International Engineering Journal For Research & Development

E-ISSN No: 2349-0721

Volume 1: Isuue 1

# FUZZY EXPERT SYSTEM FOR THE DIAGNOSIS OF COMMON LIVER DISEASE

**Prof. S. L. Satarkar[1], Dr. M. S. Ali[2]**

[1]Associate Professor and Head, Department of CSE, COE & T, Akola – 444104 (India)

[2]Principal, Prof. Ram Meghe College of Engg. and Mang. Amravati – 444701 (India)

## *Abstract:*

***Decision support through expert systems becomes part of everyday life. The aim of this study is to design a fuzzy expert system for the diagnosis of Cirrhosis which is one of the common diseases of the liver. The designed system is based on the sequential combination of the Bonacini score, which includes AST/ALT ratio, Platelet count and INR. The system has 3 input fields and one output field. Input fields are AST/ALT ratio, Platelet count and INR and the output field refers to the risk of cirrhosis. It is integer valued from 0 to 6. The system uses Mamdani Inference method. The results obtained from the designed system are compared with the actual data of patients in the database and observed results of the designed system are well within the limits set by the domain expert. The system can be used as decision support for the prediction of the cirrhosis and can avoid the need of the liver biopsy.***

***Keywords: Expert System, Fuzzy, Medical Diagnosis,***

## 1. Introduction

Cirrhosis is a serious disease of the liver which replaces healthy liver tissue with scar tissue. The scar tissue blocks the flow of blood in the liver and slows down the vital functions of liver[1].

Various possible causes of cirrhosis are

**A. Alcoholic diseases**:

Alcohol injuries may affect the normal functioning of the liver by blocking the metabolism of fat, proteins and carbohydrates[2]

**B. Chronic Infection**

Chronic hepatitis A, B, C and D infection can cause inflation of the liver and can damage the liver which can lead to cirrhosis.[3]

**C. Fatty liver**

Fatty liver associated with diabetes and obesity can affect the normal functioning of the liver which may cause cirrhosis.[4]

**D. Hemochromatosis**

Diseases such as hemochromatosis in which excessive absorption and disposition of iron takes place in liver can cause cirrhosis[5]

**E. Inherited diseases**

Certain inherited diseases such as Alpha-1 antitrypsin deficiency, Glycogen storage diseases, Wilson disease and cystic fibrosis can cause Cirrhosis [6].

Cirrhosis can cause loss of appetite, weakness, jaundice, itching and fatigue. Complication of Cirrhosis includes edema and ascites, bleeding from varices, hepatopulmonary syndrome and liver cancer[7]. Patient's history, physical examination of patient and blood test can suggest the diagnosis of Cirrhosis. The conformation

can be done by the liver biopsy, but biopsy may cause complications. Several non invasive tests which includes routine laboratory test can predict cirrhosis [8].

The aim of this research is to design a Fuzzy expert system using Bonacini score to predict diagnostic accuracy of cirrhosis. The investigation of cirrhosis involves uncertainty and imprecision, hence fuzzy logic is the most suitable tool for the development of this system. This paper is organized as follows:

- Design of the system is presented in Section 2
- Input variables are present in Section 2.A
- Output variable is presented in Section 2.B
- Fuzzy rule base is presented in Section 2.C

## 2. Design Of The System

In this section we show the fuzzy expert system designing, Membership functions, fuzzy rule base, fuzzification and defuzzifaction. The first step of the system designing is determination of input and output variables. There are three input variables and one output variable. Next the membership functions of all the variables are designed.

