An Expert System For Hepatitis B Diagnosis Using Artificial Neural Networks

Dakshata Panchal
Asst. Professor,
SFIT,Mumbai

Seema Shah
Principal,
VIT, Mumbai

ABSTRACT

Hepatitis B including chronic liver disease is quite common in the world, which may cause damage to hepatocytes. The severity may range from healthy carrier to decompensated cirrhosis. In medicine, diagnosis is "the recognition of a disease or stipulation by its apparent signs and symptoms" or "the analysis of the underlying physiological! Biochemical cause(s) of a disease or condition". An important issue in medical diagnosis is the risk stratification, which refers to the sorting of patients based on the severity of disease. In case the clinical problem lies beyond the physician's competence, the solution is to consult a specialist, however in common, expert opinion is either unavailable or not available in a timely fashion. The physician is left without adequate time to devote to each case and struggling to keep up with the newest developments in his field owing to our increasing expectations of the highest quality health care and the rapid growth of ever more detailed medical knowledge.

In this paper we have described an expert system for the diagnosis of the Hepatitis B virus disease, which consists of the generalized regression neural network. The main aim of the system is to classify the patient in two categories : Infected or Immune mentioning the causes and severity.

Keywords : Medical Diagnosis; Artificial Intelligence, Neural Networks; Hepatitis B; Generalized Regression Neural Networks; Hepatitis B virus(HBV); Hepatitis B DNA

1. INTRODUCTION

Diagnosis is a methodology for identification, by process of elimination, of the nature of anything. Medicine, science, engineering, business, etc. are some of the areas that employ diagnosis[1][2]. Almost all the physicians are confronted during their formation by the task of learning to diagnose. Here, the problem of deducing certain diseases or formulating a treatment has to be solved by them on the basis of more or less specified observations and knowledge. In order to keep more of the relevant information constantly in mind the physicians are encouraged by continued training and recertification procedures.

However, it is assured that most of what is known cannot be known by most individuals due to the fundamental limitations of human memory and recall coupled with the growth of knowledge. A good physician employs his knowledge, experience, and talent during a medical diagnosis procedure to diagnose a disease. The diagnosis is then determined by taking the total available patients' status into account. The appropriate treatment is prescribed depending on the diagnosis and the entire process might be iterated. The diagnosis might be reconfigured, refined, or even rejected in every iteration.

Recent practice for medical treatment make it mandatory that patients consult specialists for further diagnosis and treatment. Other medical practitioners may not have adequate expertise or experience in handling certain high-risk diseases. Nonetheless, typical waiting time for treatments may be few days, weeks or even months. Possibly, by the time the patients consult the specialists the diseases may have already spread out. Since the majority of the high-risk disease could only be cured at the early stage, the patients may have to endure for the rest of their life, due to which new approaches with the support of computer technology for the diagnosis of diseases is essential. The mortality rate and the waiting time to see the specialist could be reduced by employing the computer technology or computer program or software developed by emulating human intelligence which supports the doctors in making decisions without the direct consultation with the specialists. It is possible to shortlist the patients with high-risk factors or symptoms or predicted to be highly effected with certain diseases or illness to see the specialist for further treatment.

Artificial Neural Networks (ANN) is presently a 'hot' research area in medicine and it is believed that they will receive extensive application to biomedical systems in the next few years. Hepatitis B including chronic liver disease is quite common in the world, which may cause damage to hepatocytes. The severity may range from healthy carrier to decompensated cirrhosis. The aim is to embed an intelligent system for the diagnosis of the Hepatitis B virus disease, as Hepatitis is one of the serious diseases which demands expensive treatment and severe side effects can appear very often.

2. ARTIFICIAL NEURAL NETWORKS

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurones) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurones.

Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be

used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyse. This expert can then be used to provide projections given new situations of interest and answer "what if" questions. Other advantages include:

1. Adaptive learning: An ability to learn how to do tasks based on the data given for training or initial experience.
2. Self-Organisation: An ANN can create its own organisation or representation of the information it receives during learning time.
3. Real Time Operation: ANN computations may be carried out in parallel, and special hardware devices are being designed and manufactured which take advantage of this capability.
4. Fault Tolerance via Redundant Information Coding: Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilities may be retained even with major network damage.

