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PROGNOSIS OF LIVER DISORDERS IN DNA POSITIVE HBV PATIENTS BASED ON FUZZY SOFT SETS

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ABSTRACT:
Liver disease and disorders are serious public health burdens because of the high prevalence among populations worldwide and poor long-term clinical outcome. The outcomes of the disease include deaths from liver decompensation, cirrhosis and HCC. Many liver diseases, including chronic HBV and HCV infection, ALD, NAFLD, autoimmune liver disease and drug-induced liver disease (DILI), potentially threaten a large proportion of the global population. The fuzzy soft set principle theory has been used for the developing of a diagnostic system in medicine and devise a prediction system named as fuzzy soft expert system which is a rule-based system uses fuzzy set and fuzzy soft set. There are five main components included in the basic structure, they are: (1) A fuzzication that translates the inputs (real-values) into fuzzy values, (2) obtaining fuzzy sets, (3) changing in to fuzzy soft sets, (4) reduction of normal parameter of fuzzy soft sets, (5) output data by algorithm. Fifty two individuals suspected and managed as HBV patients were involved in this study.All of them were attending liver diseases unit at Azadi teaching hospital in Duhok, Kurdistan Region-Iraq. They were being managed by the herpetology specialist as HBV infected patients. Their parameters (Alanine Aminotransferase (ALT), Aspartate aminotransferase (AST), Total Serum Albumin (Alb.), and Total Serum Bilirubin (T.S.Bil.)), were used as input data and the score of each patient was calculated. The developed fuzzy soft expert system was used to obtain the score for each as prognostic model for liver disorders. The score of 10 of those patients are selected and compared with the clinical status of each base on signs and symptoms of the HBV infection. Score more than 101.844 was considered to be highly linked with HBV infection. Scores less than 101.844 was considered to be not related to HBV infection.

KEYWORDS: Fuzzy soft expert system, Liver disorders disease, Mean corpuscular volume, Alkaline phosphates, Alanine aminotransferase.

1. INTRODUCTION

The liver is one of the vital organs of the human body and it is one of the members of the digestive tract that helps to digest food and get rid of toxic body materials. Liver diseases occur as a result of exposure to chemicals, infectious agents and harmful alcoholic drinks, but some people born with problems in the liver. Because of the high prevalence worldwide, liver disease cause serious public health problems, including premature deaths from liver decompensation, cirrhosis and HCC. There are several types of liver diseases, for example, at least 2 billion people worldwide are affected with HBV infection; among those, 350–400 million are considered as chronic HBV carriers. The HBV carrier rates vary from low (0.1%–2%) in the USA and Western Europe, to intermediate (2%–8%) in Mediterranean countries and Japan, and to high (8%–20%) in sub-Saharan Africa and most parts of Asia(Lok 2004). About 150 million people worldwide are affected with HCV infections, both ALD and NAFLD are highly prevalent in developed countries and reported to have prevalence of approximately 7.4% and 20%–33% in the general adult populations, respectively(Lazo et al. 2011; Rehm et al. 2013). In 2005, more than185 million people were estimated to be HCV-specific antibody positive, representing 2.8% of the world's population. However, there are marked differences in the HCV prevalence among different countries and regional age- and risk-groups, ranging from 0.1% to 5% (Cui et al. 2013). The presence of metabolic syndrome is a strong predictor for the presence of nonalcoholic steatohepatitis (NASH) in patients with NAFLD. Moreover, type 2 diabetes causes more severe steatohepatitis and advanced fibrosis, and patients with diabetes have an increased risk for cirrhosis and HCC. In general, all types of chronic hepatitis will finally progress into end-stage liver diseases (ESLD), such as cirrhosis, chronic LF, and HCC when remain without efficient treatment. The presence of hepatocyte death, reflected by increased of serum alanine amino transferase (ALT) and aspartate amino transferase (AST), is a widely used marker to screen and monitor patients with liver disorders. Moreover, these markers drive therapeutic decisions; have prognostic value for patients with hepatitis B virus (HBV)(Lok 2004; Lazo et al. 2011; Cui et al. 2013; Rehm et al. 2013), and hepatitis C virus (HCV)(Wiese et al. 2000; Ghany et al. 2003; Hui et al. 2003; Wiese et al. 2014). There were also no reports on the combination of liver lobe volume with albumin to determine the presence of esophageal varices in cirrhotic patients(Ranjith et al. 2003; Wiese et al. 2014). Many liver proteins are routinely measured in serum to diagnose liver dysfunction. For examples, serum aspartate amino transferase (AST), alanine amino transferase (ALT), and alkaline phosphatase (ALP) are useful diagnostic markers for liver diseases, including nonalcoholic fatty liver disease (NAFLD), which is a clinically important

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manifestation of the metabolic syndrome. Serum CRP levels are also increased in NAFLD (Kerner et al. 2005; Booth et al. 2008).

In the current study, it has been intended to develop a hepatic disorders fuzzy soft expert model based on fuzzy soft sets. This model simulates the physicians in the prognosis assessment process of the liver disorders. Many other medical expert systems have been established such as INTERNIST(Miller et al. 1982) and CADIAG-2 (Adlassnig et al. 1982). However, all of them have been applied to assess the risk factors of cardiac disease (Genest et al. 1991; Wung et al. 1999; Gamberger et al. 2003; Ranjith et al. 2003; Chirinos et al. 2007; Vaisi-Raygani et al. 2010).

