Fuzzy neural network method for assessing the effectiveness of odontogenic phlegmons treatment of the maxillofacial region

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ABSTRACT

The paper analyzes the main areas of application of mathematical methods in medical diagnostics, formulates the principles of diagnostics based on fuzzy logic. The basic structure of the MIS medical information system for assessing the degree of engraftment of effectiveness of odontogenic phlegmons treatment of the maxillofacial region was developed and the main recommendations for its design were put forward, namely: the selection and purpose of the system; selection of the structural scheme of the system; formation and analysis of the list of nosological forms, collection of statistically reliable information about the severity of symptoms; choosing a method of processing biomedical information; construction of an algorithm for solving the problems of evaluating biomedical information and forming diagnostic and prognostic conclusions. The practical value of the work lies in the possibility of using an automated medical expert system to solve the problems of medical diagnosis based on fuzzy logic when assessing the degree of engraftment of effectiveness of odontogenic phlegmons treatment of the maxillofacial region.

Keywords: medical expert systems; fuzzy logic; patient safety, odontogenic phlegmons, supporting diagnostic decision-making based on fuzzy logic

1. INTRODUCTION

Today, the treatment of odontogenic phlegmons of the maxillofacial region remains an extremely urgent problem in the practice of maxillofacial surgery against the background of the numerical increase in their frequency and adverse consequences, especially in liver pathology. In this case, an important role is played by impaired microcirculation at the level of localization of the abscess. In this regard, a constant search is underway for ways to increase the effectiveness of treatment of patients with odontogenic phlegmons of the maxillofacial region, new technologies for diagnosis and surgical and medical treatment of this contingent of patients are being developed and implemented in practice, taking into account the impact on the blood supply of the affected area. Most often, the spread of purulent inflammation occurs from the teeth of the lower jaw, most often after extraction to spread, which leads to complications - submandibular phlegmon, which very often develops as a result of the spread of carious teeth: damage to the periosteum of the gums to the submandibular lymph nodes. Inflammatory processes of the tissues of the maxillofacial region in all cases are infectious in nature, that is, in their occurrence, development and course, an important role belongs to the microbial flora[1,2,3].

The article analyzes the main directions of the prospects for the application of mathematical methods in medical diagnostics based on fuzzy logic for assessing the effectiveness of treatment of odontogenic phlegmons of the maxillofacial region. The basic structure of the medical information system MIS for assessing the dynamics of treatment of odontogenic phlegmons has been developed. The results of the study allowed us to conclude that the results obtained are highly reliable when assessing the effectiveness of treatment of odontogenic phlegmons of the maxillofacial region. The practical value of the work is realized in the possibility of using an automated medical expert system to solve medical diagnostic problems based on fuzzy logic for assessing the effectiveness of treatment of odontogenic phlegmons of the maxillofacial region[4,5,6].

The *purpose of the study* is to develop a mathematical model for evaluating the effectiveness of treatment of odontogenic phlegmons of the maxillofacial region.

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2. FEATURES OF USING EXPERT MEDICAL SYSTEMS TO ASSESS THE EFFECTIVENESS OF ODONTOGENIC PHLEGMONS TREATMENT OF THE MAXILLOFACIAL AREA

Odontogenic phlegmons of the maxillofacial area (MFA) are purulent-inflammatory processes that develop in soft tissues due to infections originating from the teeth or periodontium. They can lead to severe complications: sepsis, mediastinitis, cerebral sinus thrombosis, etc. Effective treatment requires rapid diagnosis, monitoring of the patient's condition and correction of therapy[7,8,9].

The role of expert medical systems (EMS). EMS are intelligent computer programs that simulate expert decisions in a certain medical field. They can:

- analyze clinical and laboratory data;
- recommend treatment measures;
- predict the effectiveness of therapy;
- identify the risk of complications.

Advantages of using EMS

- Reduction of medical errors;
- Acceleration of diagnosis and decision-making;
- Objectification of assessment of treatment effectiveness;
- Possibility of long-term monitoring of treatment results.

Limitations and challenges

- The need for high-quality data entry;
- Possible errors in the case of incomplete anamnesis;
- High cost of implementation;
- Perception of EMS as a “competitor” of the doctor, rather than an assistant.

Features of the use of EMS in the treatment of odontogenic phlegmons of the maxillofacial region (main functions): presented in tables 1 and 2.

