than 150,000

2. Early DHF Phase

• Platelet count is decreasing but above 100,000

• White Cell count is decreasing

3. Possible of leaking Phase or the critical stage

• Platelet count is less than 100,000

• White Cell Count (WCC) is increasing after decreasing.

4. Critical Phase (Leaking Phase)

• Platelet count is decreasing than 100,000 or maintaining below 100,000

• White Cell Count (WCC) is increasing

• Pulse pressure is less than 30

• Increasing the PCV

• UO is decreasing

• Capillary refilling time is more than 2 seconds

5. Bleeding Phase

• Pulse pressure is decreasing

• PCV is decreasing (20%) or static (in the period of PCV should increase)

• Capillary refilling time is decreasing

• Urine Output is decreasing

6. Recovery Phase

• Platelet count is increasing by 5000

• Urine Output is increasing

• Stabilization of PCV

If these were represented using a tree diagram, it would show likes below.

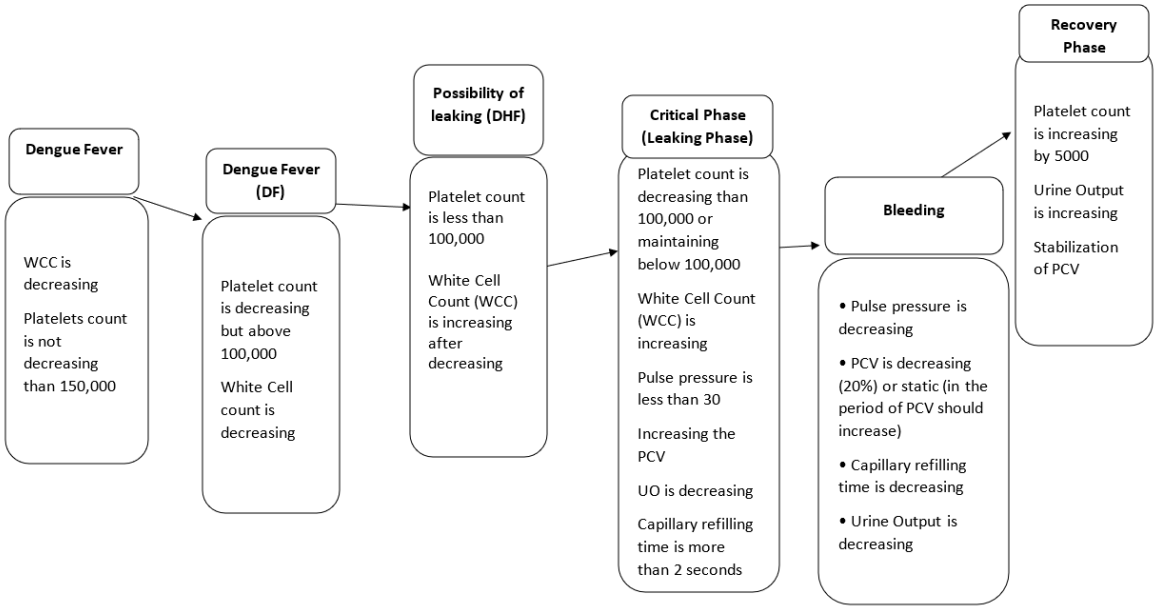


Figure 4.1 : Tree Diagram of the previous system

4.3 Recovery phase differences in new study.

According to the previous study, the cases are straight forward. It looks like to get recovered from the illness patients must undergo all the stages. But that is not true. The patient may fall into the recovering phase from any main phases over here. A patient may go through all these stages, and at last, the patient will recover, or else the patient may recover from the first phase. It depends on the immune system of the patients. In the new study, the recovering phases from each stage have been addressed and shown in the tree diagram properly.

Furthermore in the previous study, in the recovering phase, if the platelet count increases from 5000, is taken as a sign of recovering, but according to the new research the value 5000 is removed because there were several cases where platelets were increases more than 5000 at some instances, but after some time again it decreases. Comparison of recovering phase in the previous study and the new study is shown below.