The fuzzy expert system (FES) has a set of fuzzy rules and functions, i.e., acquisition of knowledge, is considered to be the important issue in the design and establishment of fuzzy expert system. However, it is difficult for the experts to define the exact rule set when there are too many potential rules. In a project conducted by (Neshat et al. 2008) for the diagnosis of liver disorders using the fuzzy expert system, all of the data used in this project, enabled liver disorders diagnosis according to their qualities, Hopfield neural network and fuzzy Hopfield neural network was also used for the diagnosis of liver disorders and it was presented for the first time by (Neshat et al. 2010). Diagnosing hepatitis disease by using fuzzy Hopfield neural network was introduced by (Neshat et al. 2014). Breast cancer and liver disorders classification using artificial immune recognition system (AIRS) with performance evaluation by fuzzy resource allocation mechanism was discussed by (Polat et al. 2007).

The current paper is designed as follows. Section 2 presents the fuzzy soft sets and data description. In Section 3, methods and the implementation of the potential system are presented. The experimental results are discussed in details in Section 4. Conclusions are presented in Section 5.

2. BACKGROUND

Zadeh (1965) introduced the theory of fuzzy sets. The fuzzy set theory has been used to solve problems in variable disciplines. But there exists a difficulty: how to set the membership function in each particular case. (Molodtsov 1999) initiated a novel concept of soft set theory, which is a completely new approach for modeling vagueness and uncertainty. Soft set theory has a rich potential for applications in several directions, few of which had been shown by Molodtsov in(Molodtsov 1999). After Molodtsov's work, some different applications of soft sets were studied in(Chen et al. 2005),(Maji et al. 2002). Recently, (Mohammed et al. 2016) used expert system it's called "Soft Expert System" for the prognosis and diagnosis the coronary artery disease. (Maji 2001) presented the definition of fuzzy soft set and Roy et al. presented some applications of this notion to decision making problems in(Roy et al. 2007). Using the fuzzy soft set theory, (Roy et al. 2007)have presented an algorithm for identification of an object, which is based on the comparison of different objects. Later, (Kong et al. 2009), pointed out that Roy's algorithm is incorrect and then they presented a modified algorithm, which is based on the comparison of choice values of different objects.(Bashir et al. 2013) introduced the concept of possibility of fuzzy soft expert set and also defines its basic operations, namely complement, union, intersection, AND & OR, studies some of their properties. Also it gives an application of this theory in solving a decision making in problems. In another study, (Adam et al. 2016)introduced the concept of a multi Qfuzzy soft expert set and its operations, which are equality, union, intersection and subset, OR& AND. and also illustrated application of this novel concept in a decision making process and it is expected that the approach will be useful to handle other realistic uncertain problems. (Hassan et al. 2016) studied and introduced a fuzzy soft expert system to be used for the prediction of patients who suffer from coronary artery disease. It is a pioneering approach that apply fuzzy soft sets to a medical problem solving. Hence, this pioneering application can be extended and expanded further to be implemented in other databases. (Hazaymeh et al. 2012) introduced the principle of generalized fuzzy soft expert set and explained some of its properties, also, the application of this theory has helped in decision making processes.

2.1 Soft Sets

Definition 2.1.1 (Zadeh 1965)A fuzzy subset A of a universal set X is defined by a membership function $\mu_A: X \to [0,1]$, where $\mu_A(x)$ is interpreted as a grade in which an element $x \in X$ has a property A, or a grade in which x is consistent to A. The closer the value of $\mu_A(x)$ is to 1, the more x belongs to A. Ais completely characterized by the set of pairs

$$A = \{(x, \mu_A(x)) | x \in X \text{ and } \mu_A : X \to [0,1]\}.$$

The classical union and intersection of ordinary subsets of X can be extended by the following formula, proposed by(Zadeh 1965):

$\forall x \in X$,

$\mu_{A\cap B}(x) = \min[\mu_A(x), \mu_B(x)]$,

$\forall x \in X, \quad \mu_{A\cup B}(x) = \max[\mu_A(x), \mu_B(x)]$,

Where $\mu_{A\cap B}$ and $\mu_{A\cup B}$ are, respectively, the membership functions of $A \cap B$ and $A \cup B$.

Definition 2.1.2 (Molodtsov 1999) Let X to be as an initial universe and E as set of parameters, and let P(X) be denoted as the power set of XandA $\sqsubset$ E. A pair (F, A) is referred to as soft set over X, where F is a mapping given by $F: A \to P(X)$. On the other hand, a soft set over X is a parameterized family of subsets of the universe X, for $\varepsilon \in A$, $F(\varepsilon)$ might be recognized as the set of ε −approximate elements of the soft set(F, A).

Definition 2.1.2 (Maji 2001) Let X refers to an initial universe and E as a set of parameters. Let I^X denote the fuzzy set of $X$and$A \sqsubset E$. A pair (F, A) is called fuzzy soft set over X, where F is a mapping given by $F: A \to I^X$.

Definition 2.1.3 (Maji 2001) (OR operation on fuzzy soft sets) If $(\tilde{F}, A)$ and $(\tilde{G}, B)$ are two fuzzy soft sets over X, then "$(\tilde{F}, A)$OR $(\tilde{G}, B)$" denoted by $(\tilde{F}, A)$ V $(\tilde{G}, B)$ is defined by $(\tilde{F}, A)$ V $(\tilde{G}, B) = (\tilde{H}, A \times B)$, where $\tilde{H}(\alpha, \beta) = \tilde{F}(\alpha) \sqcup \tilde{G}(\beta), \forall(\alpha, \beta) \in A \times B$, where $\sqcup$ is the union operation of fuzzy sets.

Algorithm 2.1.4.(Roy et al. 2007).

