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ARTIFICIAL NEURAL NETWORK MODELING OF SEVERITY OF POISONING AND MORTALITY PROGNOSIS FOR ALPHA-AMANITIN POISONING

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Abstract:

In Russia, from year to year, a large number of poisonings with conditionally edible and poisonous mushrooms are recorded. A significant part of this statistics falls on the Voronezh region, for example, in 2000, 240 people were hospitalized with mushroom poisoning, among them 58 children, 44 patients died, and in 2001 322 people were poisoned, and 41 died. Mortality in case of mushroom poisoning was 13-18%. The main share in the structure of mushroom poisoning in the forest-steppe belt of Russia is poisonous poisoning (Amanita phalloides) - up to 80%.

Toxins of the pale toadstool have mainly hepatotoxic and nephrotoxic and enterotoxic effects, cause damage to membrane structures, inhibit oxidative phosphorylation, inhibit the formation of RNA, DNA, damage the cytoskeleton. Pale toadstool contains two groups of toxins: phallotoxins (the main representative is phalloidin) and amatoxins (mainly amanitin). □-amanitin contained in the mushrooms of the genus Amanita is a highly toxic compound, the lethal dose for humans is 5–8 mg (orally), toxic when inhaled, inhaled. The main cause of death in amatoxin poisoning is acute hepatic failure, less often acute hepatorenal failure.

The prognosis for recovery of injuries depends on the severity of the poisoning. Poisonings are divided into lungs - with moderate gastroenteritis and mild hepatopathy; moderate severity - accompanied by severe gastroenteritis, hepatopathy and nephropathy; and severe - pronounced gastroenteritis, severe hepato-and nephropathy.

The degree of toxic hepatopathy is determined on the basis of clinical and laboratory data. Mild hepatopathy is detected only by laboratory and instrumental studies. In case of moderate hepatopathy, clinical signs of liver damage are noted (an increase and tenderness during palpation, jaundice, hemorrhagic diathesis phenomena) in combination with more intensive changes in laboratory and instrumental data. Severe hepatopathy along with more pronounced changes characteristic of moderately severe hepatopathy are characterized by mental disorders with the development of hepatic encephalopathy.

At present, the concept of the predominant hepato-nephrotoxicity of the toadstool fungi dominates. In accordance with this, the clinic conducts dynamic monitoring of the indicators of cytolytic, cholestatic and hepatopathy syndromes, as well as signs of renal failure and coagulopathy in victims. These indicators are contained in archival materials on the basis of which the neural network model of mushroom poisoning developed by us was built.

Clustering was performed using a Kohonen self-organizing matrix of 3 by 3 dimensions. The resulting 9 clusters were combined into three "superclusters," which increased the stability of the cluster structure. The resulting clusters are characterized by a low risk of death (5%), medium risk (20%) and high risk (70%) of death.

Keywords: acute liver failure, mushroom poisoning, amanita phalloides, hepatopathy forecast, Kohonen matrix clustering,

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INTRODUCTION:

Actual classification of severity of poisoning with amanita phalloides mushrooms is according to the severity of hepatopathy and gastroenteritis. Mild poisoning with amanita phalloides toxins is accompanied by mild gastroenteritis and mild hepatopathy [1]; moderate poisoning - severe gastroenteritis, moderate hepatopathy and nephropathy (mild or moderate) [2, 3]. Severe poisoning - 50% of all cases, manifested by pronounced gastroenteritis, severe hepatopathy and nephropathy, with the development of the clinic of acute hepatic and renal failure [4].

Evaluation of the severity of hepatopathy is based on clinical and laboratory data. Mild hepatopathy is characterized by the absence of any clinical signs of liver damage. Liver dysfunctions are detected only by laboratory and instrumental studies. In case of moderate hepatopathy, clinical signs of liver damage are noted (an increase and tenderness during palpation, jaundice, hemorrhagic diathesis phenomena) in combination with more intensive changes in laboratory and instrumental data. Severe hepatopathy (acute liver failure), along with more pronounced changes characteristic of moderately severe hepatopathy, is characterized by mental disorders with the development of hepatic encephalopathy.

MATERIAL AND METHODS:

When toxic hepatopathy naturally suffers protein, lipid metabolism, the function of accumulation of glycogen. In the treatment of patients with amatoxin poisoning, much attention is paid to various laboratory parameters, which are designed to reflect the dynamics of pathological processes in the liver: the phenomena of cytolysis — AsAT, AlAT; cholestasis - total bilirubin and its fractions; hepatocellular failure - albumin, cholesterol, phospholipid levels, HDL, LDL, hemostasis. Hourly diuresis, electrolyte levels (Na, K, Ca) of serum, urea and creatinine allow you to monitor the functional state of the excretory system. In addition, during intensive care, indicators of the acid-base state of the internal environment of the body are determined. Routine measurement of blood pressure and heart rate is performed to monitor the state of hemodynamics. From the point of view of toxicodynamics, the information content of these indicators will be different in the toxigenic and somatogenic phase of poisoning.