Table 4.1 : Comparison of Recovering phase

Previous Study	**New Study**
Platelet count is increasing by 5000	Platelets significantly increasing from lower level. It may go higher than upper limit of normal.
Urine Output is increasing	WCC – Increasing or static
Stabilization of PCV	PCV decreasing and stabilizing
	Urine output increasing
	Capillary refilling < 2sec
	Pulse may decrease significantly, sometimes bradycardic.

4.4 New parameters added

The previous study has looked into following attributes of the blood profile.

- Platelets
- White blood cells
- Pulse pressure
- Packed cell volume
- Urine output
- Capillary refilling time

In the new study, two more parameters are added. Those are Serum Glutamic Oxaloacetic Transaminase (SGOT) which is known as aspartate aminotransferase (AST) and Serum Glutamic Pyruvic Transaminase (SGPT) also known as alanine aminotransferase (ALT). These are enzyme in the blood which vary according to the functionality of the liver. If the liver is working fine, there will be significantly less amount of these enzymes in the blood, and it increases when the liver cells start failing. Healthy persons SGOT and SGPT values are shown below.

Table 4.2 : SGOT, SGPT Normal Ranges.

Type of enzyme	Range
SGOT	5-40
SGPT	7-56

One study shows these enzymes can predict the severity of the patient. The study was followed India, 281 patients were tested and analyzed the data to find the variations of enzyme according to the severity of the dengue.[8] Mainly following data was gained.

Characteristic	Disease			DF vs DHF	DF vs DSS	DHF vs DSS
	DF	DHS	DSS	p value	p value	p value
No of Patients	248	21	12			
Mean SGOT(U/L)	218.528	1747.762	8519.083	0.008	0	0
Mean SGPT(U/L)	125.805	856.429	2777.583	0	0	0
Mean S.Albumin(gm%)	3.735	4.01	2.65	0.704	0.248	0.237
Mean Bilirubin(mg/dl)	0.78	2.01	2.69	0	0	0
Mean INR	1.25	1.449	2.19	0	0	0

According to the values, one point is clear. When the severity of the dengue is higher, the level of enzyme increases in thousand from the typical values.

4.5 New phases added

4.5.1. Dengue shock syndrome

Dengue shock syndrome (DSS) is one of the severe phases of dengue disease. This comes under the category of DHF. The main parameter to identify the DSS is pulse pressure. If pulse pressure is getting lower than 20, a probability that leads to dengue shock syndrome phase will take higher value. Other parameters that are following will provide a stronger identification of DSS.

- Reduced pulse volume or impalpable
- Increasing PCV

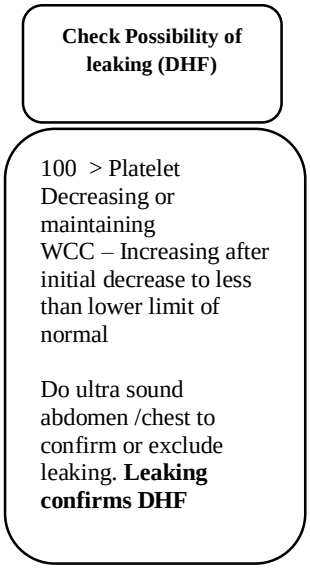
  Urine output is less than 0.5ml/Kg/hr or nil
- Capillary refilling > 2sec
- SGPT and SGOT increasing

4.5.2. Liver cell necrosis

This would lead to liver cell necrosis if the liver enzymes increased in thousands. If the case gets more severe, the liver will fail to function, and it may lead to death. When a patient gets into DHF it is crucial to monitor those patients closely.

4.5.3 Intermediate phase between DHF and DF

Leaking is another good parameter to differentiate DHF and DF. Undergoing an ultra-sound scan is the best method to check where it is leaking or not.



The above stage is an intermediate stage between DF and DHF. At this stage patient should under the ultrasound scan. If the result is positive, the patient falls into DHF and is the result is negative that the patient falls into DF. In an ultrasound scan, the result will mention the level of leaking. According to the levels, the severity of leaking can be understood.

