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MUSHROOM POISONING IN CHILDREN AND ADOLESCENTS. DIAGNOSIS AND TREATMENT. REVIEW

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ABSTRACT

Mushroom poisoning is the most common form of plant food poisoning. In childhood, poisoning with wild mushrooms often has an unfavorable prognosis due to the speed and depth of development of homeostatic disorders, which are due to the anatomical and physiological characteristics of the child's body, and the incompleteness of the formation of many of its systems. First of all, the cause of severe poisoning is the immaturity of the detoxification and elimination systems. Timely diagnosis, determination of the exact causes and mechanisms of poisoning, severity, and early treatment from the moment of poisoning are of the greatest importance in predicting treatment. Diagnosis of mushroom poisoning is very difficult since the general clinical picture of the disease is similar to the clinical picture of chemical poisoning of various etiologies. The duration of the rehabilitation period mainly depends on the initial severity of the pathological process. The purpose of this work was to consider the features of poisoning by poisonous mushrooms in children and adolescents and to study the principles of diagnosis and treatment of poisoning, as reflected in relevant literary sources.

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Introduction

The use of mushrooms for food is an ancient tradition of the people living on the territory of modern Russia. Even though knowledge about the correct collection and preparation of forest mushrooms has been passed down from generation to generation, the problem of poisoning them is still relevant. Poisoning by poisonous and conditionally edible mushrooms in children is especially difficult due to the peculiarities of the structure and functioning of body systems at an early age.

As stated in the "Federal clinical guidelines for the provision of emergency care for acute poisoning in children", poisoning (intoxication) is an acute or chronic, life-threatening condition that develops as a result of the interaction of the human body and poison [1]. Poisoning can develop as a result of the ingress of poison from the external environment (exogenous poisons), as well as as a result of saturation of the body with toxins formed in it when the functions of organs and systems are impaired (endogenous poisons) [2].

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Poisons are a group of substances of organic (animal or plant) or anthropogenic origin, the impact of which on a living organism causes poisoning (acute toxic effects), which leads to the death of the organism or the development of various disorders of biochemical, physiological, genetic, mental and other processes and functions [3].

Mushroom poisoning, according to ICD-10, is classified as a harmful effect resulting from contact with toxic substances contained in eaten foods, in this case, wild mushrooms [4]. At the same time, we mean toxic substances produced by the fungus itself, for example, amanitin, muscarine, etc.

In childhood, poisoning with wild mushrooms often has an unfavorable prognosis due to the speed and depth of development of homeostatic disorders, which are due to the anatomical and physiological characteristics of the child's body, and the incompleteness of the formation of many of its systems. First of all, the cause of severe poisoning is the immaturity of the detoxification and elimination systems [5]. Timely diagnosis, determination of the exact causes and mechanisms of poisoning, severity, and early treatment from the moment of poisoning are of the greatest importance in predicting treatment.

Epidemiology, Pathogenesis, Toxicokinetics, Toxicodynamics, and Clinical Picture of the Disease

According to modern data reflected in the scientific literature, the overall mortality in case of poisoning by poisonous and conditionally poisonous wild mushrooms is 12-16%. At the same time, poisoning with the most poisonous of them (Lepiota, Galerina, Amanita phalloides), containing amanitotoxins, increases the lethality to 40-50%, and severe and extremely severe forms make it almost absolute (85-100%) [6].

Most often, mushroom poisoning is seasonal and is directly related to the growing season and the collection of wild mushrooms. The main prognostic factor of wild mushroom poisoning is the amount of toxins that have entered the body, which directly depends on the amount of mushrooms eaten and the patient's body weight. Therefore, children and adolescents are at risk of developing severe intoxications, which are more likely to lead to severe consequences of poisoning, up to death [7].

Given the wide variety of poisonous fungi and, accordingly, the clinical picture of poisoning, in the scientific literature and clinical practice regarding this pathology, it is customary to consider the pathogenesis of poisoning in terms of the development of syndromes that characterize the main mechanism of toxic action and the pathogenesis of poisoning by one type or another **(Table 1)**.