3. OVERVIEW OF HEPATITIS B

The term 'hepatitis' simply means inflammation of the liver[3]. Hepatitis may be caused by a virus or a toxin such as alcohol. Other viruses that can cause injury to liver cells include the hepatitis A and hepatitis C viruses. These viruses are not related to each other or to hepatitis B virus and differ in their structure, the ways they are spread among individuals, the severity of symptoms they can cause, the way they are treated, and the outcome of the infection. Hepatitis B is an infection of the liver caused by the hepatitis B virus (HBV).The major modes of transmission of hepatitis B (sexual transmission, illicit drug use, exposure to infected blood) and the effect of universal vaccination of infants. When a person first gets hepatitis B, they are said to have an 'acute' infection. Most people are able to eliminate the virus and are cured of the infection. Some are not able to clear the virus and have 'chronic' infection with hepatitis B that is usually life-long. The hepatitis B virus is a DNA virus, meaning that its genetic material is made up of deoxyribonucleic acids. It belongs to a family of viruses known as Hepadnaviridae. The virus is primarily found in the liver but is also present in the blood and certain body fluids[2].

Hepatitis B virus consists of a core particle (central portion) and a surrounding envelope (outer coat). The core is made up of DNA and the core antigen (HBcAg). The envelope contains the surface antigen (HBsAg). These antigens are present in the blood and are markers that are used in the diagnosis and evaluation of patients with suspected viral hepatitis.The hepatitis B virus reproduces in liver cells, but the virus itself is not the direct cause of damage to the liver. Rather, the presence of the virus triggers an immune response from the body as the body tries to eliminate the virus and recover from the infection. This immune response causes inflammation and may seriously injure liver calls. Therefore, there is a balance between the protective and destructive effects of the immune response to the hepatitis B virus.

Infection with hepatitis B is suspected when the medical history and the physical examination reveal risk factors for the infection or symptoms and signs that are suggestive of hepatitis B. Abnormalities in the liver tests (blood tests) also can raise suspicion; however, abnormal liver tests can result from many conditions that affect the liver. The diagnosis of hepatitis B can be made only with specific hepatitis B virus blood tests. These tests are known as hepatitis 'markers' or 'serology.' Markers found in the blood can confirm hepatitis B infection and differentiate acute from chronic infection. These markers are substances produced by the hepatitis B virus (antigens) and antibodies produced by the immune system to fight the virus. Hepatitis B virus has three antigens for which there are commonly-used tests - the surface antigen (HBsAg), the core antigen (HBcAg) and the e antigen (HBeAg).

3.1 HBSAG AND ANTI-HBS

The presence of hepatitis B surface antigen (HBsAg) in the blood indicates that the patient is currently infected with the virus. Anti-HBs provide complete immunity to subsequent hepatitis B viral infection. The diagnosis of chronic hepatitis B is made when the HBsAg is present in the blood for at least six months. In chronic hepatitis B, HBsAg can be detected for many years, and anti-HBs does not appear.

3.2 ANTI-HBC

In acute hepatitis, a specific class of early antibodies (IgM) appears that is directed against the hepatitis B core antigen (anti-HBc IgM). Later, another class of antibody, anti-HBc IgG, develops and persists for life, regardless of whether the individual recovers or develops chronic infection. Only anti-HBc IgM can be used to diagnose an acute hepatitis B infection.

3.3 HBEAG, ANTI-HBE, AND PRE-CORE MUTATIONS

Hepatitis B e antigen (HBeAg) is present when the hepatitis B virus is actively multiplying, whereas the production of the antibody, anti-HBe, (also called HBeAg seroconversion) signifies a more inactive state of the virus and a lower risk of transmission. In some individuals infected with hepatitis B virus, the genetic material for the virus has undergone a structural change, called a pre-core mutation.

3.4 Interpretation of Hepatitis B Blood Tests

The following table gives the usual interpretation for sets of results from hepatitis B blood (serological) tests.

Table.1 Markers for Hepatitis B Diagnosis

Marker	Value
AgHBs	Positive
AgHBs	Negative
AgHBe	Positive
AgHBe	Negative
anti - VHD	Positive
anti – VHD	Negative
anti - VHC	Positive

Rule: IF (AgHBs=Positive) AND (AgHBe= positive) AND (anti-VHD= Negative) THEN Hepatitis B.