1. Input the fuzzy-soft-set $(\tilde{F}, A)$, $(\tilde{G}, B)$and$(\tilde{H}, C)$.
2. Input the parameter set P as observed by the observer.
3. Compute the corresponding resultant-fuzzy-soft-set $(\tilde{S}, P)$ from the fuzzy soft sets $(\tilde{F}, A)$, $(\tilde{G}, B)$ and $(\tilde{H}, C)$ and place it in tabular form.
4. Construct the Comparison table of the fuzzy-soft-set (S, P) and compute r_i and $t_i$for o_i, $\forall i$.
5. Compute the score of $o_i, \forall i$.
6. The decision is S_k if $S_k = \max_i S_i$.
7. If k has more than one value, then any one of o_k may be chosen.

Algorithm 2.1.5 (Kong et al. 2009).

From Step 4 the algorithm is revised as below: c_{ij} and $r_i$should be redesigned as

$c_{ij} = \sum_{k=1}^{m}(f_{ik} - f_{jk})$, and $r_i = \sum_{j=1}^{m} c_{ij}$, where f_{ik} is the value of the membership of the v_i object for the kth parameter, m is the parameters number.

Step 5: the decision is k if $r_k = \max_i r_i$.

2.2 Database Description

In the current study, the Data are obtained from patients recruited to the liver diseases unit at Azadi teaching hospital in Duhok, Kurdistan region. The attributes of the52 patients that were involved in the current study are:
(1) Alanine aminotransferase (ALT) or (SGPT)
(2) Aspartate aminotransferase (AST)
(3) Total Serum Albumin (Alb.)
(4) Total Serum Bilirubin (T.S.Bil.)

3. MATERIALS AND METHODS

The system discussed in the present work offers a diagnostic assistance concerned with liver diseases. The outputs obtained by the system are compared with independent diagnosis provided by physicians. The generic medical fuzzy soft expert system that has been designed has been examined, and it was found to be helpful in diagnosing the liver disease risk with certain accuracy. The basic structure of fuzzy soft expert system includes four main components, as depicted in (Fig. 1): (1) a fuzzication, which translates inputs (real-valued) into fuzzy values; (2) from fuzzication of data set to obtain fuzzy soft sets; (3) a new fuzzy soft sets by normal parameter reduction of fuzzy soft sets; (4) an algorithm to get the output data.

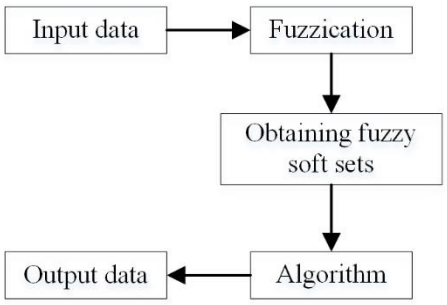

Figure 1. Fuzzy soft expert system basic structure

3.1 Computing of Data Set Membership Functions

The membership functions associated with each membership variable shape is defined using the membership function editor in the fuzzy tool box, each input variable membership functions are defined as follows:

3.1.1 Alanine Aminotransferase (ALT): Alanine Aminotransferase field is one of the most important factors considered in this system. In this field, we have 3 linguist variables (fuzzy sets) (Low (L), Normal (N) and High (H)). Membership functions of "Low" and "High" fuzzy sets are trapezoidal while membership function of "Normal" fuzzy sets is triangular as shown in Figure 2. We defined the fuzzy membership expressions for ALT input field as in Equation 1.

$$ALT_L(x) = \begin{cases} 1 & x \le 7 \\ \dfrac{9-x}{2} & 7 < x \le 9 \end{cases}$$

$$ALT_N(x) = \begin{cases} \dfrac{x-7}{24.5} & 7 \le x \le 31.5 \\ \dfrac{56-x}{24.5} & 31.5 < x \le 56 \end{cases}$$

$$ALT_H(x) = \begin{cases} \dfrac{(x-53)^3}{27} & 53 \le x < 56 \\ 1 & 56 \le x \end{cases} \quad (1)$$

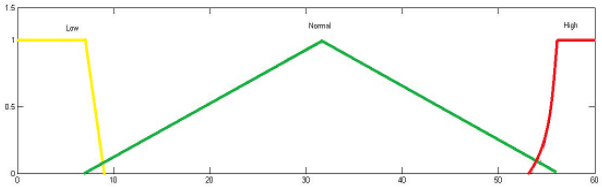

Figure 2. Membership function *ALT*

3.1.2 Aspartate aminotransferase (AST): The effect of aspartate aminotransferase level on the result was salient and can alter it easily. The alkaline phosphates field is categorized into three fuzzy sets are Low (L), Normal (N) and High (H)). Membership functions of "Low" and "Normal" sets are trapezoidal whereas membership functions of "High" sets are triangular. Membership functions of alkaline phosphates field are shown in Figure 3. The fuzzy membership expressions for the alkaline phosphates input field was defined as in Equation 2.

$$AST_L(x) = \begin{cases} 1 & x \le 10 \\ \dfrac{12-x}{2} & 10 < x \le 12 \end{cases}$$

$$AST_N(x) = \begin{cases} \dfrac{x-10}{15} & 10 \le x \le 25 \\ \dfrac{43-x}{18} & 25 < x \le 43 \end{cases}$$

$$AST_H(x) = \begin{cases} \dfrac{(X-38)^2}{8} & 38 \le x < 40 \\ 1 & 40 \le x \end{cases} \quad (2)$$