If a patient leak in DHF phase and then start recovering, still that patient is in risk. When the leaked fluid gets reabsorbed into the intravascular compartment, the extra fluid will be removed in the urine. However, if there was a large volume of fluid reabsorbed and kidneys are unable to remove it rapidly, the intravascular compartment will get overloaded, leading to congestive

cardiac failure. Reduction in fluid intake and diuretic (frusemide) is useful. Those types of patients should monitor very carefully until they get fully recovered.

4.6 Total fluid quota

In the critical period of the dengue the fluid which is given to the patient should be monitored and controlled. There are several rules to follow when the total fluid is calculated. The following details show how the total fluid which should be given to the patient is calculated.

Calculation of total fluid quota for the critical period

M (Maintenance) = 100ml/kg for first 10 kg

+50 ml/kg for next 10 kg

+20 ml/kg for balance weight

5% of body weight = 50ml x body weight (kg)

E.g. Body weight 22 kg (This is the ideal or actual body weight, whichever is smaller)

M = 100 x 10 + 50 x 10 + 20 x 2 =1540 ml 5% = 50 x 22 =1100 ml M + 5% = 1540 + 1100 =2640 ml

Note: The maximum weight for which fluid is calculated in any patient should not exceed 50 kg. Accordingly, M+5% should not exceed 4600ml in any patient.[6]

4.7 Ideal Bodyweight

When calculating the total fluid quota for a patient, the ideal weight is one of the main parameters. Ideal body weight is the optimal weight associated with maximum life expectancy for a given height.[9] In the previous study, this was not correctly added, and it was kept as user input. Letting the user input such a calculative parameter is not practical. In the new system, it has been calculated automatically when you enter the height.

BMI or body mass index is used here to calculate the ideal weight of a patient. According to the BMI values, patients can be categorized into the following categories.

- Underweight: BMI is less than 18.5
- Normal weight: BMI is 18.5 to 24.9
- Overweight: BMI is 25 to 29.9
- Obese: BMI is 30 or more

In this case, ideal weight is related to normal weight. Hence the BMI value should be a range of 18.5 – 24.9. In the system, an average has been taken from this range, and it has been taken as the BMI value.

BMI value = (18.5 + 24.9)/2

= 21.7

And this value has been rounded off to 22

Then the ideal body weight is calculated using this BMI value by substituting the following equation.

Ideal Body weight = BMI value (for ideal body weight) x Height^2 mtr

In the new system, the user does not need to calculate and enter the ideal body weight. As soon as the height is entered, ideal body weight will be automatically generated.

CHAPTER FIVE

ANALYSIS AND DESIGN

5.1 Chapter Introduction

This chapter shows the design aspect, which is built in the research. This chapter will show the method of how to use the system and what is the problem in the previous system and what has been solved up to now.

5.2 Overciting Problem in suggestions.

In the system, after the details are given, the user can press a button and get the relevant suggestions for the patient. There was a bug in the system. The suggestions were overrating again and again. For an example if we looked at the patient A and then looked at the patient B, suggest for the patient A and B both will be appearing there hence the correct suggestions will not be able to find properly. The following image shows the situation.