Table 1. Main functions of odontogenic phlegmons treatment of the maxillofacial region

Function	Description
Assessment of the severity of the condition	Based on symptoms, blood parameters (leukocytosis, ESR, C-reactive protein), temperature, pulse
Choosing the optimal treatment	Based on anamnesis, presence of concomitant diseases (diabetes mellitus, immunodeficiency))
Choosing the optimal treatment	Recommendations for antibiotic therapy, the need for surgical intervention
Monitoring the effectiveness	Assessment of the dynamics of the inflammatory process, the effectiveness of antibiotics

Table 2. Examples of EMS in maxillofacial surgery

System name	Brief description
DentalExpert	Decision support system for the assessment of infectious and inflammatory processes in dentistry
MDSS (Medical Decision Support System)	Platform for clinical decision-making, in particular in the treatment of phlegmon
AI-DentMax	Expert system with elements of artificial intelligence for the prediction of the effectiveness of antibiotic therapy

Expert medical systems play an increasingly important role in the treatment of odontogenic phlegmons of the maxillofacial region. They contribute to increasing the effectiveness of therapy, more accurate prediction of the course of the disease and reducing the risk of complications. At the same time, their successful use requires integration with electronic medical records and training of medical personnel[10,11,12].

3. MATERIALS AND METHODS

Clinical examination of patients was carried out on the basis of the Department of Surgical Dentistry and Maxillofacial Surgery of the Vinnytsia National Medical University named after M. I. Pirogov in the Department of Maxillofacial Surgery of the Vinnytsia Regional Clinical Hospital named after M. I. Pirogov. The studies were performed in compliance with the main provisions of the "Rules of Ethical Principles for Conducting Scientific Medical Research with Human Participation", approved by the Declaration of Helsinki (1964-2013), ICH GCP (1996), EEC Directive No. 609 (dated 11/24/1986), orders of the Ministry of Health of Ukraine No. 690 dated 09/23/2009, No. 944 dated 12/14/2009, No. 616 dated 08/03/2012. All patients gave voluntary written informed consent to the examination in advance.

In the dental clinic, 37 patients with odontogenic facial phlegmons who received standard treatment and without liver pathology were examined. The patients' ages ranged from 22 to 45 years. All patients underwent densitometric (research of erythrocyte sedimentation rate, G-index of nuclear leukocytes), biochemical (alkaline phosphatase, bilirubin) and oral hygiene examination (Fedorov-Volodkin index). All patients were divided into 3 groups: control group, n =10, patients with odontogenic facial phlegmons who received standard treatment and without liver pathology; comparison group, n =12, patients with odontogenic facial phlegmons who received standard treatment on the background of chronic liver pathology; main group, n =15, patients with odontogenic facial phlegmons who received the proposed treatment on the background of liver pathology.

Glutargin and topical Inflorax were additionally administered to the standard treatment. The study was conducted on the 3rd, 7th, and 10th day. The use of Glutargin and topical Inflorax in the complex treatment of odontogenic phlegmon of the maxillofacial region allows improving microcirculation in the area of inflammation, which will accelerate the recovery of patients and reduce the number of complications.

Expert database for determining the degree of engraftment of effectiveness of odontogenic phlegmons treatment of the maxillofacial region is shown in table 3.

Table 3. Expert database for determining the degree of engraftment of effectiveness of odontogenic phlegmons treatment of the maxillofacial region

Degree of engraftment	ESR, or erythrocyte sedimentation rate, mm/h					Indicator of rod nuclear leukocytes					Total hemoglobin level (μmol/l)					Alkaline phosphatase (units/l)					Fedorov-Volodkin Index				
	0 ÷10	10.1÷ 20.0	20.1÷ 30.0	30.1÷ 40.0	40.1÷ 100	0÷ 3	4÷ 6	7÷ 9	10÷ 12	13÷ 30	0 ÷10	10.1÷ 20.0	20.1÷ 30.0	30.1÷ 40.0	40.1÷ 100	35 ÷79	80÷ 119	120÷ 159	160 ÷199	200÷ 500	1.1 ÷1.5	1.6 ÷2.0	2.1÷ 2.5	2.6÷ 3.4	3.5÷ 5.0
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
High	+					+					+					+					+				
Sufficient		+					+					+					+					+			
Moderate			+					+					+					+					+		
Relative				+					+					+					+					+	
Low					+					+					+					+					+
One-way ANOVA & LSD test	p1-2=0,002																								

According to the methodology for building decisive rules of the decision support subsystem based on fuzzy logic, we break down the range of changes of each of the informative parameters: densitometric (research of erythrocyte sedimentation rate, G-index of nuclear leukocytes), biochemical (alkaline phosphatase, bilirubin) and oral hygiene (the index Fedorov-Volodkin) by 5 degrees of engraftment, corresponding to the qualitative fuzzy terms low (L), low average (LA), average (A), high average (HA), high (H) (table 4 and 5).