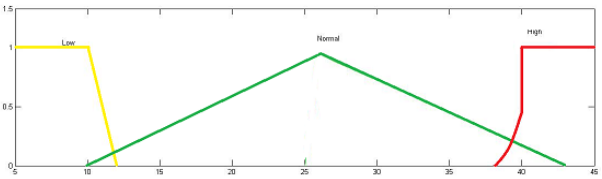

Figure 3. Membership function *AST*

3.1.3 Total Serum Albumin (Alb.): variable values of total Serum Albumin may be easily contribute to the alteration of the results. The input variables were classified into three fuzzy sets, they were (L) low, (N) Normal, and (H) high. The membership functions of "low" and "high" were trapezoidal while membership functions of "Normal" were triangular. We defined the fuzzy membership expressions for mean corpuscular volume input field as in Equation 3. The membership functions of the mean corpuscular volume (MCV) field are illustrated in Figure 4.

$$Albumin_L(x) = \begin{cases} 1 & x \le 3.4 \\ \dfrac{3.6-x}{0.2} & 3.4 < x \le 3.6 \end{cases}$$

$$Albumin_N(x) = \begin{cases} \dfrac{x-3.2}{1.2} & 3.2 \le x \le 4.4 \\ \dfrac{5.5-x}{1.1} & 4.4 < x \le 5.5 \end{cases}$$

$$Albumin_H(x) = \begin{cases} (\dfrac{x-5.2}{0.2})^4 & 5.2 \le x \le 5.4 \\ 1 & 5.4 < x \end{cases} \quad (3)$$

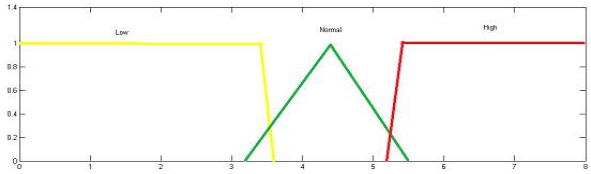

Figure 4. Membership function *Alb*

3.1.4 Total Serum Bilirubin (T.S.Bil.): Total Serum Bilirubin field is one of the most important factors considered in this system. In this field, we have 3 linguist variables is categorized into three fuzzy sets are Low (L), Normal (N), High (H). Membership functions of "Low" and "High" fuzzy sets are trapezoidal while membership function of "Normal" fuzzy sets is triangular as shown in Figure 5. We defined the fuzzy membership expressions for Total Serum Bilirubin field as in Equation 4.

$$T.Beli_L(x) = \begin{cases} 1 & x \le 0.3 \\ \dfrac{0.4 - x}{0.1} & 0.3 < x \le 0.4 \end{cases}$$

$$T.Beli_N(x) = \begin{cases} \dfrac{x - 0.3}{0.65} & 0.3 < x \le 0.95 \\ \dfrac{2 - x}{1.05} & 0.95 < x \le 2 \end{cases}$$

$$T.Beli_H(x) = \begin{cases} (\dfrac{x - 1.7}{0.2})^2 & 1.7 \le x < 1.9 \\ 1 & 1.9 \le x \end{cases} \quad (4)$$

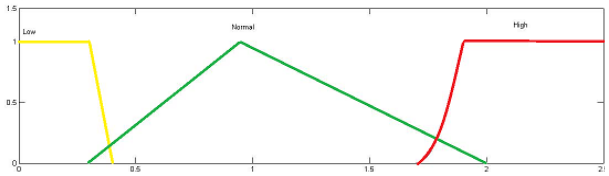

Figure 5. Membership function *T. Bil*

4. RESULTS AND DISCUSSIONS

The present study has been achieved on lab data of 52HBV patients recruited attended the hepatology unit at Azadi teaching hospital, Duhok city. The data of only ten patients are interpreted. Input values of those patients are shown in Table 1.

Table 1. The input values of ten DNA positive HBV patients compared with DNA negative individuals.

Patients	ALT	AST	Albumin	T.S.Bil
P1	17	12	4.26	0.16
P8	130	65	4.91	0.14
P14	64	33	4.97	0.27
P20	14	14	5.33	0.37
P27	19	22	3.72	0.52
P33	21	17	4.69	0.72
P39	24	22	5.37	2.99
P45	34	28	4.44	0.9
P48	94	46	4.83	0.24
P52	130	108	4.3	1.25

The data in Table 1 is not convenient for applying to fuzzy soft sets directly. For reason, we are using Equations (1-4) to get patients values as shown in Table 2.

Table 2. The membership functions of some patients.

Patients	ALT	AST	Albumin	T.S.Bil
P1	0.40N	0.13N	0.88N	1L
P8	1H	1H	0.53N	1L
P14	1H	0.55N	0.48N	1L
P20	0.28N	0.26N	0.15N,0.03H	0.1N
P27	0.48N	0.8N	0.43N	0.33N
P33	0.57N	0.46N	0.73N	0.64L
P39	0.69N	0.8N	0.11N,0.27H	1H
P45	0.89N	0.83N	1N	0.92N
P48	1H	1H	0.60N	1L
P52	1H	1H	0.91N	0.71N

4.1 Fuzzy Soft Sets Obtaining

A fuzzy soft set is the combination of the result of a fuzzy set and a soft set theory. Thus, a fuzzy set can be transformed to a fuzzy soft set.

Let $U = \{p1, p2, p3, \dots, p52\}$ be the set of fifty two adult patients and the parameter $E = \{(ALT)L, (ALT)N, (ALT)H, (AST)L, (AST)N, (AST)H, (Albumin)L, (Albumin)N, (Albumin)H, (T.Bil)L, (T.Bil)N, (T.Bil)H\}$. Suppose that $A, B, C, D \subset E$, where

$A = \{(ALT)L, (ALT)N, (ALT)H\}$,
$B = \{(AST)L, (AST)N, (AST)H\}$,
$C = \{(Albumin)L, (Albumin)N, (Albumin)H\}$ *and*
$D = \{(T.Bil)L, (T.Bil)N, (T.Bil)H\}$.