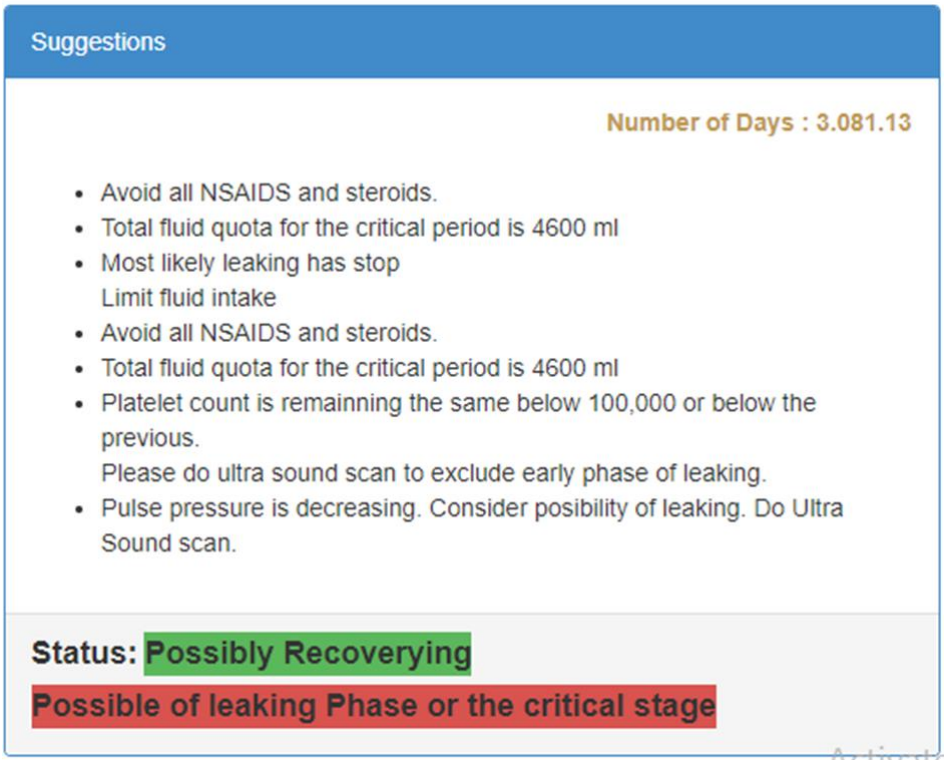


Figure 5.1 :Overciting in previous system

This issue was solved, and now the system does not oversight the suggestions.

5.3 Algorithm to find the Total fluid quota.

According to the given equations, the total fluid quota should be measured properly and should give the patient hourly. To find this amount of water, an algorithm was generated. For the algorithm, the weight is the only input. Then the total fluid quota will be generated from that algorithm.

```
if (weight < 50){
        if(weight < 10)
        {totalFluid = weight*100;}
        else
        {totalFluid = 1000;}
        if(weight > 10 && weight < 20)
      {totalFluid = totalFluid + (weight-10)*50;}
        else if(weight > 20)
        {totalFluid = totalFluid + (weight-20)*20 + 500;}
        totalFluid = totalFluid + weight*50    }
       else{
        totalFluid = 4600;}
```

5.4 Navigation for the system.

5.4.1 Home page

The previous system did not have a proper navigating system. Navigating is updated in the new system.

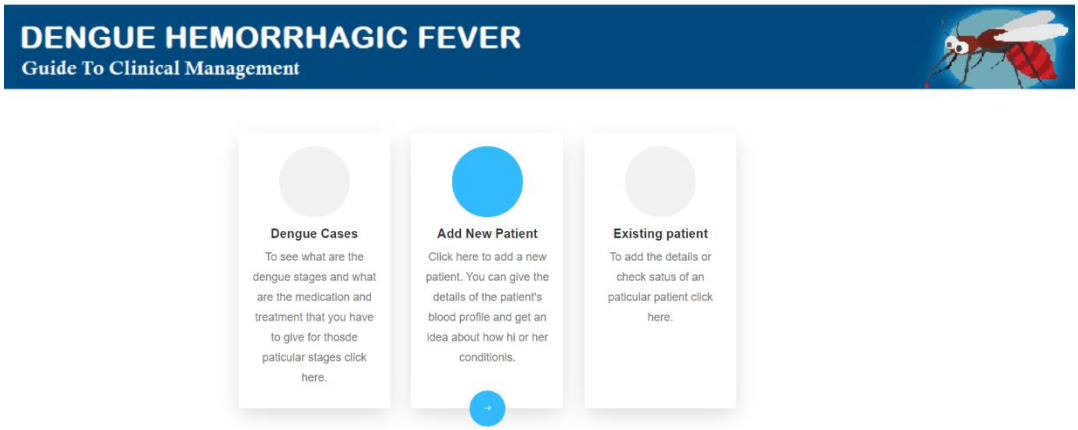


Figure 5.2 :Home page

The system will first deliver this page. From there, the user can navigate to three pages. To add a new patient, or to check details and get suggestions about the Existing patient, or at last to see the cases and all the rules in those case.

