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A Fuzzy Rule Based Expert System for Assessment of Severity of Hemolytic Anemia

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ABSTRACT

In this research paper we developed a fuzzy rule based expert system for intelligent diagnosis of the severity of the Hemolytic Anemia through the fuzzy logic. Where fuzzy logic is used as a tool for developing this fuzzy rule based expert system for diagnosis of Hemolytic Anemia.

Key-Word- fuzzy logic, fuzzy expert system, hemolytic anemia, rule based system, Disease diagnosis.

1. Introduction

Hemoglobin disease is a group of blood disorders passed down through the families in which abnormal structured hemoglobin produced. Hemoglobin disease happens when the part of the red blood cell that carries oxygen throughout the body is changed. This part which is changed is called hemoglobin. Our body makes three types of blood cells - white blood cells to fight infection, platelets to help your blood clot and red blood cells to carry oxygen throughout our body, this red blood cell contain hemoglobin. Hemoglobin is a red, iron-rich protein that gives blood its red colour. Hemoglobin is very necessary because it picks up oxygen in the lungs and carries it to the other parts of the body.

The most common examples of hemoglobin disease are hemolytic anemia. Hemolytic Anemia is a condition in which the body does not have enough healthy red blood cells. Red blood cells are made in the bone marrow. They live about 120 days in the bloodstream and then die. When blood cells die, the body's bone marrow makes more blood cells to replace them. However, in hemolytic anemia, the bone marrow can't make red blood cells fast enough to meet the body's needs. Hemolytic anemia is caused by high rates of red blood cell damage. Many diseases, conditions and factors can cause the body to destroy its red blood cells. These causes can be inherited or acquired. In inherited hemolytic anemia child can get a faulty red blood cell gene from one or both of parents. These abnormal cells may be fragile and break down while moving through the bloodstream. Hemolytic anemia

often can be successfully treated or controlled but inherited forms of hemolytic anemia are lifelong conditions that may require ongoing treatment. Hemoglobin C is an abnormal form of hemoglobin associated with hemolytic anemia. The most common symptom of hemolytic anemia is tiredness, shortness of breath, dizziness, headache, jaundice, paleness of skin, chest pain and fever [1], [2].

2. Methodology

Fuzzy logic is a method to provide specific path for diagnosis and decision making because of their approaches to deal with uncertainties and ambiguity in the knowledge and information. In the world of medicine fuzzy logic play an important role. FL is based on Fuzzy Set Theory that was established by Lofti A. Zadeh in 1965 [5] [6]. Fuzzy set theory and fuzzy logic are highly suitable for developing rule based system in medical field for diagnosis of diseases. In this research paper we design a fuzzy rule based system for diagnosis of hemolytic anemia. Basically Fuzzy Rules are linguistic IF-THEN constructions that have the general form "IF A THEN B". A is called the premise and B is the consequence of the rule [4].

Designing of Fuzzy Rule Based System, we take the six symptoms which are related and mostly used for the diagnosis of hemolytic anemia are:

1. Level of hemoglobin 'A' 2.Presence of hemoglobin C 3.Tiredness/weakness 4.Jaundice 5.Chest pain 6.Fever. These six symptoms were used as an input in fuzzy rule based system. Based on these symptoms severity of hemolytic anemia was predicted as an output [3].

2.1. Database for Fuzzy Rule Based System For Diagnosis Of Hemolytic Anemia

For the six symptoms, six input variables and one output variable "Severity of Hemolytic Anemia" was created. The input variables (Symptoms) were divided in to membership functions, which is define as follows (with membership value)

2.2. Input variable and their membership value-

1. Level of hemoglobin A - Low- 0-5
   Med- 5 -10

2. Presence of hemoglobin C - Present - 1
   Absent - 0

3. Tiredness/weakness - Mild - 0- 4
   Moderate - 3-7
   Sever - 6-10

4. Jaundice - Mild - 0-3
   Moderate - 2-6

Sever - 5-10

5. Chest pain - Mild - 0-3

Moderate - 2-7

Sever - 6-10

6. Fever - Mild - 0-4

Moderate -3-8

Sever - 7-10

2.3. Output variable and their membership value-

In this system, we have considered a different output variable, which divides in to 4 fuzzy sets namely normal , subclinical , minor, major and range for these membership function is 0 to 100.fuzzy set normal and major are of trapezoidal and another two sets are of triangular shape as in Figure 1.