Now, some fuzzy soft sets of E as

$F: A \to I^X$, $G: B \to I^X$, $H: C \to I^X$, $M: D \to I^X$, each fuzzy soft can be written in the form $\left\{\frac{pi}{j}, i = 1,2,3, \dots 52 \text{ and } j \in [0,1]\right\}$

$$F(ALT)L = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{0}, \dots, \frac{p52}{0}\right\},$$

$$F(ALT)N = \left\{\frac{p1}{0.40}, \frac{p2}{0.65}, \frac{p3}{0}, \dots, \frac{p51}{0.36}, \frac{p52}{0}\right\},$$

$$F(ALT)H = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{1}, \dots, \frac{p41}{0.03}, \dots, \frac{p51}{0}, \frac{p52}{1}\right\},$$

$$G(AST)L = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{0}, \frac{p4}{0}, \frac{p5}{1}, \dots, \frac{p47}{1}, \dots, \frac{p52}{0}\right\},$$

$$G(AST)N = \left\{\frac{p1}{0.13}, \frac{p2}{0.93}, \frac{p3}{0}, \dots, \frac{p51}{0.53}, \frac{p52}{0}\right\},$$

$$G(AST)H = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{1}, \dots, \frac{p8}{1,}, \frac{p9}{1}, \dots, \frac{p37}{0.12}, \dots, \frac{p52}{1}\right\},$$

$$H(Albumin)L = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{0}, \dots, \frac{p19}{1}, \dots, \frac{p23}{1}, \dots, \frac{p52}{0}\right\},$$

$$H(Albumin)N = \left\{\frac{p1}{0.88}, \frac{p2}{0.65}, \frac{p3}{0.29}, \dots, \frac{p52}{0.91}\right\},$$

$$H(Albumin)H = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{0}, \dots, \frac{p20}{0.03}, \dots, \frac{p39}{0.27}, \dots, \frac{p52}{0}\right\},$$

$$M(T.Bil)L = \left\{\frac{p1}{1}, \frac{p2}{0}, \frac{p3}{0}, \dots, \frac{p6}{0.2}, \dots, \frac{p52}{0}\right\},$$

$$M(T.Bil)N = \left\{\frac{p1}{0}, \frac{p2}{0.38}, \frac{p3}{0.45}, \dots, \frac{p43}{0.47}, \dots, \frac{p52}{0.71}\right\}, \text{ and}$$

$$M(T.Bil)H = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{0}, \frac{p4}{0}, \frac{p5}{1}, \frac{p6}{0}, \dots, \frac{p18}{1}, \frac{p19}{1}, \dots, \frac{p52}{0}\right\}.$$

4.2 Reduction of Normal Parameter of the Fuzzy Soft Sets

In problems needing decision making, parameter reduction is an important issue. In such process, the parameters' number in a problem could be minimized efficiently and only highlighting the key parameters, for that we used (Kong et al. 2008) for a fuzzy soft set $(\tilde{F}, A)$ describe the 'ALT', the fuzzy soft set $(\tilde{G}, B)$ describes the 'AST', the fuzzy soft set $(\tilde{H}, C)$ describes the '$Albumin$' and the fuzzy soft set $(\tilde{M}, D)$ describes the '$T.S.Bil$'. Now, we can obtain a new fuzzy soft sets as following:

$$F(ALT)N = \left\{\frac{p1}{0.40}, \frac{p2}{0.65}, \frac{p3}{0}, \dots, \frac{p51}{0.36}, \frac{p52}{0}\right\},$$

$$F(ALT)H = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{1}, \dots, \frac{p41}{0.03}, \dots, \frac{p51}{0}, \frac{p52}{1}\right\},$$
$$G(AST)L = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{0}, \frac{p4}{0}, \frac{p5}{1}, \dots, \frac{p47}{1}, \dots, \frac{p52}{0}\right\},$$
$$G(AST)N = \left\{\frac{p1}{0.13}, \frac{p2}{0.93}, \frac{p3}{0}, \dots, \frac{p51}{0.53}, \frac{p52}{0}\right\},$$
$$G(AST)H = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{1}, \dots, \frac{p8}{1,}, \frac{p9}{1}, \dots, \frac{p37}{0.12}, \dots, \frac{p52}{1}\right\},$$
$$H(Albumin)L = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{0}, \dots, \frac{p19}{1}, \dots, \frac{p23}{1}, \dots, \frac{p52}{0}\right\},$$
$$H(Albumin)N = \left\{\frac{p1}{0.88}, \frac{p2}{0.65}, \frac{p3}{0.29}, \dots, \frac{p52}{0.91}\right\},$$
$$H(Albumin)H = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{0}, \dots, \frac{p20}{0.03}, \dots, \frac{p39}{0.27}, \dots, \frac{p52}{0}\right\},$$
$$M(T.Bil)L = \left\{\frac{p1}{1}, \frac{p2}{0}, \frac{p3}{0}, \dots, \frac{p6}{0.2}, \dots, \frac{p52}{0}\right\},$$
$$M(T.Bil)N = \left\{\frac{p1}{0}, \frac{p2}{0.38}, \frac{p3}{0.45}, \dots, \frac{p43}{0.47}, \dots, \frac{p52}{0.71}\right\}, \text{ and}$$
$$M(T.Bil)H = \left\{\frac{p1}{0}, \frac{p2}{0}, \frac{p3}{0}, \frac{p4}{0}, \frac{p5}{1}, \frac{p6}{0}, \dots, \frac{p18}{1}, \frac{p19}{1}, \dots, \frac{p52}{0}\right\}.$$

Thus each fuzzy soft of the form $\left\{\frac{pi}{j}, i = 1,2,3, \dots 52 \; and \; j = 0\right\}$ is neglected.