5.4.2 Rules and Cases.

This html page has been added to give information about dengue cases and rules. Any user who has no idea about the disease can get a slight idea about the systems, parameters which will change on each phase.

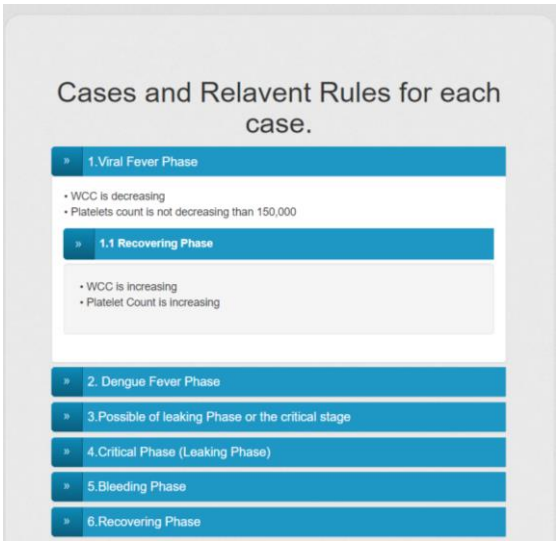


Figure 5.3 : Cases and Rules

5.4.3 Add new patients.

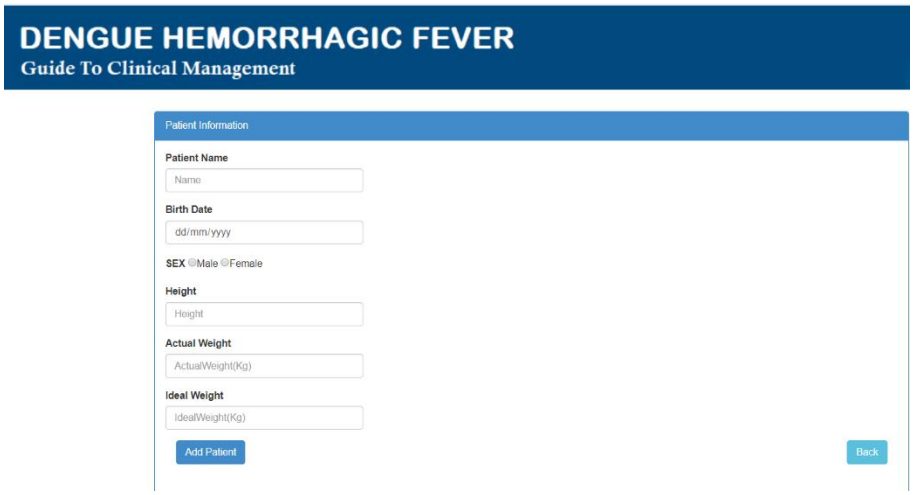


Figure 5.4 : Add patient

From this page, user can add a new patient to the database. Over here, ideal weight will be filled automatically when the height of the patient is inserted.