Table 1. Syndromes of wild mushroom poisoning

Type of syndrome	Mushrooms that cause poisoning	Toxic substances	Toxicodynamics of poisoning
Phalloidin syndrome	Pale toadstool, spring fly agaric, Stinky fly agaric	Amanitotoxins or amatoxins (amanitins, amanin, amanullin) and phallotoxins	Amanitotoxins interrupt protein synthesis in the cell, which leads to its death. The most vulnerable cells with intensive protein synthesis are hepatocytes, enterocytes, nephrocytes, and lymphocytes. The cells of the intestinal mucosa are the first to be affected. Phallotoxins, according to experimental data, lead to the destruction of the hepatocyte membrane and inhibition of oxidative phosphorylation in mitochondria. Phallotoxins are largely destroyed by the action of the enzyme systems of the gastrointestinal tract and in conditions of their low absorption in the intestine have practically no toxic effect.
Gyrometer syndrome	Gyromitra esculenta, sponge mushroom	Gyromitrin (N-methyl-N-formyl ethanol-hydrazone)	In the body, as a result of hydrolysis, a cytotoxic compound N-monomethylhydrazine is formed, capable of inhibiting the synthesis of DNA and RNA, and ethylene-gyromitrin is the most toxic. In liver cells, hydrazines form unstable diaz compounds, which are a source of free radical formation, cytolysis, and necrosis in liver tissue. In the clinical picture of poisoning with lines, in addition to liver and kidney damage due to the presence of organic acids in mushrooms (fumaric acid, etc.), hemolysis develops and, accordingly, hemoglobinuria nephrosis.
Mycoatropin (Pantherine) syndrome	Panther fly agaric, red fly agaric	Derivatives of isoxazole (ibotenic acid, muscimol), muscaridin, derivatives of choline and acetylcholine, hercynine, derivatives of indole	Substances affect the gamma-aminobutyric acid of the brain, providing a mixed psychotropic effect. The general toxic effect is defined as anticholinergic.
Sudorin (Muscarinic) syndrome	Mushrooms of the genus Clitocybe and Inocybe	Muscarine (2-methyl-3-hydroxy-5-trimethylammonium) and its isomers: epimuscarin, allomuscarin, epiallomuscarin	Muscarin has the greatest effect on cholinoreactive structures, in particular, by stimulating muscarinic-type cholinergic receptors and exerting an M-cholinomimetic effect. Muscarine and its isomers are thermally stable, water-soluble, and have low lipophilicity.

Paxilus (Paxilene) syndrome	Mushrooms of the genus Paxillus (Paxillus atromentosus, Paxillus involutus)	The toxic substance is not exactly known, it is assumed that it is close to the derivatives of hydrazine, the substance is thermolable.	The toxic effect presumably occurs through a cycle of immune allergic reactions, as a result of which red blood cells are damaged and hemolysis develops and is most pronounced with repeated use of mushrooms, probably due to the cumulative effect.
Orellanin syndrome	Mushrooms of the genus Cortinarius	Orellanin, cortinarin A and cortinarin B.	It is believed that only those mushrooms that contain both orellanin, cortinarin A, and cortinarin B are toxic. The main target organ for these toxins is the kidneys, in which, under their influence, interstitial nephritis develops after 2-4 days without damage to the glomeruli.
Coprin (Coprinien) syndrome	Some mushrooms of the genus Coprinus (coprino chiomato)	Koprin	When coprin enters the body, L-amino cyclopropanol is formed as a result of hydrolysis, which inhibits the enzyme aldehyde dehydrogenase. This leads to an excessive accumulation of acetaldehyde, which is formed (as a natural product of ethanol oxidation) in the case of ethyl alcohol intake. The effect of acetaldehyde on the autonomic nervous system causes a reaction similar to alcohol-teturam (alcohol-antabuse) in the treatment of chronic alcohol dependence with teturam
Rubberoid (Rubberidien) syndrome	Entoloma sinuatum, Tricholoma pardinum, Tricholoma virgatum, Tricholoma pardinum, Amanita smithiana, Hypholoma fasciculare	The so-called resin-like substances, aldehydes, and ketones contained in these mushrooms	Toxic substances have a pronounced irritating effect on the mucous membrane of the gastrointestinal tract, and when ingested from the digestive tract into the blood, some of them can affect other organs.
Psychodisleptic (Narcotic) syndrome	Psilocybe, mushrooms of the genus Stropharia, mushrooms of the genus Panellus, mushrooms of the genus Gymnopilus, Mycena pura		Psychedelic syndrome, including psilocybin (narcotic with synthetic hallucinations), stearyl-Pyron (with visual hallucinations), indolamine (with auditory hallucinations), is clinically manifested by inappropriate behavior, excessive arousal, and hallucinations (visual and auditory).