4.3 Algorithm

By using the algorithm, it patient that suffer a liver disorders will be predictable 2.1.4. according to the following steps:

1- Input new fuzzy soft sets $(\tilde{F}, A), (\tilde{G}, B), (\tilde{H}, C), (\tilde{M}, D)$ as shown inTables 3- 6.

Table 3. Some fuzzy soft set $(\tilde{F}, A)$.

Patients	*(ALT)N=ε_1*	*(ALT)H=ε_2*
P1	0.40	0
P8	0	1
P14	0	1
P20	0.28	0
P27	0.48	0
P33	0.57	0
P39	0.69	0
P45	0.89	0
P48	0	1
P52	0	1

Table 4. Some fuzzy soft set $(\tilde{G}, B)$.

Patients	*(AST)L=ε_3*	*(AST)N=ε_4*	*(AST)H=ε_5*
P1	0	0.13	0
P8	0	0	1
P14	0	0.55	0
P20	0	0.26	0
P27	0	0.8	0
P33	0	0.46	0
P39	0	0.8	0
P45	0	0.83	0
P48	0	0	1
P52	0	0	1

Table 5. Some fuzzy soft set $(\tilde{H}, C)$.

Patients	*(Albumin)L=ε_6*	*(Albumin)N=ε_7*	*(Albumin)H=ε_8*
P1	0	0.88	0
P8	0	0.53	0
P14	0	0.48	0
P20	0	0.15	0.03
P27	0	0.43	0
P33	0	0.73	0
P39	0	0.11	0.27
P45	0	1	0
P48	0	0.60	0
P52	0	0.91	0

Table 6. Some fuzzy soft set $(\tilde{M}, D)$.

Patients	*(T.S.Bil)L=ε_9*	*(T.S.Bil)N=ε_{10}*	*(T.S.Bil)H=ε_{11}*
P1	1	0	0
P8	1	0	0
P14	1	0	0
P20	0	0.1	0
P27	0	0.33	0
P33	0.64	0	0
P39	0	0	1
P45	0	0.92	0
P48	1	0	0
P52	0	0.71	0

2- Using the "OR" operation between the new fuzzy soft sets $(\tilde{F}, A), (\tilde{G}, B), (\tilde{H}, C), (\tilde{M}, D)$as shown in Tables 7- 8.

3- Compute c_{ij} and r_i, as described by using Algorithm 2.1.5. From (Tables 7 - 9), we can obtain r_1 =-69.755, r_8 = 302.564, r_{14} = 145.004, r_{20} = -639.676, r_{27} = -225.236, r_{33} = -112.915, r_{39} = 101.844, r_{45} = 270.844, r_{48} = 323.884, , r_{52} = 254.204.

4- As can be seen, patients:P_8 , P_{14}, P_{45}, P_{48}&P_{52}have very high values of r_i. Hence this patient is potentially suffering from liver disorders. The relationship between P_i and r_i where $i = 1, 8, 14, 20, 27, 33, 39, 45, 48, 52$ is illustrated in (Figure 7).

Table 7. Some results of fuzzy soft set $(\tilde{L}, E)$.

Patients	ε_{13}	ε_{14}	ε_{15}	ε_{23}	ε_{24}	ε_{25}	ε_{16}	ε_{17}	ε_{18}	ε_{26}	ε_{27}	ε_{28}	ε_{19}	ε_{110}	ε_{111}	ε_{29}
P1	0.40	0.40	0.40	0	0.40	0	0.4	0.88	0.4	0	0.88	0	1	0.40	0.40	1
P8	0	0	1	1	1	1	0	0.53	0	1	1	1	1	0	0	1
P14	0	0.55	0	1	1	1	0	0.48	0	1	1	1	1	0	0	1
P20	0.28	0.98	0.28	0	0.26	0	0.28	0.28	0.28	0	0.15	0.03	0.28	0.28	0.28	0
P27	0.48	0.8	0.48	0	0.8	0	0.48	0.48	0.48	0	0.43	0	0.48	0.48	0.48	0
P33	0.57	0.57	0.57	0	0.46	0	0.57	0.73	0.57	0	0.73	0	0.64	0.57	0.57	0.64
P39	0.69	0.8	0.69	0	0.8	0	0.69	0.69	0.69	0	0.11	0.27	0.69	0.69	1	0
P45	0.89	0.89	0.89	0	0.83	0	0.89	1	0.89	0	1	0	0.89	0.92	0.89	0
P48	0	0	1	1	1	1	0	0.60	0	1	1	1	1	0	0	1
P52	0	0	1	1	1	1	0	0.91	0	1	1	1	0	0.71	0	1

Table 8. Some results of fuzzy soft set $(\tilde{L}, E)$.