Table 4. Features of quantitative assessment for determining the degree of engraftment of effectiveness of odontogenic phlegmons treatment of the maxillofacial region

Factors / Degree of engraftment	ESR, or erythrocyte sedimentation rate, mm/h (X1)	Indicator of rod nuclear leukocytes (HU), (X2)	Total hemoglobin level (μmol/l), (X3)	Alkaline phosphatase (units/l), (X4)	Fedorov-Volodkin Index, (X5)
High $\mu^{I}(x_1x_2x_3x_4x_5)$	0 ÷ 10	0 ÷ 3	0 ÷ 10	35 ÷ 79	1.1 ÷ 1.5
Sufficient $\mu^{II}(x_1x_2x_3x_4x_5)$	10.1 ÷ 20.0	4 ÷6	10.1 ÷ 20.0	80 ÷ 119	1.6 ÷ 2.0
Moderate $\mu^{III}(x_1x_2x_3x_4x_5)$	20.1÷ 30.0	7 ÷ 9	20.1÷ 30.0	120 ÷ 159	2.1 ÷ 2.5
Relative $\mu^{IV}(x_1x_2x_3x_4x_5)$	30.1 ÷ 40.0	10÷ 12	30.1 ÷ 40.0	160 ÷199	2.6 ÷ 3.4
Low $\mu^{V}(x_1x_2x_3x_4x_5)$	40.1 ÷ 100	13 ÷ 30	40.1 ÷ 100	200 ÷ 500	3.5 ÷ 5.0
min/max	0 ÷ 100	0 ÷ 30	0 ÷ 100	35 ÷ 500	1.1 ÷ 5.0

Table 5. Knowledge base for fuzzy for diagnostics determining the degree of engraftment of effectiveness of odontogenic phlegmons treatment of the maxillofacial region

Clinical forms of the degree of engraftment					
	(X1)	(X2)	(X3)	(X4)	(X5)
$\mu^{I}(x_1x_2x_3x_4x_5)$	L	L	L	L	L
	L	L	L	LA	L
	L	L	L	L	LA
$\mu^{II}(x_1x_2x_3x_4x_5)$	L	LA	LA	LA	LA
	LA	LA	L	LA	LA
$\mu^{III}(x_1x_2x_3x_4x_5)$	LA	LA	LA	LA	LA
	LA	LA	LA	A	LA
$\mu^{IV}(x_1x_2x_3x_4x_5)$	A	A	A	A	A
	A	A	A	HA	A
$\mu^{V}(x_1x_2x_3x_4x_5)$	A	HA	A	A	HA
	HA	HA	A	A	H
	HA	H	HA	HA	HA
	HA	HA	HA	H	H
	H	H	H	H	H

When setting the functions of belonging of informative features X1 ÷ X5 to fuzzy terms on the interval [0;1], the well-known function[3,14] is used, the graph of which is shown in Figure 1.

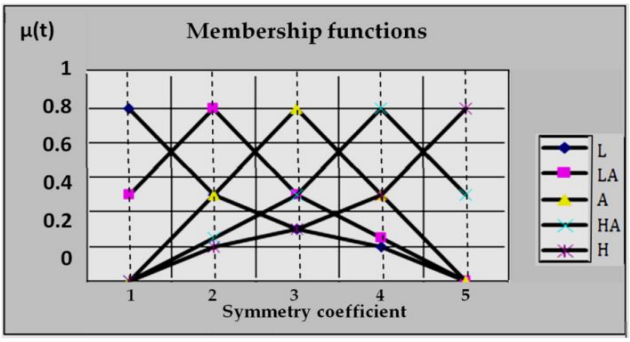


Figure 1. Membership functions[3,14]

Based on the knowledge base developed by experts, presented in Table 4 and Table 5, and the above-mentioned membership functions of fuzzy terms[3,14], models of decision-making support rules were developed for assessing the degree of engraftment of effectiveness of treatment of odontogenic phlegmons of the maxillofacial region.