For clinical and diagnostic purposes, poisonings are divided into two groups: poisonings with a short and long latent period. Poisoning with a short incubation period is caused by fungi of the following species: Psilocybe, Entoloma, individual representatives of the genus Amanita, etc. Poisoning with a long incubation period is caused by the use of the following types of fungi: Amanita phalloides, Gyromitra, Cortinarius mucosus, etc.

The generalization of the accumulated experience indicates a significant polymorphism of the clinical manifestations of acute mushroom poisoning, affecting the organs of the gastrointestinal tract, the central and peripheral nervous system, as well as the cardiovascular system, and excretory organs - the liver, kidneys [8].

Diagnosis of Poisoning with Poisonous Mushrooms in Children and Adolescents

The algorithm for diagnosing poisoning with wild mushrooms includes clinical diagnostics, diagnostic imaging, and laboratory biochemical studies **(Figure 1)**. At the same time, special studies of the qualitative and quantitative content of toxic substances in the patient's body are often difficult; the analysis of the obtained samples of fungi is used when there is an obvious anamnestic connection between poisoning and the consumption of forest mushrooms [9].

Clinical diagnosis and examination of patients with potential poisoning by poisonous wild mushrooms are often difficult if it is not possible to establish a history of mushroom consumption itself since its main picture is expressed by a general gastrointestinal syndrome, which is characteristic of most poisonings of other etiologies, as well as several infectious and inflammatory diseases [10]. Mushroom poisoning with a short latent period, as a rule, does not pose a threat to the life of the patient, although it does not completely exclude the possibility of simultaneous poisoning with poisonous mushrooms such as pale toadstool (Amanita phalloides).

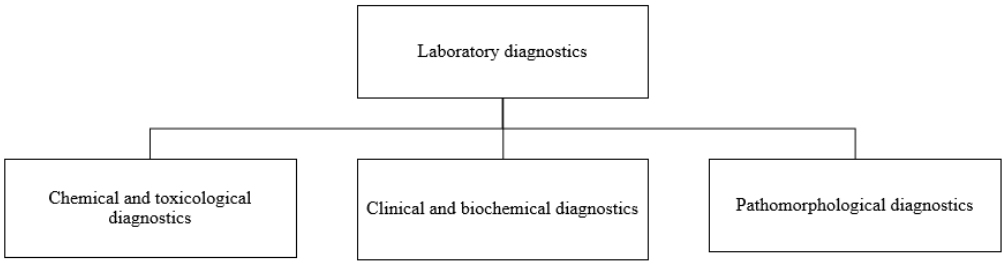

Figure 1. Types of laboratory diagnostics

In order to determine the characteristics of fungal poisoning in modern medicine, laboratory diagnostics are used. To identify mushroom toxins, which by their nature have a complex chemical structure, chemical-toxic diagnostics are used to determine the presence and concentration of toxins in urine, serum, or blood plasma [11].

When conducting clinical and biochemical diagnostics in patients with symptoms of gastroenteritis, in whose anamnesis the fact of the use of wild mushrooms was determined, metabolic acidosis and hemoconcentration (increase in hematocrit up to 50%) are detected, plasma electrolyte disturbances, functional prerenal nephropathy can be observed [12].

During the period of imaginary well-being, attention should be paid to the possible increase in enzymatic activity, reflecting the cytolysis of hepatocytes. The most informative is the level of the enzyme gamma-glutamyl transpeptidase, an enzyme (protein nature) that is found in the cells of the liver and pancreas, and the level of which in the blood increases with liver diseases and alcohol abuse [13].

Pathological diagnostics carried out on patients who died from poisoning with wild mushrooms showed that pathological changes often depend on the characteristics of the used mushrooms, the course of the poisoning process, and the timing of death.

In the early period (6-8 hours), death usually occurs as a result of water-electrolyte disorders in the course of cholera-like poisoning. At the same time, signs of dehydration and gastroenteritis are noted. Circulatory disorders, dystrophic changes are noted in the organs, and a liquid state of the blood is noted.

The main cause of death in the future is acute hepatic, rarely hepatic-renal failure. At the same time, ecchymosis and extensive hemorrhages in the serous membranes of the mucous membranes of the stomach, intestines, and parenchymal organs are observed [14]. Microscopy of the liver shows the disappearance of glycogen, the destruction of the cell membranes of hepatocytes, and their complete necrosis. Fatty degeneration of the liver, heart muscle, and kidneys is also characteristic. Colonies of pathogenic bacteria were found in the intestinal wall. Increased diffusion of endotoxin from the intestine into mesenteric microvessels led to the development of systemic endotoxemia and a leukocyte-mediated hepatotoxic effect. From this, it can be concluded that intestinal damage plays a significant role in the development of acute hepatic-renal failure in poisoning with poisonous mushrooms, which is an indication of oral antibiotic therapy [15, 16].