Patients	ε_{210}	ε_{211}	ε_{36}	ε_{37}	ε_{38}	ε_{46}	ε_{47}	ε_{48}	ε_{56}	ε_{57}	ε_{58}	ε_{39}	ε_{310}	ε_{311}	ε_{49}
P1	0	0	0	0.88	0	0.13	0.88	0.13	0	0.88	0	1	0	0	1
P8	1	1	0	0.53	0	0	0.53	0	1	1	1	1	0	0	1
P14	1	1	0	0.40	0	0.55	0.55	0.55	0	0.48	0	1	0	0	1
P20	0.1	0	0	0.15	0	0.26	0.26	0.26	0	0.15	0.03	0	0.1	0	0.26
P27	0.33	0	0	0.43	0	0.8	0.8	0.8	0	0.43	0	0	0.33	0	0.8
P33	0	0	0	0.73	0	0.46	0.73	0.46	0	0.73	0	0.69	0	0	0.64
P39	0	1	0	0.11	0.27	0.8	0.8	0.8	0	0.11	0..27	0	0	1	0.8
P45	0.92	0	0	1	0	0.83	0.91	0.83	0	1	0	0	0.92	0	0.22
P48	1	1	0	0.60	0	0	0.66	0	1	1	1	1	0	0	1
P52	0.71	0	0	0.91	0	0	0.91	0	1	1	1	0	0.71	0	0

Table 9. The some results of fuzzy soft set $(\tilde{L}, E)$.

Patients	ε_{410}	ε_{411}	ε_{59}	ε_{510}	ε_{511}	ε_{69}	ε_{610}	ε_{611}	ε_{79}	ε_{10}	ε_{711}	ε_{89}	ε_{810}	ε_{811}
P1	0.13	0.13	1	0	0	1	0	0	1	0.49	0.88	1	0	0
P8	0	0	1	1	1	1	0	0	1	0.53	0.53	1	0	0
P14	0.55	0.55	1	0	0	1	0	0	1	0.48	0.48	1	0	0
P20	0.26	0.26	0	0.1	0	0	0.1	0	0.15	0.15	0.15	0	0.1	0.03
P27	0.8	0.8	0	0.33	0	0	0.33	0	0.43	0.43	0.43	0.03	0.33	0
P33	0.46	0.46	0.64	0	0	0.64	0	0	0.73	0.73	0.73	0.64	0	0
P39	0.8	1	0	0	1	0	0	1	0.11	0.11	1	1	0.27	1
P45	0.92	0.83	0	0.92	0	0	0.92	0	1	0.92	1	0	0.92	0
P48	0	0	1	1	1	1	0	0	1	0.60	0.60	1	0	0
P52	0.71	0	1	1	1	0	0.71	0	0.91	0.91	0.91	0	0.71	0

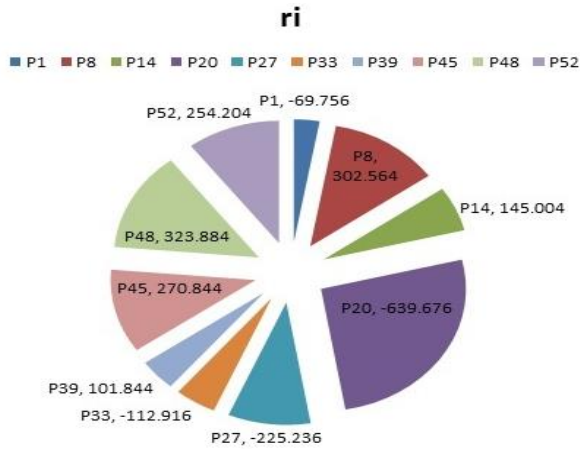

Figure 6. The relationship between P_i and r_i.

5. CONCLUSIONS

Based on the scores obtained from the data of the ten patients involved in present study, a a fuzzy soft expert system has been developed for the prediction of liver disorders among patients depending on Alanine Aminotransferase *(ALT),* Aspartate aminotransferase *(AST),* Total Serum Albumin *(Alb.)* and Total Serum Bilirubin *(T.S.Bil.)* parameters. This would a pioneering trend that apply fuzzy the soft sets and implement it in the field of medical diagnosis in a way of predicting patients that are have from Liver Disorders in DNA Positive HBV Patients. Table 10 shows the final score for these ten patients and the corresponding action taken by the assigned specialist doctor. It helps the physician to take the clinical decision. Scores shown in Table 10 are comparing between DNA positive HBV patients and DNA negative individuals. Moreover, it has been concluded that patients with HBV score greater than 101. 844 more likely will have liver disorders.

Table 10. Score of each of the ten patients based on the fuzzy soft set formula

Patients	ALT	AST	Albumin	T.S.Bil.	Viral DNA load by (PCR)	r_i- HBV*	Decision
P1	17	12	4.26	0.16	Negative	-69.756	Low prognosis
P8	130	65	4.91	0.14	1965 iu/ml	302.564	High prognosis
P14	64	33	4.97	0.27	6477 iu/ml	145.004	High prognosis
P20	14	14	5.33	0.37	Negative	-639.676	Low prognosis
P27	19	22	3.72	0.52	Negative	-225.236	Low prognosis
P33	21	17	4.69	0.72	Negative	-112.916	Low prognosis
P39	24	22	5.37	2.99	Negative	101.844	Low prognosis
P45	34	28	4.44	0.9	351.26 * 10^7iu/ml	270.844	High prognosis
P48	94	46	4.83	0.24	26.2*10^3 iu/ml	323.884	High prognosis
P52	130	108	4.3	1.25	3732666 iu/ml	254.204	High prognosis

* Represents the score of each patient based on (fuzzy soft set formula).

The formula could be designed as computer software that is applicable for data entry by the lab technicians or the physicians to get the right score of any managed patient and to interpret the degree of prognosis of the function.