For degree of engraftment (High) $\mu^{I}(x_1x_2x_3x_4x_5)$

$$\mu^{d1}(X_1, X_2, X_3, X_4.X_5) = \mu^{L}(X_1)\cdot\mu^{L}(X_2)\cdot\mu^{L}(X_3)\cdot\mu^{L}(X_4)\cdot\mu^{L}(X_5)\cup$$
$$\mu^{L}(X_1)\cdot\mu^{L}(X_2)\cdot\mu^{L}(X_3)\cdot\mu^{LA}(X_4)\cdot\mu^{L}(X_5)$$
$$\cup\mu^{L}(X_1)\cdot\mu^{L}(X_2)\cdot\mu^{L}(X_3)\cdot\mu^{L}(X_4)\cdot\mu^{LA}(X_5)$$

For degree of engraftment (Sufficient) $\mu^{II}(x_1x_2x_3x_4x_5)$

$$\mu^{d2}(X_1, X_2, X_3, X_4.X_5) = \mu^{L}(X_1)\cdot\mu^{LA}(X_2)\cdot\mu^{LA}(X_3)\cdot\mu^{LA}(X_4)\cdot\mu^{LA}(X_5)\cup$$
$$\mu^{LA}(X_1)\cdot\mu^{LA}(X_2)\cdot\mu^{L}(X_3)\cdot\mu^{LA}(X_4)\cdot\mu^{LA}(X_5);$$

For degree of engraftment (Moderate) $\mu^{III}(x_1x_2x_3x_4x_5)$

$$\mu^{d3}(X_1, X_2, X_3, X_4.X_5) = \mu^{LA}(X_1)\cdot\mu^{LA}(X_2)\cdot\mu^{LA}(X_3)\cdot\mu^{LA}(X_4)\cdot\mu^{LA}(X_5)\cup$$
$$\mu^{LA}(X_1)\cdot\mu^{LA}(X_2)\cdot\mu^{LA}(X_3)\cdot\mu^{A}(X_4)\cdot\mu^{LA}(X_5);$$

For degree of engraftment (Relative) $\mu^{IV}(x_1x_2x_3x_4x_5)$

$$\mu^{d4}(X_1, X_2, X_3, X_4.X_5) = \mu^{A}(X_1)\cdot\mu^{A}(X_2)\cdot\mu^{A}(X_3)\cdot\mu^{A}(X_4)\cdot\mu^{A}(X_5)$$
$$\cup\mu^{A}(X_1)\cdot\mu^{A}(X_2)\cdot\mu^{A}(X_3)\cdot\mu^{HA}(X_4)\cdot\mu^{A}(X_5);$$

For degree of engraftment (Low) $\mu^{V}(x_1x_2x_3x_4x_5)$

$$\mu^{d5}(X_1, X_2, X_3, X_4.X_5) = \mu^{A}(X_1)\cdot\mu^{HA}(X_2)\cdot\mu^{A}(X_3)\cdot\mu^{A}(X_4)\cdot\mu^{HA}(X_5)\cup$$
$$\mu^{HA}(X_1)\cdot\mu^{HA}(X_2)\cdot\mu^{A}(X_3)\cdot\mu^{A}(X_4)\cdot\mu^{H}(X_5)$$
$$\cup\mu^{HA}(X_1)\cdot\mu^{H}(X_2)\cdot\mu^{HA}(X_3)\cdot\mu^{HA}(X_4)\cdot\mu^{HA}(X_5)\cup$$
$$\mu^{HA}(X_1)\cdot\mu^{HA}(X_2)\cdot\mu^{HA}(X_3)\cdot\mu^{H}(X_4)\cdot\mu^{H}(X_5)\cup$$
$$\mu^{H}(X_1)\cdot\mu^{H}(X_2)\cdot\mu^{H}(_3)\cdot\mu^{H}(X_4)\cdot\mu^{H}(X_5).$$

For the formalization of the indices, membership functions are given that correspond to the rules of fuzzy sets[3,13,14]. Therefore, logical equations for evaluating the degree of engraftment of of effectiveness of treatment of odontogenic phlegmons of the maxillofacial region will have the following form for factors (X_1 - X_5).