At first the input variables with their membership functions are described. In second step output variable with its membership functions are described. In second step output variable with its membership functions are described. Rules of the system, fuzzification and defuzzifaction is explained in the next section

### A. Input variables

#### 1. AST/ALT Ratio

The aspartame aminotransferase/alanime aminotransferase (AST/ALT) ratio differentiate between various causes of liver damage. AST/ALT values less than 2 indicate normal condition. Value greater than 2 indicates presence of alcoholic injury to liver[9]. Fuzzy set range of AST/ALT Ratio is shown in Table 1. Membership functions for fuzzy sets are trapezoidal and triangular and are shown in Figure 1.

| Input field | Range | Fuzzy set |
|---|---|---|
| | > 1.7 | Score0 |
| AST/ALT RATIO | 1.2-1.7 | Score1 |
| | 0.6-1.19 | Score2 |
| | < 0.6 | Score3 |

**Table 1:** Fuzzy sets of AST/ALT Ratio

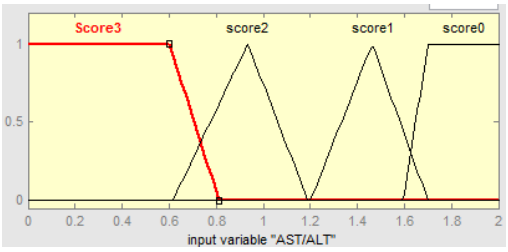


**Figure 1:** Membership function for AST/ALT Ratio

**2. INR**

Stands for international Normalized ratio. PROTIME INR or PT/INR test is used to determine bloods clotting tendency and is measure of liver damage. The results of prothrombin time vary due to variable in the material used to perform the result. The INR was devised to standardize the result[10].

This variable has three fuzzy sets score0, score1 and score2. Table 2 shows fuzzy set range of INR. Membership functions for fuzzy sets are trapezoidal and triangular and are shown in Figure 2.

| Input field | Range | Fuzzy set |
|---|---|---|
| | < 1.1 | Score0 |
| INR | 1.1-1.4 | Score1 |
| | >1.4 | Score2 |

**Table 2:** Fuzzy Sets of INR

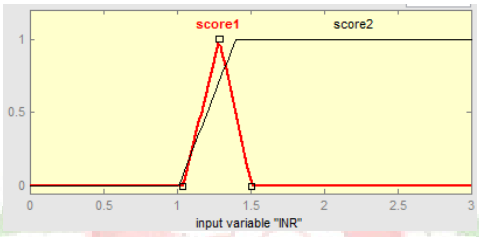


**Figure 2:** Membership Functions for INR

**3. PLT**

Platelets are the cells present within our blood. Whenever any blood vessel gets damage platelet bind the damaged vessel and cause blood to clot. Liver damage due to alcohol or due to any other reasons may drop platelet count[11].

This variable has 5 fuzzy sets score0, score1, score2, score3,score4 and score5. Fuzzy set range of PLT is shown in table3. Membership functions for fuzzy set are trapezoidal and triangular and are shown in Figure 3.

| Input field | Range | Fuzzy set |
|---|---|---|
| | > 340 | Score0 |
| | 280-340 | Score1 |
| | 220-279 | Score2 |
| PLT | 219-260 | Score3 |
| | 100-159 | Score4 |
| | 40-99 | Score5 |
| | <40 | Score6 |

**Table 3:** Fuzzy sets of PLT

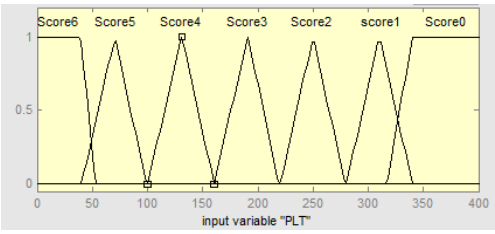

**Figure 3:** Membership functions for PLT

**B. Output Variable**

The aim of the system is to identify risk status of Cirrhosis. The output is a value from 0 to 10 representing Low risk, Intermediate risk & High risk. This output variable has three fuzzy sets Low risk, Intermediate risk and high risk. These fuzzy sets and its ranges are shown in Table 4. The membership functions of these fuzzy sets are triangular and trapezoidal and are shown in Figure 4.

