

Framework for Early Diagnosis of Waterborne diseases with similar symptoms

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Abstract

Medical diagnosis is a complex procedure which heavily depends upon the expertise and availability of the practitioner. Mortality rate of human being affected by waterborne diseases though is reducing over the past decade, still is considerable enough to make it a global concern. The symptoms associated with various water borne diseases overlap with each other which causes confusion, an early and effective diagnosis would help healthcare organizations to provide efficient patient care. An expert system would facilitate in this process by providing inference with the symptoms collected. The Expert System will act as a tool of assistance for the medical experts in identifying the disease based on the symptoms specified by the patients.

Keywords: Water borne diseases , rule based expert systems CLIPS, symptoms, knowledge base, facts, rules.

I. INTRODUCTION

In developing countries major illnesses are a result of water-borne diseases, with diarrhea being the frontrunner causing child deaths. [7] The symptoms of many waterborne diseases like dengue, malaria are similar to an extent and can cause

confusion during diagnosis. The early diagnosis of these diseases is a major concern to physicians and health bodies. According to WHO the child deaths due to waterborne diseases can be easily prevented through timely diagnosis and hygiene. [8] Due to the economic, climatic, geographic conditions of the developing countries the availability of medical aid to vast population is not easy task. The crunch in availability of health officials at government led medical institutions makes early diagnosis a major problem. [10] The spread of these diseases are rapid and can create panic in people. The need for an accurate and appropriate diagnosis is pivotal.

To ensure that these diseases do not increase the mortality rate an effective and efficient system should be in place to assist the health officers. [11] One of the important characteristic of a health care system is to provide efficient mechanism to reduce the suffering of patients. This involves reduction in diagnosis time and control on costs incurred in providing it. The process of medical diagnosis is complex and requires expert information to facilitate the process. The various pathological process required to identify the waterborne diseases consumes time and requires expertise. Due to shortage of experts, medical practitioners are under constant pressure. Lack of experience is also a concern.

Inexperienced practitioners might find early diagnosis and effective treatment difficult to achieve. An expert system would provide significant help to these practitioners, to make a degree of difference in their diagnosis procedure. Expert systems would reduce the costs and also improve the treatment procedure by giving inference based on the symptoms. There are many expert systems which have addressed to individual diseases but have not taken into consideration the overlapping symptoms among the various water-borne diseases. [6]

There is an essential need to provide an expert system which would give an inference about the type of waterborne disease, considering the similarities in symptoms of the various diseases in this category. This can be achieved by amalgamation of technical and medical knowledge. This paper tries to provide a framework for modeling the diagnosis done by physicians. [9]

II. WATERBORNE DISEASES

Water-borne diseases are diseases infected as a result of drinking water polluted by human or animal wastes, which contain pathogenic microorganisms. [12] A detailed scenario of water-associated diseases is complex to present because of number of reasons. Over the past many decades, the scenario of water-related diseases has become increasingly comprehensive, with the emergence of many modern infections related to waterborne diseases and the re-emergence of diseases already known to the world. [13] The major challenges of waterborne diseases are the difficulty in classifying or identifying which is the particular disease the patient is suffering since most of the symptoms remain to be same for most of the waterborne disease.

TABLE I: Mortality Rate in 2015

WHO Regions	Malaria	TB	Cholera	Dengue
African	394200	450000	70706	3200000
South East Asia	34874	460000	63807	1600000
Eastern Mediterranean	9964	88000	34000	320000

Above table presents the mortality rate due to different waterborne diseases in the year 2015 of different regions. [16]

The global scenario of water and health has very strong local measurable impact with some 1.1 billion people still not getting access to drinkable water sources and some 2.4 billion people to satisfactory sanitation. Presently we have very strong proof that sanitation, water and hygiene-related diseases estimate for 2,213,000 deaths annually. [14]

To ensure that the diseases do not increase the mortality rate a practical and regimented system should be in place to assist the health officers. Most waterborne diseases result into diarrheal problems. 88 percent of cases related to diarrhea all over the world are as a result of unsafe water, not sufficient sanitation or not adequate hygiene, because of this 1.7 million deaths are reported each year, mostly in small children. The common cause of death is dehydration. [15]

III. MEDICAL EXPERT SYSTEM TYPES

The expert systems are the systems developed to solve problems with complexity in a specialized domain, at the position of high level of human intelligence and acting as highly expertise. It knows how to and where to apply the stored knowledge effectively and efficiently.