5.4.4 Existing patients

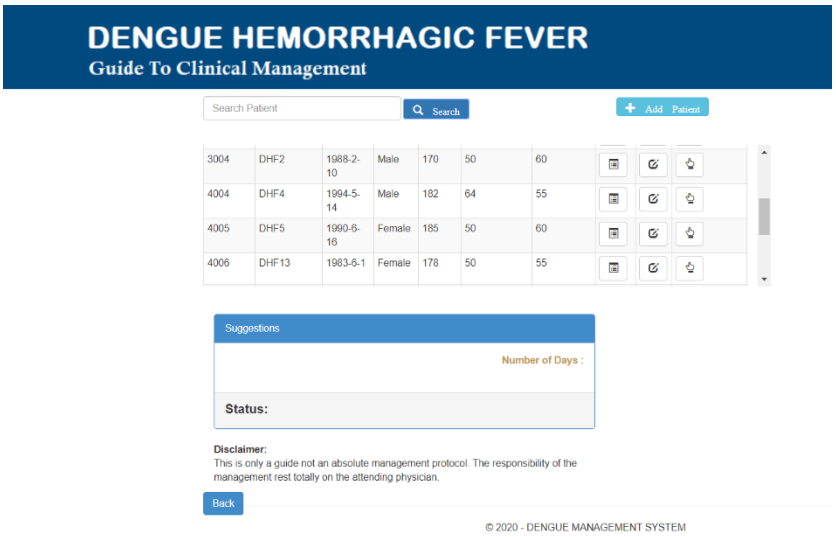


Figure 5.5 : Existing patient page

In this page, you may see all the patients, as well as the newly added patients, or else the user can search for a patient by name.

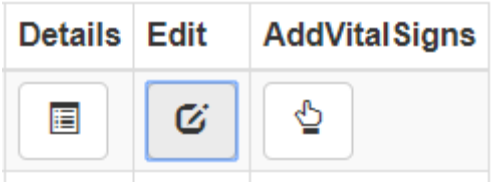


Figure 5.6 : Buttons in patients table

From the “Details” buttons, the user can take decisions according to the relevant patient. It will show the phase of the patient as well. From the “Edit” button user can edit the previously added data. An at last from “AddVitalSign” button user can add vital sings to relevant patient. The page which will redirect when “AddVitalSign” button clicked is shown below.

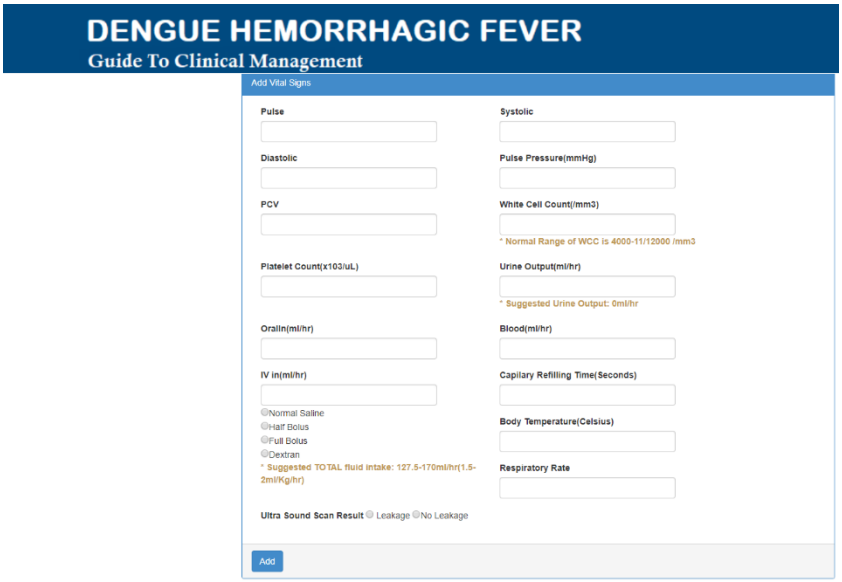


Figure 5.7 : Add Vital Sings

5.5 Chapter Summary

This chapter shows the algorithm to calculate total fluid quota and also address the issue which was being faced when the system is running.

CHAPTER SIX

EVELUATION

6.1 Chapter Introduction

The previous chapter was about analysis and design and this chapter about the evaluation. It will explain what the outcomes of this system are and how accurate this worked. What are the testing methods which are used and what are the resulted outcomes has given to each respected dengue phase.

6.2 Evaluation

In the evaluation process, a sample set of data was collected and feed into the system. All the data were gathered from the Centre for Clinical Management of Dengue and Dengue Hemorrhagic Fever at District General Hospital, Negambo. Data were inserted and checked the correctness of predations given from the system. The data was first divided its true category. One by one were inserted first to check the prediction first. From that, the accuracy level of giving the correct prediction was calculated for each dengue phase. Then randomly selected data were inserted to the system accuracy was calculated. Server application was hosted in localhost and Client and server with the same machine is used to test the user interface stability and to check the outputs were correct.