Treatment of Poisonous Mushroom Poisoning in Children and Adolescents

In case of suspected fungal poisoning, especially pale toadstool, due to the risk of developing an acute and severe condition and the difficulty of diagnosing poisoning, treatment should be started immediately [17].

In general, the treatment of poisoning is not specific, it is aimed at the rapid removal of toxic substances from the body, the correction of impaired vital functions, the treatment of complications such as damage to the liver, kidneys, and hemorrhagic syndrome. With the development of syndromes similar to atropine or muscarine poisoning, specific therapy is carried out.

Since the diagnosis of this type of poisoning is based only on the correct collection of anamnestic data and the study of the clinical picture of poisoning, especially in the acute period of poisoning, it can be quite difficult to establish the etiology of the disease. In this regard, the general treatment regimen is initially the same for poisoning by all types of fungi. In the future, when obtaining laboratory diagnostic data and further assessing the course of the disease, treatment requires choosing the right strategy [18, 19].

Therefore, in the treatment of poisoning with wild mushrooms, it is recommended to prescribe treatment in the toxicogenic and somatogenic stages. At the first stage, it is necessary to follow the rules for the provision of medical care used for all types of acute poisoning of chemical etiology. At the toxigenic stage of treatment, it is necessary to provide accelerated elimination of toxins from all affected organs and systems, specific antidote therapy according to indications, as well as symptomatic therapy aimed at protecting those organs and systems that are predominantly affected by this toxin due to specific and non-specific action.

At the somatogenic stage, it is necessary to correctly assess the degree of damage to all organs and systems, as well as to carry out therapeutic actions aimed at restoring their normal functioning and eliminating the consequences of somatic disorders caused by poisoning [20].

Considering the possible results of forest mushroom poisoning in children and adolescents, we noted that with mild poisoning, as a rule, there is a quick recovery and complete recovery of the body. With mild severity, damage to the excretory systems, kidneys, and liver are often observed, the activity of which can be restored by the end of the second week of intensive care. Severe poisoning requires a longer stay in the hospital, at least 21 days, and the prognosis of treatment is determined by the

dynamics of recovery of the kidneys, liver, and homeostasis. In the most severe course, complicated by acute hepatic or hepatic-renal failure, the prognosis of the disease is very serious and often unfavorable, especially with the development of hepatic encephalopathy. Treatment in this case can be delayed up to 30-60 days.

Conclusion

In childhood, poisoning with wild mushrooms often has an unfavorable prognosis due to the speed and depth of development of homeostatic disorders, which are due to the anatomical and physiological characteristics of the child's body, and the incompleteness of the formation of many of its systems. First of all, the cause of severe poisoning is the immaturity of the detoxification and elimination systems. Timely diagnosis, determination of the exact causes and mechanisms of poisoning, severity, and early treatment from the moment of poisoning are of the greatest importance in predicting treatment.
The prognosis and outcome of mushroom poisoning, especially pale toadstool, is determined by the timing of the start of treatment, since according to the data studied, it can be argued that with early hospitalization and poisoning of mild or moderate severity, a positive result is practically guaranteed.
Diagnosis of mushroom poisoning is very difficult since the general clinical picture of the disease is similar to the clinical picture of chemical poisoning of various etiologies. In the treatment of poisoning with wild mushrooms, it is recommended to prescribe treatment in the toxicogenic and somatogenic stages. The duration of the rehabilitation period depends mainly on the initial severity of the pathological process. In mild cases of forest mushroom poisoning, full recovery of health occurs fairly quickly (usually 8 days). With moderate poisoning, this process stretches for 2-3 weeks and ends with general asthenia, lasting up to a month. Recovery from severe forms of poisoning is very slow (from 2 to 6 months), and subsequent asthenia lasts just as long. In 20% of this contingent of patients, hepatopathy becomes chronic.
Patients who have suffered severe poisoning with fly agaric, pale grebes, and other fungi that cause the development of liver and kidney dysfunction should be advised to observe at the place of residence, the duration of which will be determined by the state of the liver, kidneys, and organs of the gastrointestinal tract.

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