Expert Systems can be classified into; rule based, known as rule-based expert systems, and those that based on the theory of probability and graphical models, often called probabilistic expert system. Rule-based systems, evolved from the work of Buchanan and Shortliffe on the MYCIN system, aim is to capture human expertise in terms of rules of the form of if condition then action. There is strong evidence that establish that this rule is capable of broadcast human thought process. A bunch of rules can be used to store in a expert's relevant domain knowledge and can then be used to make the system behave like expert's problem solving in that domain.

There are different types of expert systems, each meant to perform specialized tasks like interpretation, prediction, diagnosis, design, planning, monitoring, repairing, debugging, repair, instruction and control.

Fuzzy Based

A fuzzy expert system is an expert system that makes use of fuzzy based logic instead of Boolean logic. In simple words, a fuzzy expert system is a collection of functions and rules that are used to reason about data. Unlike traditional expert systems, which are basically symbolic reasoning engines, fuzzy expert systems are mainly focused towards numerical processing. [17]

Fuzzy logic is basically a multi-valued logical system which allows in between values to be defined between conventional evaluations. Facts like very warm or very cold can be formulated in mathematical way. In a way an attempt is made to implement a more human-like approach of thinking in the programming of computers. Fuzzy based way to modelling is based on verbally stated rules mixed throughout the parameter space. [18]

Rule Based

Rule-based systems are the common form of artificial intelligence. A rule based system as the name suggests makes use of rules as the knowledge representation for coding the knowledge into the system. The meaning of rule-based systems based almost on expert systems, which are system that acts as human expert in giving solution to a knowledge used problem. Rather than depicting knowledge in a declarative and static way as whether true or false, rule-based system represent knowledge in terms of a particular set of defined rules that suggests what actually to do or what to infer in a particular given situation. [19]

IV. EXISTING SYSTEMS

Providing timely and due attention has to be provided medical problems. Due to non availability of medical resources diagnosis and treatment of diseases get delayed. In an effort to take care of such problems, many researchers have drawn outline and constructed expert systems which will give suggestions for doctors and people coming for treatment [2]

It has been found out that of late restorative application particularly, on conclusion of some heart sicknesses has been quickly expanded on the grounds that its significance and adequacy to identify ailments and arrange patients. It has been shown the outline of a specialist framework that plans to give the patient with foundation to reasonable analysis and treatment.[3] The proposed strategy is made out of four phases. The primary stage is accepting the indications from the patient. The second stage is asking for from the patient to make some examination and examination to help the framework to settle on a right choice in the analysis. The third stage is doing determination of patient as indicated by data from patient (manifestations, examination and examination). The four phase is deciding the name of fitting solution or what ought to be done until the patient recoups (step treatment), so this framework can give suitable analysis and treatment for two heart illnesses to be specific; angina

pectoris and localized necrosis. There are a few projects utilized for finding and framework examination, such as CLIPS and PROLOG] [3]

There are many skin infections having comparative side effects, along these lines, the most imperative goal keeping in mind the end goal to endorse the suitable treatment - is the correct conclusion of the ailment. In this paper the outline of the proposed Expert System which was created to help dermatologists in diagnosing a portion of the skin infections are introduced, a review about the skin infections are shown, the reason for illnesses are sketched out and the treatment of ailment at whatever point is conceivable is given. [4]