4. NEURAL NETWORKS IN MEDICAL DIAGNOSIS

Artificial Neural Networks (ANN) are currently a 'hot' research area in medicine and it is believed that they will receive extensive application to biomedical systems in the next few years. At the moment, the research is mostly on modelling parts of the human body and recognising diseases from various scans (e.g. cardiograms, CAT scans, ultrasonic scans, etc.)[4]. Neural networks are ideal in recognizing diseases using scans since there is no need to provide a specific algorithm on how to identify the disease. Neural networks learn by example so the details of how to recognize the disease are not needed. What is needed is a set of examples that are representative of all the variations of the disease. The quantity of examples is not as important as the 'quantity'. The examples need to be selected very carefully if the system is to perform reliably and efficiently.

Artificial neural networks could be used in every situation in which exists a relationship between some variables that can be considered inputs and other variables that can be predicted (outputs). The most important an advantage using artificial neural networks is that this kind of system solves problems that are too complex for conventional technologies, do not have an algorithmic solution or the solution is too complex to be used. These characteristics have often appeared in medicine. Artificial neural networks have been successfully applied on various areas of medicine, such as: diagnostic systems, biomedical analysis, image analysis, drug development[5].

Hepatitis B diagnosis is possible using following Neural Networks

- BPNN: Back Propagation N/N
- RBFNN: Radial Basis Function N/N
- PNN: Probabilistic N/N
- GRNN: Generalized Regression N/N

A comparative Analysis of all the above networks proved that generalized regression neural network will be the best suitable network in diagnosis of Hepatitis B. The capability of Genaralized Regression Neural Network to get trained faster compared to other networks and acheiving results for even the few missing attribute makes it used for diagnosis process[6].

5. GENERALIZED REGRESSSION NEURAL NETWORKS FOR HEPATITIS B DIAGNOSIS

Generalized Regression Neural Network (GRNN) is a type of neural network using kernel-based approximation to perform regression and is one of the so-called Bayesian networks. GRNNs have some advantages and disadvantages which are broadly similar to PNNs. GRNNs can only be used for regression problems,whereas PNNs are used for classification problems. It trains almost instantly, but tends to be large and slow (although, unlike PNNs, it is not necessary to have one radial unit for each training case, the number still needs to be large).Like an RBF network, a GRNN does not extrapolate. GRNN, as proposed by Donald F. Specht in [Specht 91] falls into the category of probabilistic neural networks[7,8]. This neural network like other probabilistic neural networks needs only a fraction of the training samples a back propagation neural network would need. The data available from measurements of an operating system is generally never enough for a back propagation neural network. Therefore the use of a probabilistic neural network is especially advantageous due to its ability to converge to the underlying function of the data with only few training samples available.

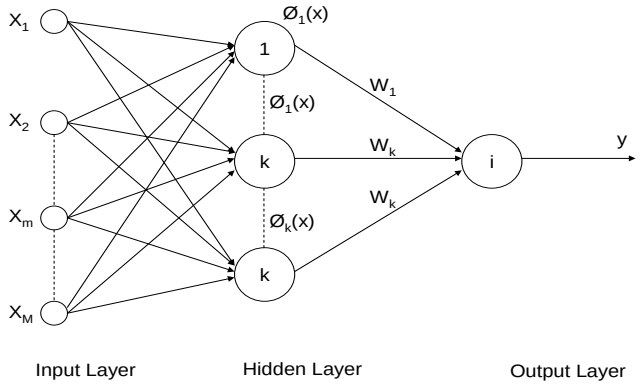

Fig.1 Generalized regression neural network

Input Layer – where the inputs are applied.
Hidden layer – where a nonlinear transformation is applied on the data from the input space to the hidden space; in most applications the hidden space is of high dimensionality.
Linear output layer – where the outputs are produced.

6. EXPERIMENTAL RESULTS

The diagnosis of the disease for a new patient to be performed on basis of the Markers is facilitated by the primary phase. At the outset, the system intends to diagnose the kind of hepatitis: B or others. It is necessary to specify the values of the three markers namely Hepatitis B surface Antigen AgHBs), anti-VHC and anti-VHD. Table 2 shows a few sample results.