| Output | Range | Fuzzy set |
|---|---|---|
| | < 3 | Low Risk |
| RiskStatus | 3-7 | Intermediate Risk |
| | > 7 | High Risk |

**Table 4:** Fuzzy sets of Output variable Risk Status

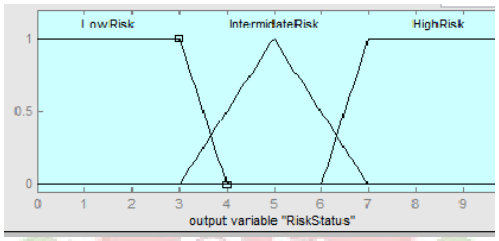


**Figure 4:** Membership function for output variable Risk Status.

**C. Fuzzy Rule Base**

The rule base is determined with the help of an expert doctor. The rule base consists of 85 well defined rules that determine the risk status by the evaluation of the input variables. The rule base is shown in Table 5.

| Rule | INR | AST/ALT | PLT | RiskStatus | Rule | INR | AST/ALT | PLT | RiskStatus |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Score0 | Score0 | Score0 | LowRisk | 44 | Score1 | Score2 | Score1 | IntermediateRisk |
| 2 | Score0 | Score0 | Score1 | LowRisk | 45 | Score1 | Score2 | Score2 | IntermediateRisk |
| 3 | Score0 | Score0 | Score2 | LowRisk | 46 | Score1 | Score2 | Score3 | IntermediateRisk |
| 4 | Score0 | Score0 | Score3 | IntermediateRisk | 47 | Score1 | Score2 | Score4 | IntermediateRisk |
| 5 | Score0 | Score0 | Score4 | IntermediateRisk | 48 | Score1 | Score2 | Score5 | HighRisk |
| 6 | Score0 | Score0 | Score5 | IntermediateRisk | 49 | Score1 | Score2 | Score6 | HighRisk |
| 7 | Score0 | Score0 | Score6 | IntermediateRisk | 50 | Score1 | Score3 | Score0 | IntermediateRisk |
| 8 | Score0 | Score1 | Score0 | LowRisk | 51 | Score1 | Score3 | Score1 | IntermediateRisk |
| 9 | Score0 | Score1 | Score1 | LowRisk | 52 | Score1 | Score3 | Score2 | IntermediateRisk |
| 10 | Score0 | Score1 | Score2 | LowRisk | 53 | Score1 | Score3 | Score3 | IntermediateRisk |
| 11 | Score0 | Score1 | Score3 | IntermediateRisk | 54 | Score1 | Score3 | Score4 | HighRisk |
| 12 | Score0 | Score1 | Score4 | IntermediateRisk | 55 | Score1 | Score3 | Score5 | HighRisk |
| 13 | Score0 | Score1 | Score5 | IntermediateRisk | 56 | Score1 | Score3 | Score6 | HighRisk |
| 14 | Score0 | Score1 | Score6 | IntermediateRisk | 57 | Score2 | Score0 | Score0 | LowRisk |
| 15 | Score0 | Score2 | Score0 | LowRisk | 58 | Score2 | Score0 | Score1 | LowRisk |
| 16 | Score0 | Score2 | Score1 | LowRisk | 59 | Score2 | Score0 | Score2 | IntermediateRisk |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 17 | Score0 | Score2 | Score2 | IntermediateRisk | 60 | Score2 | Score0 | Score3 | IntermediateRisk |
| 18 | Score0 | Score2 | Score3 | IntermediateRisk | 61 | Score2 | Score0 | Score4 | IntermediateRisk |