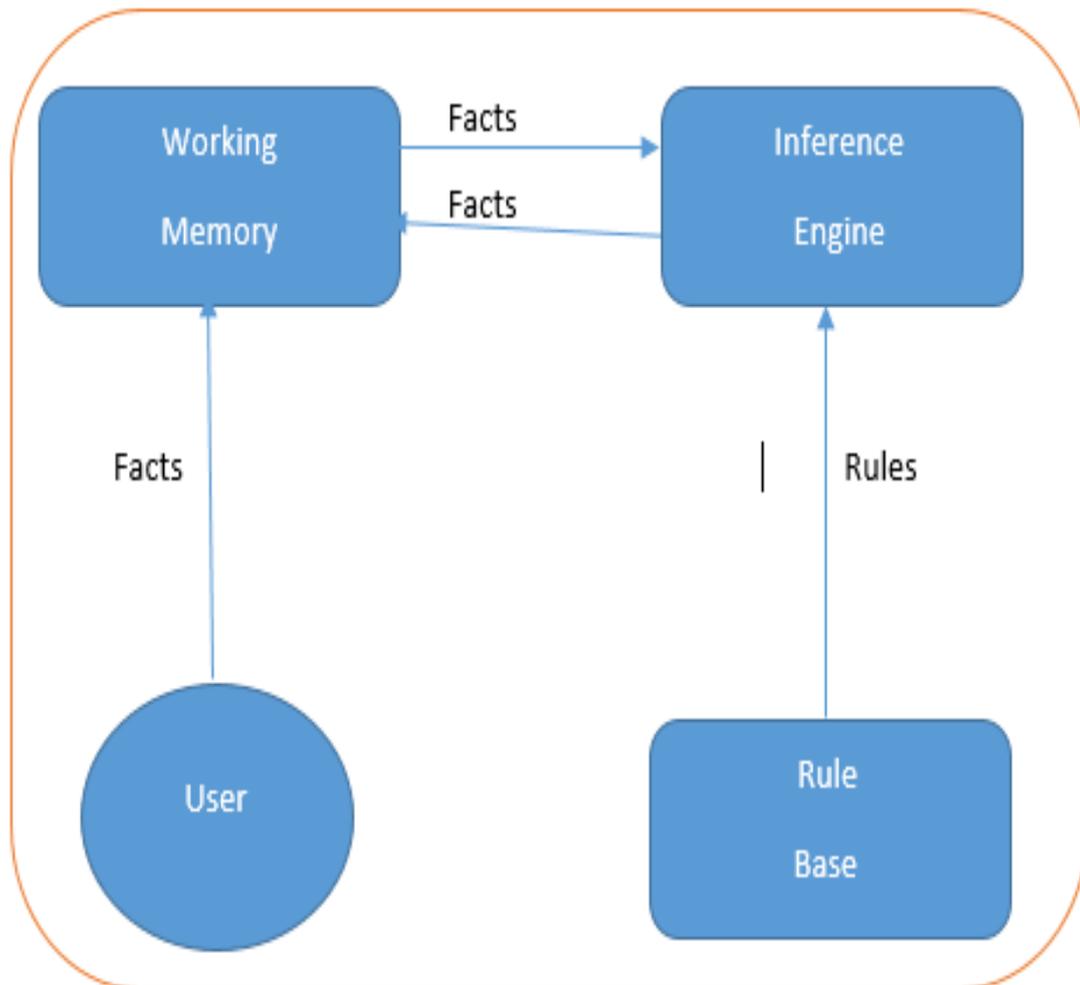
PSG-EXPERT, a specialist framework in the area of rest issue investigating polysomnographic information also provides an apt framework for medical expert systems.. The created programming apparatus is tended to from two perspectives: (1)- as a coordinated situation for the advancement of determination arranged master frameworks; (2)as an assistant analysis device in the specific space of rest issue. [4]

Created over a Windows stage, this product apparatus develops a standout amongst the most famous shells – CLIPS (C Language Integrated Production System) with the accompanying components: in reverse fastening motor; chart based clarification offices; learning editorial manager including a fluffy certainty supervisor and a tenets proofreader, with certainties rules trustworthiness checking; conviction amendment instrument; worked on the off chance that generator and approval module. It in this way gives graphical support to learning procurement, version, clarification and approval. From an application space perspective, PSG-Expert is a helper conclusion framework for rest issue in view of polysomnographic data, that goes for helping the restorative master in his determination errand by giving programmed examination of polysomnographic information, outlining the consequences of this investigation as far as a report of significant discoveries and conceivable finding reliable with the polysomnographic information. Rest issue order takes after the International Classification of Sleep Disorders. Real elements of the framework include: perusing on patient's information records; organized route on Sleep Disorders depictions as indicated by ASDA definitions; web connections to related pages; conclusion steady with polysomnographic information; graphical UI including chart based illustrative offices; vulnerability displaying and conviction correction; generation of reports; association with remote databases. [1]