For factors X_1:

$$\tilde{\mu}^{L}(X_1) = \begin{cases} 1.0 - 0.02x_3, x_3 \in [0;25) \\ 0.67 - 0.0067x_3, x_3 \in [25;100] \end{cases};\qquad \tilde{\mu}^{LA}(X_1) = \begin{cases} 0.02x_3 + 0.5, x_3 \in [0;25) \\ 1.5 - 0.02x_3, x_3 \in [25;50) \\ 1.0 - 0.01x_3, x_3 \in [50;100] \end{cases};\qquad \tilde{\mu}^{A}(X_1) = \begin{cases} 0.02x_3, x_3 \in [0;50] \\ 2 - 0.02x_3, x_3 \in [50;100] \end{cases};$$

$$\tilde{\mu}^{HA}(X_1) = \begin{cases} 0.01x_3, x_3 \in [0;50) \\ 0.02x_3 - 0.5, x_3 \in [50;75) \\ 2.5 - 0.02x_3, x_3 \in [75;100] \end{cases};\qquad \tilde{\mu}^{H}(X_1) = \begin{cases} 0.0067x_3, x_3 \in [0;75) \\ 0.02x_3 - 1, x_3 \in [75;100] \end{cases}.$$

For factors X^2:

$$\tilde{\mu}^{L}(X_2) = \begin{cases} 1 - 0.067x_2, x_2 \in [0;7.5) \\ 0.67 - 0.02x_2, x_2 \in [7.5;30] \end{cases};\qquad \tilde{\mu}^{LA}(X_2) = \begin{cases} 0.067x_2 + 0.5, x_2 \in [0;7.5) \\ 1.5 - 0.067x_2, x_2 \in [7.5;15); \\ 1.0 - 0.03x_2, x_2 \in [15;30] \end{cases}$$

$$\tilde{\mu}^{A}(X_2) = \begin{cases} 0.067x_2, x_2 \in [0;15) \\ 2 - 0.067x_2, x_2 \in [15;30] \end{cases};\qquad \tilde{\mu}^{HA}(X_2) = \begin{cases} 0.033x_2, x_2 \in [0;15) \\ 0.067x_2 - 0.5, x_2 \in [15;22.5); \\ 2.5 - 0.067x_2, x_2 \in [22.5;30] \end{cases}$$

$$\tilde{\mu}^{H}(X_2) = \begin{cases} 0.022x_2, x_2 \in [0;22.5) \\ 0.067x_2 - 1, x_2 \in [22.5;30] \end{cases}.$$

For factors X_3:

$$\tilde{\mu}^{L}(X_3) = \begin{cases} 1.0 - 0.02x_3, x_3 \in [0;25) \\ 0.67 - 0.0067x_3, x_3 \in [25;100] \end{cases};\qquad \tilde{\mu}^{LA}(X_3) = \begin{cases} 0.02x_3 + 0.5, x_3 \in [0;25) \\ 1.5 - 0.02x_3, x_3 \in [25;50) \\ 1.0 - 0.01x_3, x_3 \in [50;100] \end{cases};\qquad \tilde{\mu}^{A}(X_3) = \begin{cases} 0.02x_3, x_3 \in [0;50] \\ 2 - 0.02x_3, x_3 \in [50;100] \end{cases};$$

$$\tilde{\mu}^{HA}(X_3) = \begin{cases} 0.01x_3, x_3 \in [0;50) \\ 0.02x_3 - 0.5, x_3 \in [50;75) \\ 2.5 - 0.02x_3, x_3 \in [75;100] \end{cases};\qquad \tilde{\mu}^{H}(X_3) = \begin{cases} 0.0067x_3, x_3 \in [0;75) \\ 0.02x_3 - 1, x_3 \in [75;100] \end{cases}.$$

For factors X_4:

$$\tilde{\mu}^{L}(X_4)=\begin{cases}1.15-0.0043x_4, x_4\in[35;151.25)\\ 0.72-0.014x_4, x_4\in[151.25;500]\end{cases};\qquad \tilde{\mu}^{LA}(X_4)=\begin{cases}0.004x_4+0.349, x_4\in[35;151.25)\\ 1.65-0.0043x_4, x_4\in[151.25;267.5);\\ 1.07-0.002x_4, x_4\in[267.5;500]\end{cases}$$

$$\tilde{\mu}^{A}(X_4)=\begin{cases}0.0043x_4-0.15, x_4\in[35;267.5]\\ 2.15-0.0043x_4, x_4\in[267.5;500]\end{cases};\qquad \tilde{\mu}^{HA}(X_4)=\begin{cases}0.002x_4-0.075, x_4\in[35;267.5)\\ 0.0043x_4-0.65, x_4\in[267.5;383.75);\\ 2.65-0.0043x_4, x_4\in[383.575;500]\end{cases}$$

$$\tilde{\mu}^{H}(X_4)=\begin{cases}0.001x_4-0.05, x_4\in[35;383.75)\\ 0.0043x_4-1.15, x_4\in[383.75;500]\end{cases}.$$