Table 6.1 : Actual and Predicted Results

	Number of actual results	Number of correctly predicted results	Each phase accuracy
Viral Fever Picture	15	15	100%
Dengue Fever (DF)	12	12	100%
Check Possibility of leaking (DHF)	11	8	72%
DHF	13	7	53%
Dengue Shock Syndrome	8	6	75%
Recovery Phase	14	8	57%
Cardiac failure during recovery	0	0	
	73	56	

According to the results, the accuracy of the system is 76% there was not any cardiac failure patient on the data set. Hence the accuracy may have differed when those data has been added. Several types of testing methods have been used in this process. The unit test was the main method used.

Here we can see check possibility of leaking, DHF, and recovery phase has low accuracy. When looking at the recovery phase the identification of this phase is little bit harder. in the system rule which is given for that phase is “if platelet count is increasing more than 5000 the patien is on recovering phase, but there are significant amount of patients where the amount of platelet has been increased by 5000 and after few hours it agin the platet count has been decreased. Hence those patients were not in recovery phase.

“Check Possibility of leaking” and “DHF” is matter of leaking. If the patient is leaking then patient falls in to “DHF” and if not “Check Possibility of leaking” phase. Actually “Check Possibility of leaking” phase is a intermediate phase. If the rules are met for “Check Possibility of leaking” phase, the system is propting a suggestion to do ultra sound scan. If the scan is positive of leaking patient falls in to “DHF”, and if it is negative patient falls in to “DF” phase.

CHAPTER SEVEN

DISCUSSION AND FUTURE WORK

7.1 Chapter Introduction

Chapter six focuses on future work and the conclusion which has to undergo in this project. What are the things that can be added to improve the system, where and what aspects the system should be changed to improve the accuracy and speed of the system.

7.2 Discussion

Word does not have a system to recognize a critical phase in the early stages. Early detection of critical phase and its minor cases will secure many lives. Around the word a large number of patients are dying because of dengue disease, and the main reason is not identifying the correct phase of dengue and not managing the treatments. The outcome of the project which give a system to identify critical phase in its early stages and are giving suggestion to manage the treatments.

There are many regions where doctors who are specialized in dengue management are not available, in Sri Lanka as well as around the word. This system may help those areas to treat dengue patients until the proper medical help arrives. Even a normal civilian who can read can use this application and follow instructions. Current in Sri Lanka there is not any online or software which saves patient details in it. In hospitals, they only enter the details

7.3 Future work of the project

This research is mainly focused on NS1 antigen positive DHF patients. It is better if we can expand this system to DSS stage by identifying more cases and rules with more parameters.

When storing a large amount of data in the database, it can be slow. We can improve this by using indexes or any other database related techniques.

And the current developed system does not consist of enough validations and no login for the system. So, a system can be improved by applying User experience techniques with logins and validations.

These days mobile applications are popular, and everyone relays on them. This system has developed to as web-based solution, and this can be improved as a mobile application or web service. It will be portable, which makes the uses willingly use it.

Usually, in case-based reasoning, the previous case is the experience for the new one. In this system no previous cases were shown to the user. If the system can be developed to show a previous case which is similar to the new case which user just entered, with all the details, such as what type of medicine is given to the patient at that time, and what kinds of treatments have been given and what happened after those treatments, did the treatments and medicine worked or did it make worse, it will be beneficial for the user. For retrieve the previous similar cases for the new case, nearest neighbor or fuzzy logic methods or any other relevant method can be used.

If the system can be made globally available, and if the system allows all the uses to enter new cases, the system will get a great number of cases. Then by training all these test cases and clustering the cases into significantly different cases will enhance the accuracy of the system. In the system that we have now does do not have any clustering according to age, gender, country, or any other category and analyze the data; hence there were not enough data. But when the system is globally available, and users can enter cases, this problem will be solved.

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Appendix A

Pseudocode

Condition 1 : If there is only one record.

{

Avoid all NSAIDS and Steroids.