V. PROPOSED FRAMEWORK

Rule based framework has been followed for implementing the proposed expert system. Traditional problem-solving systems used perfectly structured computer algorithms, data structures, and firm reasoning plans to find solutions for a particular problem. Complex problems situations which are concerned with expert systems, efficiency can be increased by making use of heuristics: strategies or plans that mostly that the path of correct solution, but it doesn't always lead to success, it can also lead to failure.

Rule-based expert systems, make use of the captured knowledge of human intelligence in order to solve the complex real world complex problems. Knowledge which are used in the expert system is depicted in the state of set of rules. Based on the level of complexity of the problem these set of rules are used in order to solve the problems.



Symptoms Collected

Symptoms for identified diseases are collected from various government websites and official websites mainly from the website of world health organization.

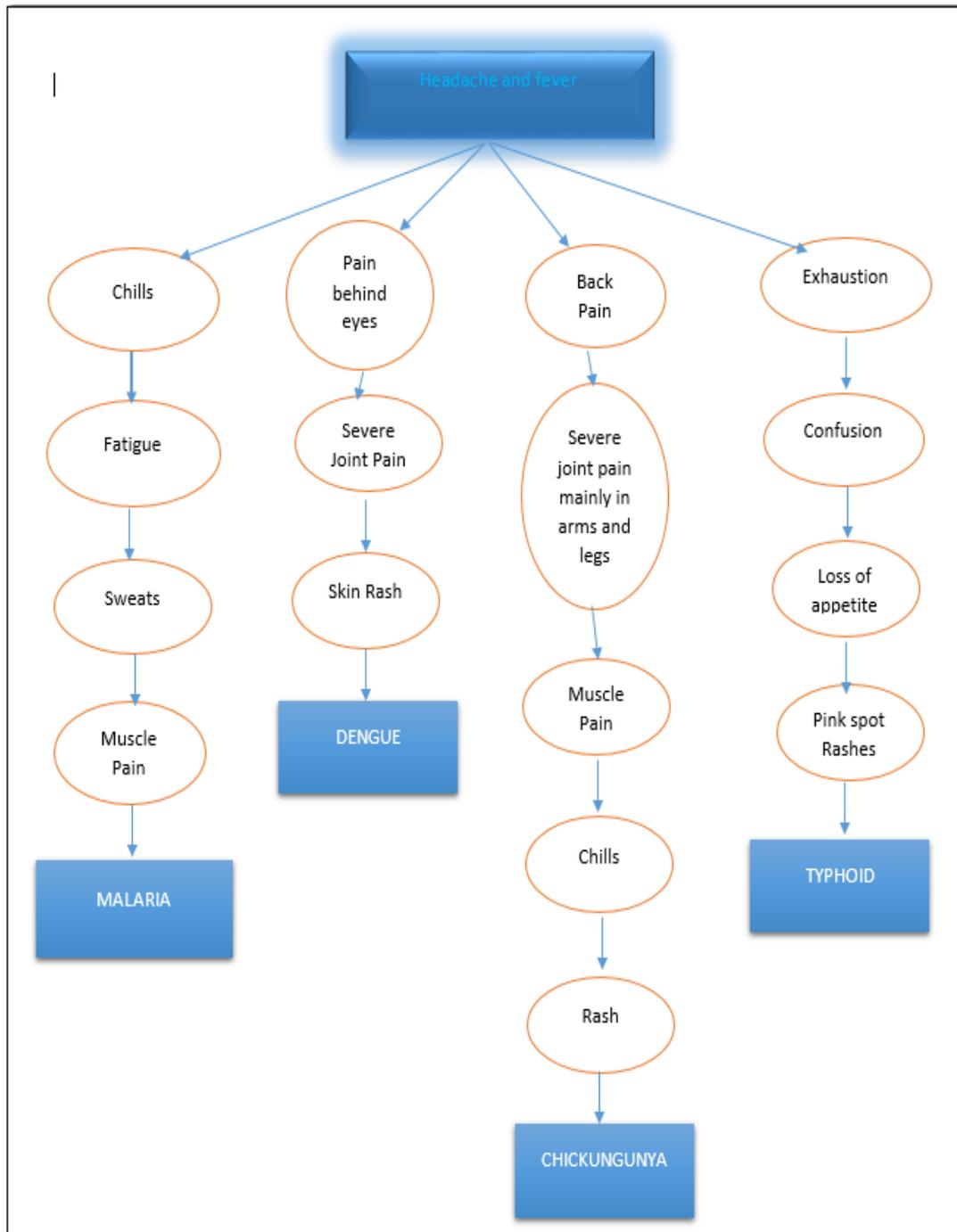
Six waterborne diseases identified for the study are: Cholera, Typhoid, Malaria, Chikungunya, Tuberculosis, Dengue, since symptoms of these diseases overlap each other and is difficult to classify and identify them. Below table contains the symptoms collected from verified official health websites [20],[21],[22],[23],[24],[25]