| 19 | Score0 | Score2 | Score4 | IntermediateRisk | 62 | Score2 | Score0 | Score5 | IntermediateRisk |
| 20 | Score0 | Score2 | Score5 | IntermediateRisk | 63 | Score2 | Score0 | Score6 | HighRisk |
| 21 | Score0 | Score2 | Score6 | HighRisk | 64 | Score2 | Score1 | Score0 | LowRisk |
| 22 | Score0 | Score3 | Score0 | LowRisk | 65 | Score2 | Score1 | Score1 | IntermediateRisk |
| 23 | Score0 | Score3 | Score1 | IntermediateRisk | 66 | Score2 | Score1 | Score2 | IntermediateRisk |
| 24 | Score0 | Score3 | Score2 | IntermediateRisk | 67 | Score2 | Score1 | Score3 | IntermediateRisk |
| 25 | Score0 | Score3 | Score3 | IntermediateRisk | 68 | Score2 | Score1 | Score4 | IntermediateRisk |
| 26 | Score0 | Score3 | Score4 | IntermediateRisk | 69 | Score2 | Score1 | Score5 | HighRisk |
| 27 | Score0 | Score3 | Score5 | HighRisk | 70 | Score2 | Score1 | Score6 | HighRisk |
| 28 | Score0 | Score3 | Score6 | HighRisk | 71 | Score2 | Score2 | Score0 | IntermediateRisk |
| 29 | Score1 | Score0 | Score0 | LowRisk | 72 | Score2 | Score2 | Score1 | IntermediateRisk |
| 30 | Score1 | Score0 | Score1 | LowRisk | 73 | Score2 | Score2 | Score2 | IntermediateRisk |
| 31 | Score1 | Score0 | Score2 | LowRisk | 74 | Score2 | Score2 | Score3 | IntermediateRisk |
| 32 | Score1 | Score0 | Score3 | IntermediateRisk | 75 | Score2 | Score2 | Score4 | HighRisk |
| 33 | Score1 | Score0 | Score4 | IntermediateRisk | 76 | Score2 | Score2 | Score5 | HighRisk |
| 34 | Score1 | Score0 | Score5 | IntermediateRisk | 77 | Score2 | Score2 | Score6 | HighRisk |
| 35 | Score1 | Score0 | Score6 | IntermediateRisk | 78 | Score2 | Score2 | Score0 | HighRisk |
| 36 | Score1 | Score1 | Score0 | LowRisk | 79 | Score2 | Score3 | Score1 | IntermediateRisk |
| 37 | Score1 | Score1 | Score1 | LowRisk | 80 | Score2 | Score3 | Score2 | IntermediateRisk |
| 38 | Score1 | Score1 | Score2 | IntermediateRisk | 81 | Score2 | Score3 | Score3 | IntermediateRisk |
| 39 | Score1 | Score1 | Score3 | IntermediateRisk | 82 | Score2 | Score3 | Score4 | HighRisk |
| 40 | Score1 | Score1 | Score4 | IntermediateRisk | 83 | Score2 | Score3 | Score5 | HighRisk |
| 41 | Score1 | Score1 | Score5 | IntermediateRisk | 84 | Score2 | Score3 | Score6 | HighRisk |
| 42 | Score1 | Score1 | Score6 | HighRisk | 85 | Score2 | Score3 | Score6 | HighRisk |
| 43 | Score1 | Score2 | Score0 | LowRisk | | | | | |