For factors X_5:

$$\tilde{\mu}^{L}(X_5)=\begin{cases}1.57-0.51x_5, x_5\in[1.1;2.07)\\ 0.85-0.17x_5, x_5\in[2.07;5.0]\end{cases};\qquad \tilde{\mu}^{LA}(X_5)=\begin{cases}0.52x_5+0.067, x_5\in[1.1;2.07)\\ 2.06-0.51x_5, x_5\in[2.07;3.05);\\ 1.67-0.33x_5, x_5\in[3.05;5.0]\end{cases}$$

$$\tilde{\mu}^{A}(X_5)=\begin{cases}0.51x_5-0.56, x_5\in[1.1;3.05]\\ 3.3-0.67x_5, x_5\in[3.05;5.0]\end{cases};;\qquad \tilde{\mu}^{HA}(X_5)=\begin{cases}0.25x_5-0.28, x_5\in[1.1;3.05)\\ 0.51x_5-1.06, x_5\in[3.05;4.03);\\ 3.08-0.52x_5, x_5\in[4.03;5.0]\end{cases}$$

$$\tilde{\mu}^{H}(X_5)=\begin{cases}0.17x_5-0.19, x_5\in[1.1;4.03)\\ 0.52x_5-1.58, x_5\in[4.03;5.0]\end{cases}.$$

In the process of assessing the degree of engraftment of effectiveness of odontogenic phlegmons treatment of the maxillofacial region, the task of developing and configuring a neurofuzzy network becomes. To develop the configuration of the parameters of this network, recurrent components proposed by Professor O.V. Mr. Rothstein[3]. The task of adjustment is carried out in the selection of such factors of membership functions $(b_i^{jp}(t), c_i^{jp}(t))$ and weights of fuzzy rules $(w_{jp}(t)$, which ensure the minimum discrepancy between the models and the evaluation results[3].

$$\sum_{i=1}^{M}(F_y(\hat{x}_1^l,\hat{x}_2^l,...\hat{x}_{12}^l,W_i)-\hat{y}_l)^2=\min_{W_i},$$

where $\langle \hat{X}_l,\hat{y}_l\rangle, l=\overline{1,M}$ experimental research data; b is the maximum coordinate; C is the factor of compression and extension (fig. 2).

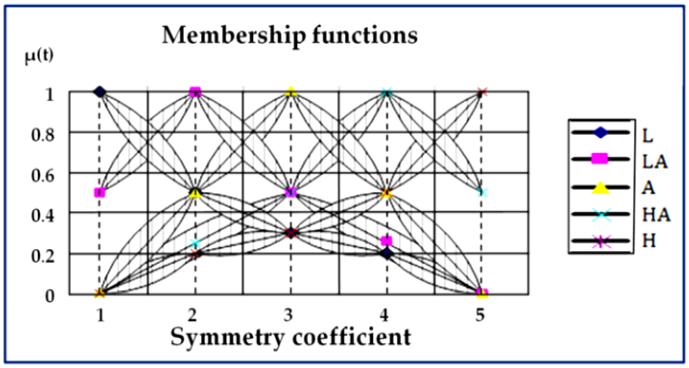


Figure 2. Function setting procedure[3,14]

The implementation scheme of the expert medical system in the form of a neural network for assessing the degree of of effectiveness of odontogenic phlegmons treatment of the maxillofacial region in patients is shown in fig. 3.
An interface was developed for the doctor, which allows to process the results of studies in a convenient way to assess the degree of implantation of of effectiveness of treatment of odontogenic phlegmons of the maxillofacial region[14,15].