Cholera(CH), Typhoid(TY), Malaria(ML), Chikungunya(ChGu), Tuberculosis(TB), Dengue(DG)

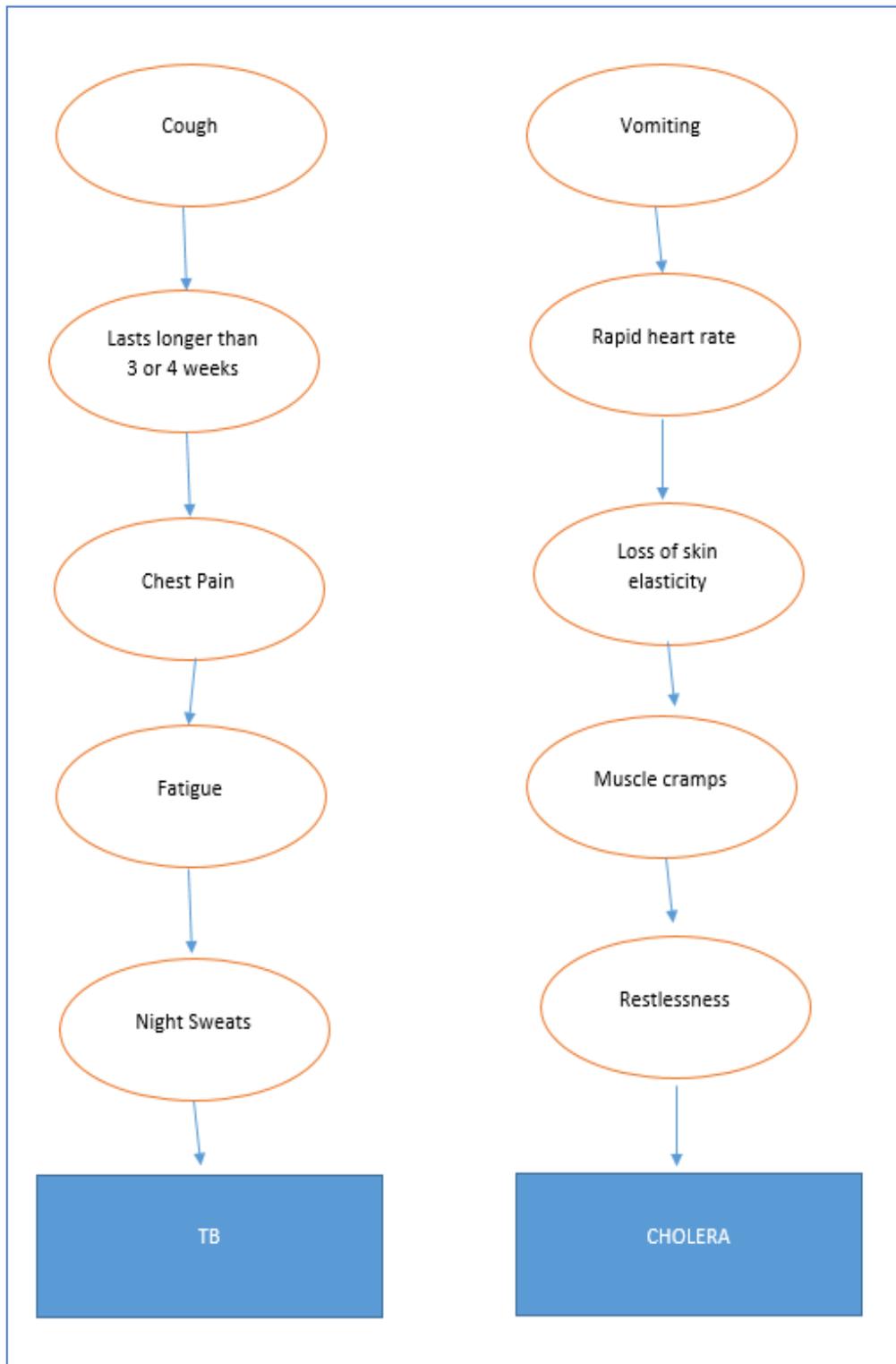
	Diseases					
Symptoms	CH	TY	ML	ChGU	TB	DENG
Rapid heart rate	Y	N	N	N	N	N
Sweats	N	N	Y	N	Y	N
Chills	N	N	Y	Y	N	N
Headache Fever	N	Y	Y	Y	N	Y
MusclePain/ Joint pain	N	N	Y	Y	N	Y
Backpain	N	N	N	Y	N	N
Rash	N	Y	N	Y	N	Y
Fatigue	N	N	Y	N	Y	N
ChestPain	N	Y	N	N	Y	N
Vomiting	Y	N	N	N	N	N
Watery Diarrhoea	N	N	N	N	N	N
Muscle Cramps	Y	Y	N	N	N	N
Pain behind eyes	N	N	N	N	N	Y
Restlessness	Y	N	N	N	N	N
Cough	N	N	N	N	Y	N
Exhaustion	Y	N	N	N	N	N