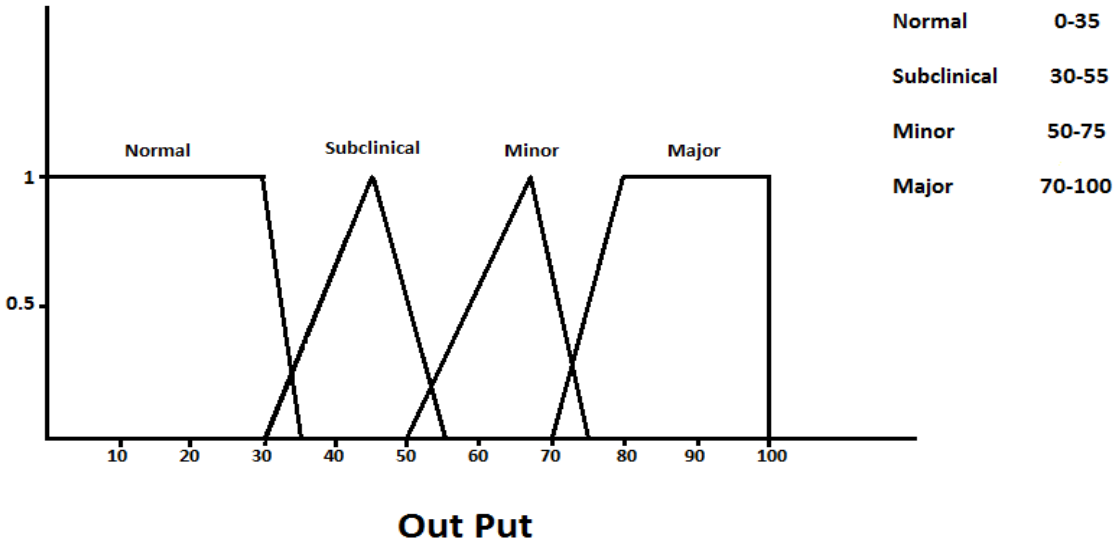

Figure1: output result

On the basis of the input and output variables, 10 rules were constructed by selecting an item in each input and output variable box and one connection (AND).

2.4. Fuzzy Rule Base

The fuzzy rules for this research were developed with the assistance of domain experts (medical doctors) who are experts in the field of medicine. This Rule based system has more than 50 fuzzy rules. Sample fuzzy rule base for hemolytic anemia diagnosis is given below-