To assess the patient's life prognosis, it became necessary to adequately model pathogenetic processes occurring in the body during different periods of intoxication [5, 6], so that the newly created model allows the patient to assess the patient's recovery rates, and this directly determines the amount of treatment measures for him. It is necessary that the model builds its conclusion based on the same information that the attending physician uses [7, 8].

After a preliminary analysis of the medical records of inpatients with mushroom poisoning, 47 laboratory parameters were selected, which were determined from these patients on different days of their inpatient stay; Blood pressure, heart rate; information about the detoxification procedures (hemodialysis, hemosorption, plasma exchange).

This information for each day in hospital was recorded in an electronic database for 181 patients (33 died and 148 survived) who were treated in the toxicological and gastroenterological departments of the Voronezh Design Bureau No. 1 for the period from 2001 to 2004. The total number of records was 1201. Subgroups of the dead and the survivors did not significantly differ in sex and age (Table 1).

RESULT AND DISCUSSION:

Considering that the severity of the patient's condition changes over time and in response to the treatment, it was decided to consider information about each day of the patient's stay in the hospital as an independent object [9, 10]. The risk of death for a patient on a given day was taken as a criterion for determining the severity of the poisoning [11, 12].

To determine the risk of death for each patient on each day of his stay in the hospital, all 1201 records were divided into clusters using the Kohonen self-organizing matrix implemented in the ST Neural Networks package. The output layer contained 9 neurons. Topological map is given in Table. 2

Table 1: Age and sex structure of the sample (n = 181)

outcome / sex	Survivors			Dead		
	N	mean	SD	N	mean	SD
Men	68	45,6	15,9	18	44,1	15,2
Women	80	47,5	20	15	46,2	18

Table 2: Distribution of objects of observation over the Kohonen self-organizing matrix nodes (n = 1201)

neuron 1 32 died / 12 survived	neuron 2 6 died / 20 survived	neuron 3 18 died / 300 survived
neuron 4 20 died / 7 survived	neuron 5 7 died / 76 survived	neuron 6 6 died / 322 survived
neuron 7 45 died / 22 survived	neuron 8 19 died / 26 survived	neuron 9 18 died / 245 survived

Each neuron on a topological map can be considered as the center of a separate cluster. Objects belonging to the same neuron belong to the same cluster. It is possible to calculate the risk of death for objects within each cluster, as the ratio of the number of observations with the outcome "died" to the total number of observations in the cluster (Table 3).

Table 3: Distribution of the relative risk of death (%) among the nodes of the Kohonen self-organizing matrix (n = 1201)

neuron 1 73	neuron 2 23	neuron 3 6
neuron 4 74	neuron 5 8	neuron 6 2
neuron 7 67	neuron 8 42	neuron 9 7

It is noteworthy that the fewer objects are included in the corresponding cluster, the more sensitive it is to the appearance of outliers. To overcome this phenomenon, several small clusters can be combined into one large “super cluster”. Such a combination does not affect the self-organizing matrix, but only affects the final interpretation of the information that is transmitted to the user by the post-processing algorithm.

In the clusters designated n4, n1 and n7, the number of observations with the outcome "died" prevails over the survivors, in addition, the total number of observations in clusters n4 and n1 is not enough to ensure their sustainability. Therefore, it would be logical to combine them into a group (class K1) - a high risk of death (70%).

Three more clusters: n9, n3 and n6 can be combined into a low risk group of death (5% - class K3). Then clusters n8, n2 and n5 are in the K2 class of medium risk (21%).

CONCLUSION:

The stability of the classification obtained after combining the corresponding neurons can be considered satisfactory. In addition, the resulting classes vary considerably. The first group of neurons (K1) differs from K2 in the risk of death by 3.5 times and from K3 by more than 10 times, a similar fourfold difference between the K2 and K3 groups.

When considering the severity of patients with mushroom poisoning, three degrees of severity of poisoning are traditionally distinguished (mild, moderate and severe); three degrees of severity of hepatopathy (mild, moderate and severe). Given this, it seems appropriate to identify three risk groups for death, which should simplify further analysis and comparison of different approaches to assessing the health of patients with fungal poisoning.

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