Flowchart

Below flowchart describes the diseases (Malaria, Dengue, Chikungunya, Typhoid) with its symptoms



Below flowchart describes Tuberculosis and cholera with its symptoms



Rules

Below table contains the rules formulated to implement the Expert System

TABLE II: Rule base for Proposed Expert System

If (fever high) THEN Malaria
If (Chills) THEN Malaria
If (Headache Fever) THEN Malaria
If (Muscle pain) THEN Malaria
If (Sweat) THEN Malaria
If (Coldness) THEN Malaria
If (Vomiting) THEN Malaria
If (High Temperature) THEN Malaria
If (Diarrhea) THEN Malaria
If (Headache) THEN Chikungunya
If (Back pain) THEN Chikungunya
If (Rash) THEN Chikungunya
If (Headache) THEN Tuberculosis
If (Abdominal Pain) THEN Tuberculosis
If (Weight Pain) THEN Tuberculosis
If (Draining Sinus) THEN Tuberculosis
If (Masses along the neck) THEN Tuberculosis
If (Skin lesions on hand, feet and elbow) THEN Tuberculosis
If (Stiffness of effected area) THEN Tuberculosis
If (Blood present in urine) THEN Tuberculosis
If (Painful or uncomfortable urination) THEN Tuberculosis
If (Hemoptysis) THEN Tuberculosis
If (Stiff Neck) THEN Tuberculosis
If (Fatigue) THEN Tuberculosis
If (Chest Pain) THEN Tuberculosis
If (Vomiting) THEN Cholera
If (Watery diarrhea) THEN Cholera
If (Leg Cramps) THEN Cholera
If (Poor appetite) THEN Typhoid Fever
If (Headache) THEN Typhoid Fever
If (Generalized aches and pains) THEN Typhoid Fever
If (Diarrhea) THEN Typhoid Fever
If (Lethargy) THEN Typhoid Fever
If (Generalized aches and pain) THEN Typhoid Fever

Working

The rules generated by the help symptoms are defined in CLIPS. When the rules are run it prompts the user to feed in answer to various questions which prompts the expert system to suggest the disease the user might be suffering as shown in below figure.