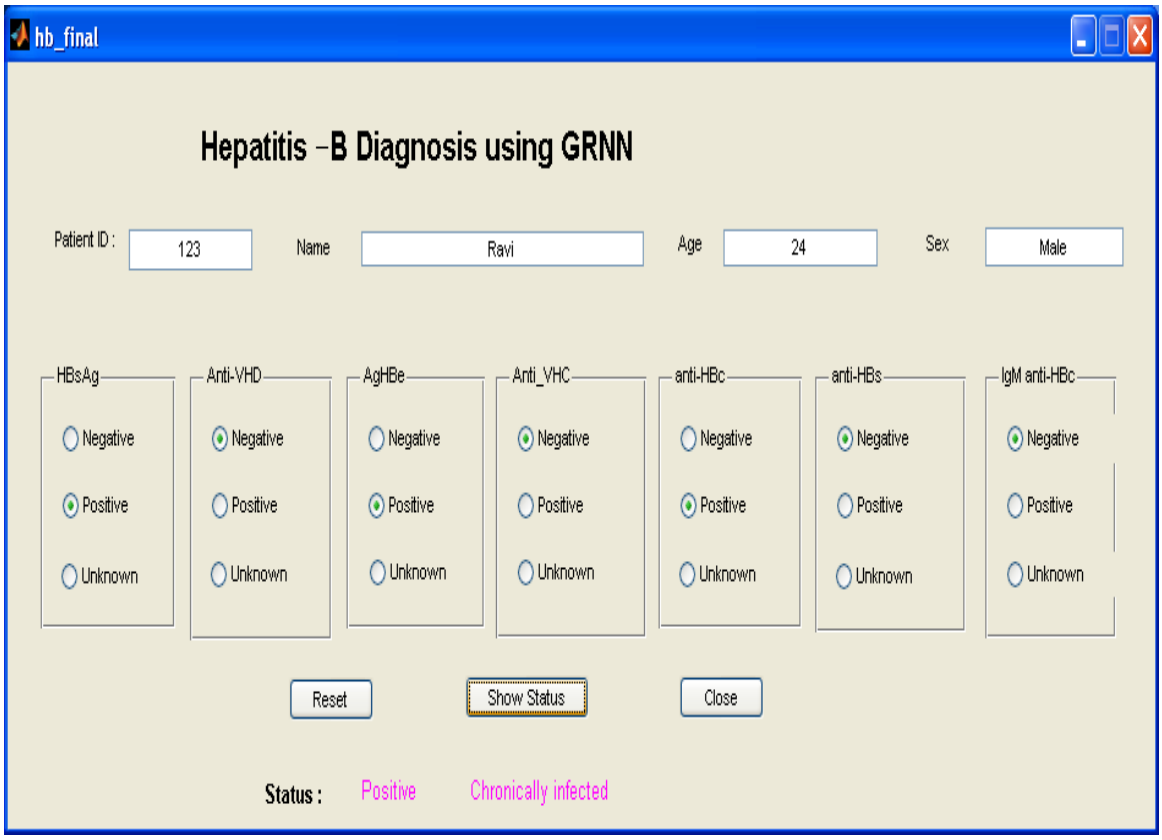

Fig.2 Hepatitis B Diagnosis Generalized regression neural network

Table. 2 The sample results for hepatitis diagnosis

Ag H Bs	Anti-V H D	Ag H Be	Anti-V H C	anti-H Bc	anti-H Bs	IgM anti-H Bc	Result	Status of Patient
0	0	0	0	0	0	0	0	Susceptible, not infected, not immune
0	0	0	0	0	1	1	0	Immune due to Hepatitis B vaccination
1	0	?	?	1	0	0	1	Chronically infected
1	0	0	0	1	0	0	1	Chronically infected
1	0	0	0	1	0	1	1	Acutely infected

7. CONCLUSION

The hepatitis B virus is a DNA virus belonging to the Hepadnaviridae family of viruses. Hepatitis B infection is transmitted through sexual contact, contact with contaminated blood , and from mother to child. Hepatitis B is not spread through food, water, or casual contact. Serologic (blood) markers specifically for hepatitis B virus are used to diagnose hepatitis B viral infection. The blood tests can also identify people who are at highest risk for complications.Injury to the liver by hepatitis B virus is caused by the body's immune response as the body attempts to eliminate the virus. Progression of chronic hepatitis B viral infection occurs insidiously (subtly and gradually), usually over several decades. The course is determined primarily by the age at which the hepatitis B viral infection is acquired and the interaction between the virus and the body's_immune_system.

GRNN (Generalized regression N/N) will be the best suitable Neural Network for Hepatitis B diagnosis which will help in reducing extra time consumption in treatment. Even if there is any number of missing parameters in blood test, the diagnosis will be done by artificial intelligence using generalized regression neural networks.

8. REFERENCES

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