1. If Hb (hemoglobin) A low and Hb (hemoglobin) C is absent and weakness is moderate and jaundice is mild and chest pain is moderate and fever is mild then result (condition of severity of hemolytic anemia) is subclinical.
2. If Hb A medium and Hb C is absent and weakness is mild and jaundice is mild and chest pain is mild and fever is moderate then result (condition of severity of hemolytic anemia) is no hemolytic anemia.
3. If Hb A low and Hb C is present and weakness is moderate and jaundice is moderate and chest pain is severe and fever is medium then result (condition of severity of hemolytic anemia) is major hemolytic anemia.
4. If Hb A low and Hb C is absent and weakness is severe and jaundice is severe and chest pain is moderate and fever is severe then result (condition of severity of hemolytic anemia) is minor hemolytic anemia.
5. If Hb A low and Hb C is absent and weakness is high and jaundice is mild and chest pain is moderate and fever is moderate then result (condition of severity of hemolytic anemia) is subclinical stage.
6. If Hb A low and Hb C is absent and weakness is medium and jaundice is mild and chest pain is moderate and fever is mild then result (condition of severity of hemolytic anemia) is no hemolytic anemia.
7. If Hb A medium and Hb C is present and weakness is moderate and jaundice is severe and chest pain is moderate and fever is severe then result (condition of severity of hemolytic anemia) is major hemolytic anemia.
8. If Hb A medium and Hb C is absent and weakness is mild and jaundice is severe and chest pain is severe and fever is moderate then result (condition of severity of hemolytic anemia) is minor hemolytic anemia.
9. If Hb A low and Hb C is absent and weakness is moderate and jaundice is mild and chest pain is severe and fever is severe then result (condition of severity of hemolytic anemia) is subclinical stage.
10. If Hb A medium and Hb C is present and weakness is severe and jaundice is severe and chest pain is severe and fever is severe then result (condition of severity of hemolytic anemia) is major hemolytic anemia.
11. If Hb A medium and Hb C is not present and weakness is high and jaundice is moderate and chest pain is severe and fever is high then result (condition of severity of hemolytic anemia) is major hemolytic anemia.

3. Testing of the Fuzzy Rule Based System

About 15 patient's data are collected for results. Table no.1 shows the data about all patients and its diagnosis result obtained from the proposed fuzzy rule based system and diagnosis made by the doctor.

Table 1: Result by fuzzy rule based system and medical expert-

	INPUT DATA						**OUTPUT-DATA**	**Doctors Diagnosis**
P..No.	**Level of Hb A**	**Hbl - C**	**weakness**	**Jaundice**	**Chest pain**	**Fever**	**Result by FES**	**Result by Expert**
1	2	0	4	2	3	4	40 (Sub clinical)	Sub clinical
2	6	0	3	3	2	2	20 (Normal)	Normal
3	3	1	5	6	6	4	80 (Major)	Major
4	5	0	7	5	6	3	65 (Minor)	Minor
5	3	0	6	4	5	4	50(Sub clinical)	Sub Clinical
6	7	0	2	1	2	1	25 (Normal)	Normal
7	4	1	7	9	10	2	90 (Major)	Major
8	7	0	4	8	9	10	70 (Minor)	Sub clinical
9	2	0	8	2	7	6	50 (Sub Clinical)	Sub Clinical
10	1	0	9	7	8	7	95 (Major)	Major
11	8	0	7	5	7	8	45 (Sub Clinical)	Normal
12	8	0	3	3	2	3	20 (Normal)	Normal
13	7	1	4	2	3	3	55(Minor)	Major
14	6	0	6	1	6	5	60(Minor)	Minor
15	5	1	5	4	9	9	80 (Major)	Major

4. Result and Discussion

In our research we have designed a fuzzy rule based system for diagnosis of hemolytic anemia.
This rule based system is developed for the diagnosis of disease on the basis of symptoms of disease for developing the system, we have used fuzzy logic. The performance of the system was analyzed by comparing the result of fuzzy rule based system with the clinical report of the patients. Total 15 patient's data was analyzed in which 12 results are positive and 3 results are negative.
True positive (TP) result = 12, True negative (TN) result = 3, so overall accuracy of the system is given by the formula:
Accuracy = TP/ (TP + TN) = 12/ (12+3) = 80%
We can see that the performance of the fuzzy rule based system is 80% accurate as compare to clinical report.

5. Conclusion

This research work was undertaken with the aim to design a fuzzy rule based system for the diagnosis of hemolytic anemia severity using Fuzzy Logic. System accuracy up to 80% is reported in the above testing. This system is flexible and easy to understand and efficient, so that common people who suspects little bit of anemia may use this system and get the result on the severity of this disease. This will be helpful to guide him to take proper remedial measures before the severity increases. So the proposed Fuzzy Rule Based System is helpful diagnostic tool for the patients and users.

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