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پێشبینیکرن ب تێکچوونا مێلاکێ ل دەڤ نەخوشیێن کولبوونا فایروسیێا مێلاکێ ژجورێ Bئەوێن ئەرینیDAN، پشتبەستیل سەر کومێن مژداریێ هویر

کورتیا لێکولینێ:

نەخوشییێن مێلاکێ دی بنە ئەگەرێن گەلک نەخوشییێن ترسناک دناف جڤاکاندا ئەوژی ژ بەر بەلاڤبونا وێ د جیهانێ دا. لدیف مەترسیا وێ تشتێن نەجاڤەرێکری تێن و دووماهیا وێ کو رەنگە بێبیت ئەگەرێ مرنا زوو وشەمابوونا مێلاکێ ورەنگە بکەهیتە وی رادی کو شێرەپێنج پیدابیت.گەلک جورێن نەخووشیا مێلاکێ یێن هەیێت ئەوژی لدیف جورێ ئەگەرانە. بەلکی مێلاک تووشی کول بوونێ بیت ژ جورێ (B)یان (C) بەلکی یان ژی ژئەگەری لاواز بونا بەرگریا خودی یان ژی ب ئەگەرێ خوارنا هندەک دەرمانا. چەمکێ تیوری یێن کومێن مژداری هوویر هاتە بەرفرهکرن بو پێژڤەبرنا سیستەمێ زانینێ دبیاڤێ نوژداری دا وپیداکرنا رێکەکێ بو هەستکرنا پێشوخت ژ کاودانین نەخوشییێئەوژی سیستەمێ شارەزایێ مژووی هوویر کو پێک دهێت(1)مژوویکرنا بیناتا (2)دیارکرنا کومێن مژووی (3)دیارکرنا کومێن مژداریێ هویر(4)ژێبرنا پرامتەرێن سروشتی ژ کومێن مژووی وهوویر(5)بکارئینانا خوارزمییێن تایبەت بو بدەستڤەئینانا ئەنجامێن دەرکی. د ڤێ ڤەکولینێ دا پێزانیین (بیانات) ژ (52)کەسێن راژا نەخووشیا وان بکولبونا مێلاکێ ژ جورێ (B) هاتبی دیارکرن ژ لایێ تایبەتمندێن نەخوشیا میلاکێ ل نەخوشخانا ئازادی یافێرکرنی ل دهوکێ وپشت بەستن هاتەکرن لدیف ڤان کارتێکەرا (ALT, AST, Albumin, T.S.Bilirubin)داکو بهینە هژمارتن د خوارزمیادا وبدەستڤەئینانا پیڤەرەکی دەستنیشانکری دا پشت بێ بهیتە بەستن بو دیارکرنا پیوەندی دنافبەرا کارتێکەرا ونەخوشیا نەساخا. هاتەبکارئینان سیستەمێ(شارەزایێ مژووی هووير) بودیارکرنا پیڤەرێ کومەکا (10)کەسی ژکوما (52)کەسا هاتنەوەرگرتن ودیار بو پیڤەر مەزنتربیت ژ (101.844) پیوندیکا بتوند هەیە دنافبەرا راژا نەخوشی وپیڤەری دگەل هەبونا نیشانییێن نەخوشیا مێلاکێ ژ جورێ (B) ئەگەر پیڤەرکێمتربیت ژ(101.844) دیاربو نیشانییێن دورستاهی ب کولبونا مێلاکێ ژ جورێ (B) نینە.

التنبؤ باضطرابات الكبد لدى مرضى التهاب الكبد الفايروسي من نوع B ايجابين DNA بالاعتماد على المجموعات الضبابية الناعمة

خلاصة البحث:

تتسبب أمراض الكبد بمشاكل صحيه خطيره بين المجتمعات وذلك لأنتشارها الواسع في العالم وخطورة عواقبها التي لا يمكن التكهن بها والتي تتضمن الموت المبكر وتضرر الكبد وتشمعه وقد تصل الى حد ألأصابه بسرطان الكبد. يوجد العديد من أمراض الكبد وتختلف بأختلاف المسبب فقد تتسبب من الأصابه بألتهاب الكبد نوع (B) أو نوع (C) او قد تكون نتيجه الأمراض الذاتية المناعه أو قد يكون الضرر ناتج عن تناول بعض الأدويه. أن مفهوم نظرية المجموعات الضبابية الناعمة قد تم توسيعها لتطوير نظام معرفي في مجال الطب وتكوين وسيلة للتنبؤ بالحالات المرضية وتم تسميتها على أنها (أنظمة الخبير الضبابية الناعمه) حيث تتضمن (1) تضبب البيانات (2) أيجاد المجموعات الضبابيه (3) أيجاد المجموعات الضبابيه الناعمه (4) أختزال المعاملات الطبيعيه للمجموعات الضبابيه الناعمه 5- أستخدام الخوارزميات للتوصل الى المعطيات الخارجه . من خلال هذه الدراسه تم أدخال البيانات ل (52)مريض مشخص بالأصابه بمرض ألتهاب الكبد الفيروسي نوع ب والذين تم تشخيصهم من قبل أخصائي أمراض الكبد في مستشفى أزادي التعليمي في دهوك. تم الأعتماد على البيانات التاليه (ALT, AST, Albumin, T.S.Bilirubin)لأدخالها في الخوارزميات والحصول على مقياس معين للأعتماد عليه في تقديرالعلاقه بين المعطيات والحاله المرضيه للمصاب. تم أستخدام (أنظمة الخبير الضبابية الناعمه) لأيجاد المقياس حيث وجد من خلال أختيار عينه من عشرة أشخاص من المشاركين في الدراسة بأنه عندما يكون المقياس اكبر من 844 .101 توجد علاقه قويه بين الحاله المرضيه والمقياس مع وجود اعراض الأصابه في حين عندما يكون المقياس اقل من 844 .101 فقد وجد بأنه لا توجد أعراض حقيقيه للأصابه بمرض ألتهاب الكبد الفيروسي نوع (B).