The fluid quota is XXX

If(Pulse Preasure =< 30)

{

-Suggest Normal Saline 5ml/Kg/Hr

}

}

Condition 2 :If there are more than one record.

If(Previos Platelet count > Platelet count Latest
AND

Previos PCV > PCV Latest
AND

Previos Pulse Preasure > Pulse Preasure Latest

AND

Previos urine output > Urine output Latest)

{

- Posibility of bleeding

- He or she may be bleeding

}

If(Previos white cell count > White cell count Latest
AND

Previos Platelet count > Platelet count Latest
AND

Platelet count Latest > 150)

{

- Dengue Fever phase

- Decreasing Platelets and white cell count

}

If(Previos white cell count > White cell count Latest
AND

Previos Platelet count > Platelet count Latest
AND

Platelet count Latest > 100)

{

- Early DHF phase

- Decreasing Platelets and white cell count

}

If(Previos Platelet count < Platelet count Latest)

{

If(Previos Platelet count - Platelet count Latest > 5000)

{

-Most likely leaking has stopped

-Limit the fluid intake

-Possibly Recovering

}

Else If(Previos urine output < Urine output Latest
AND
Previos PCV < PCV Latest)

{

-Most likely leaking has stopped

-Limit the fluid intake

-Possibly Recovering

}

}

If(Previos Platelet count >= Platelet count Latest
AND
Platelet count Latest < 100)

{

-Please do ultra sound scan to exclude early phase of leaking

If(White cell count 1 > White cell count 2
AND
White cell count 2 < White cell count 3)

{

-There is a chance of leaking

-From this point it is criticle for 48 hours

- Do close monitoring

If(Pulse Preasure < 30
AND
Previos urine output > Urine output Latest)

{
- Critical Phase

}

else

{

-Possible of leaking Phase or the critical stage

}

}

Else If(Previos white cell count < White cell count Latest)

{

If(Pulse Preasure < 20)

{

-Critical Phase (Leaking Phase)

-In critical phase and do close monitorin

}

Else If(Pulse Preasure < 30

AND

Previos PCV > PCV Latest

AND

Previos urine output > Urine output Latest)

{

-Critical Phase (Leaking Phase)

-In critical phase and do close monitoring

}

Else If(Previos Pulse Preasure > Pulse Preasure Latest)

{

-Pulse pressure is decreasing. Consider posibility of leaking. Do Ultra Sound scan

-Possible of leaking Phase or the critical stage

}

}

Else if(Previos white cell count > White cell count Latest)

{

-Decreasing WCC and decreasing Platelet count. Consider posibility of leaking. Do Ultra Sound scan

-Early DHF Phase

}

Else

{

-Early DHF Phase

}

}

Else if(Pulse Preasure =< 30)

{

If(IVin <= 5 * Actual Weight - 5 OR IVin <= 5 * Actual Weight + 5)

{

If(Previos PCV > PCV Latest)

{

If(Given IV Type = Normal Saline)

{

-Continue Normal Saline 5ml/Kg/Hr

}

If(Given IV Type = Dextran)

{

-Continue Dextran 5ml/Kg/Hr

}

}

Else

{

If(Given IV Type = Normal Saline)

{

-Increase Normal Saline to 10ml/Kg/Hr

}

If(Given IV Type = Dextran)

{

-Increase Normal Dextran to 10ml/Kg/Hr

}

}

}

Else If(IVin <= 10 * Actual Weight - 5 || IVin <= 10 * Actual Weight + 5)

{

If(Previos PCV > PCV Latest)

{

If(Given IV Type = Normal Saline)

{

-Continue Normal Saline 5ml/Kg/Hr

}

If(Given IV Type = Dextran)

{

-Continue Dextran 5ml/Kg/Hr

}

}

```
        Else
        {
        If(Given IV Type = Normal Saline)
        {
                -Increase Normal Saline to 10ml/Kg/Hr
        }
        If(Given IV Type = Dextran)
        {
        -Increase Normal Dextran to 10ml/Kg/Hr
        }
        }
        }
}
```