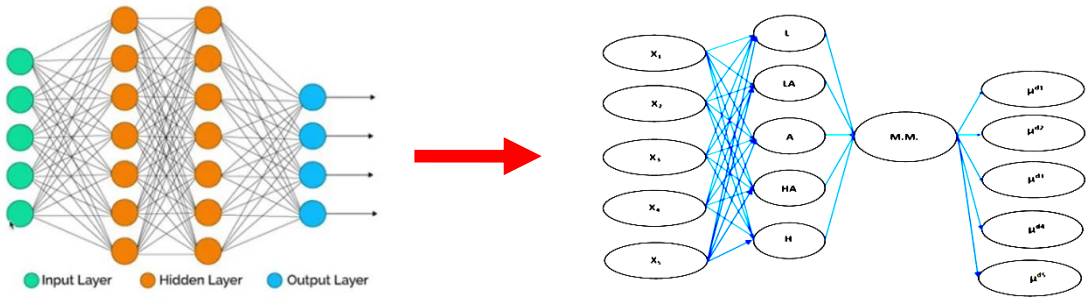


Fig. 3. Medical expert system for determining the degree of engraftment of effectiveness of treatment of odontogenic phlegmons of the maxillofacial region

The result of implementing a user interface of Medical expert system for determining for determining the degree of engraftment of effectiveness of treatment of odontogenic phlegmons of the maxillofacial region is a software system that works like this (fig 4).

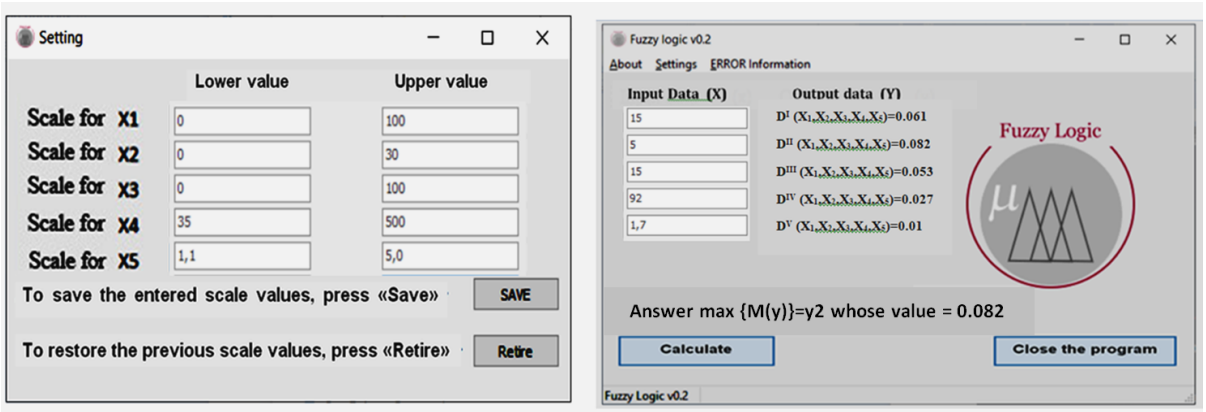


Figure 4. Medical expert system for determining for determining the degree of engraftment of effectiveness of treatment of odontogenic phlegmons

It should be noted that the reliability of supporting the correct decision-making of the medical expert system for determining the degree of engraftment of treatment of odontogenic phlegmons of the maxillofacial region based on fuzzy sets for expert assessment was 92% ($p < 0.05$)

CONCLUSIONS

The paper analyzes the main areas of application of mathematical methods in medical diagnostics, formulates the principles of diagnostics based on fuzzy logic. The basic structure of the MIS medical information system for assessing the degree of engraftment of effectiveness of odontogenic phlegmons treatment of the maxillofacial region was developed and the main recommendations for its design were put forward, namely: the selection and purpose of the system; selection of the structural scheme of the system; formation and analysis of the list of nosological forms, collection of statistically reliable information about the severity of symptoms; choosing a method of processing biomedical information; construction of an algorithm for solving the problems of evaluating biomedical information and forming diagnostic and prognostic conclusions.

Hardware and software were developed for the implementation of a convenient interface, which made it possible to formalize quantitative indicators in the form of informational signs when solving the problems of medical diagnosis of assessing the degree of engraftment of effectiveness of odontogenic phlegmons treatment of the maxillofacial region.

The results of the research and the approval of the expert medical system demonstrate the high reliability of the obtained results when assessing the degree of engraftment of effectiveness of odontogenic phlegmons treatment of the maxillofacial region.

The practical value of the work lies in the possibility of using an automated medical expert system to solve the problems of medical diagnosis based on fuzzy logic when assessing the degree of engraftment of effectiveness of odontogenic phlegmons treatment of the maxillofacial region.

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