**Table 5:** Rule Base of the System

**D. Fuzzificztion and Defuzzifaction**

This system depends on MAMDANI model for inference mechanism and uses minimum method (does not contain OR operator), Implication method used is minimum. Aggregation method between the rules is maximum ,hence fuzzification method here is MAX-MIN and Defuzzifaction method is CENTROID.

**3. Result and Discussion**

Fuzzy expert system for the risk identification of the Cirrhosis has been developed. The developed system is used to evaluate the study of twenty patients. It is found that the results obtained are in the predefined limits set by the domain expert. Table 6 shows the tested value and Figure 5 shows the result of the tested value.

| INR | AST/ALT Ratio | PLT | Risk status |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 2.44 | 0.741 | 250 | 5 |

**Table 6:** Tested Values

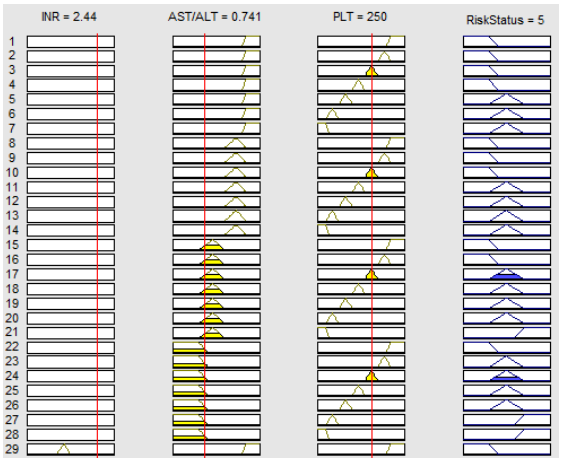


**Figure 5:** Result of Tested Values

## 4. Conclusion

The goal of this paper is design of a fuzzy expert system for the risk identification of Cirrhosis using Bonacini score. Using this system the need of the liver biopsy can be avoided[12]. The use of the fuzzy logic in the design of the system enhances the reasoning even in case of imprecise data. Combination of fuzzy logic and expert system increases the system performance.

## References

[1]. Cirrhosis sign and symptons available online at http://www.hcvadvocate.org/hepatitis/factsheets_pdf/cirrhosis_signs%20and%20symptoms.pdf

[2]. Dame Sheila Sherlock , "Alcoholic liver disease" The Lancet, Volume345, Issue 8944, Pages 227-229, (1995)

[3]. Hyung Joon Yim and Anna Suk-Fong Lok," Natural History of Chronic Hepatitis B Virus Infection: What We Knew in 1981 and What We Know in 2005", HEPATOLOGY, Pages 173-181, (2006)

[4]. "Fatty Liver Disease" , Available online at http://www.webmd.com/hepatitis/fatty-liver-disease.

[5]. Anthony S. Tavill, "Diagnosis and Management of Hemochromatosis", Hepatology, Pages 1321-1328, (2001).

[6]. Lucio Amitrano, Vincenzo Brancaccio, Maria Anna Guardascione, Maurizio Margaglione, Luigi Iannaccone, Giovanna D'andrea, Riccardo Marmo, Paul R. J. Ames And Antonio Balzano1, "Inherited Coagulation Disorders In Cirrhotic Patients With Portal Vein Thrombosis", Hepatology, Volume 31, Pages 345-348.

[7]. Cirrhosis – Symptoms available Online at http://www.webmd.com/digestive-disorders/tc/cirrhosis-symptoms

[8]. "How is cirrhosis diagnosed and evaluated?" Available online at http://www.medicinenet.com/cirrhosis/page4.htm

[9]. Gurung RB, Purbe B, Gyawali P, Risal P "The Ratio of Aspartate Aminotransferase to Alanine Aminotransferase (AST/ALT): the Correlation of Value with Underlying Severity of Alcoholic Liver Disease", KATHMANDU UNIVERSITY MEDICAL JOURNAL, VOL.11,Pages 233-236,(2013)

[10]. Tripodi A, Chantarangkul V, Primignani M, Fabris F, Dell'Era A, Sei C, Mannucci PM." The international normalized ratio calibrated for cirrhosis (INR(liver)) normalizes prothrombin time results for model for end-stage liver disease calculation",Hepatology ,Pages: 520-527,(2007).

[11]. Liu XD, Wu JL, Liang J, Zhang T, Sheng QS," Globulin-platelet model predicts minimal fibrosis and cirrhosis in chronic hepatitis B virus infected patients" ,World J Gastroenterol, Pages: 2784-92(2012).

[12]. Dana Crisan1, Corina Radu1, Mircea Dan Grigorescu, Monica Lupsor, Diana Feier1, Mircea Grigorescu1,"Prospective Non-Invasive Follow-up of Liver Fibrosis in Patients with Chronic hepatitis C" J Gastrointestin Liver Dis, Vol.21, (2012),Pages 375-382