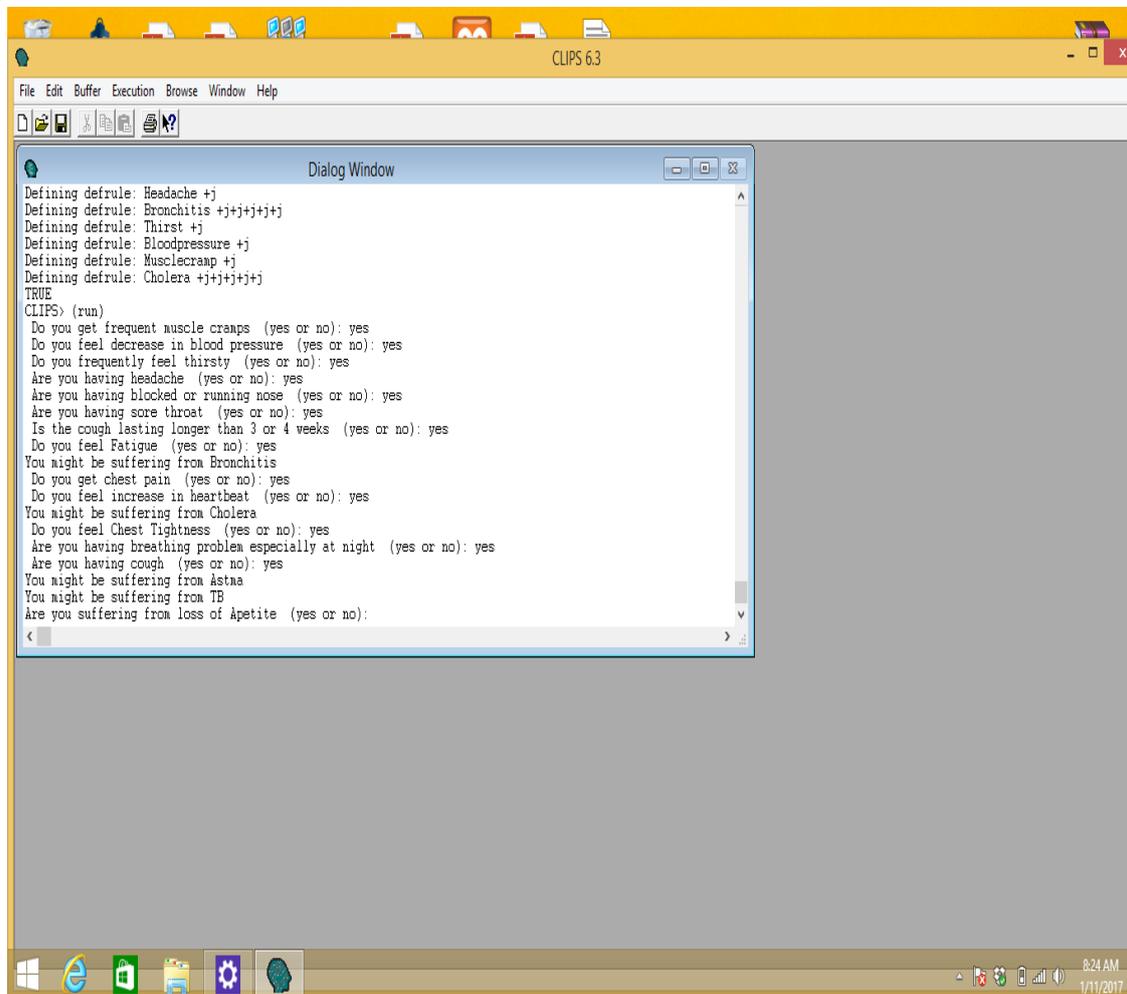


Fig I. CLIPS window

VI. CONCLUSION

With the greater penetration technology in the medical field decision support systems and expert systems are seen being integrated to the system. Health information systems are seen as means for improving medical diagnosis and eliminating diagnosis error. In this paper a framework using rule based expert system has been suggested. Physician's diagnosis and further investigations are more accurate to the use of the expert systems. But this system can be considered as an aid to facilitate. Further this model can be enhanced by considering other pathological parameters.

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