USE OF FUNCTIONAL-DIFFERENTIAL EQUATIONS IN DIAGNOSTICS OF HELMINTHS IN CHILDREN

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ABSTRACT

The article examines the types of helminths found in the body of young children, their distribution, reproduction and harm to the body of children. As well as effective methods of treating various helminths in children. An attempt is made to describe the dynamics of the development of helminthic invasion - parasites in the human body. With the help of differential equations using a mathematical model of the development of parasites, the dynamics of their change in time is described using the initial conditions.

Key words: helminthiasis, methods, mathematical model, diagnostics, functional differential equations, inpatient treatment.

I. INTRODUCTION

The article discusses the method and diagnosis when using the functional differential equation in identifying parasites and the use of functional differential equations in the diagnosis of helminths in children - the analysis of the stability of stationary solutions, their harmful effects on the human body, that is, methods of mathematical argumentation of ways to get rid of these pests ...

In Uzbekistan, an active fight is underway against various diseases caused by helminths, protozoa, as well as bacteria and viruses found in adults, especially young children. Although most parents know briefly about the parasites that inhabit the bodies of their children, they do not know what type they are.

It is known that helminthic diseases occur in humans, animals and plants. To date, it is known that more than 270 species of helminths live in the human body. However, 40 of these types of parasites are constant companions of humans and cause significant outbreaks in the body.

Features of the course of helminthiasis in children:

• high intensity of invasion,
• the most affected age is from 7 to 12 years,
• violent general and local reactions are more common, while in adults the asymptomatic variant of the course prevails.

The most common type of helminths in young children is pinworms. Pinworms are small helminths belonging to the class of nematodes, the average size of which does not exceed 10-12 mm. The body is round, elongated and
angular at the ends. Males and females of this species are different from each other. During the breeding season, the female lays eggs, so they are larger than the males. With regard to the spread of these parasites, their development will be much better if the air is moderate and the temperature is between 300 and 400 degrees, as their seeds sink to the ground. When the air is humid and the temperature is between 100 and 150 degrees, their development slows down.

Treatment of helminths is very important, because their effect on the human body leads to negative consequences. It is well known that this disease, if not treated in time, can cause many other diseases and shorten a person's life by 10-15 years.

Each parasite, including helminths, has favorable conditions for life in a living organism. Pinworms and other helminths live in the intestines of the digestive system of children. If you have been observing young children, they will put any objects in their mouths that fall into their hands. These items may contain invisible microinfections. They begin to develop after they enter the body of children from the oral cavity.

All human helminthiases are divided into three main groups, depending on the source of invasion (infection), infection routes and transmission factors.

1. Geohelminthiases are invasions, the causative agents of which develop in the environment (without the participation of an intermediate host) and are transmitted to humans through environmental elements (soil, vegetables, berries, etc.) contaminated with invasive eggs (larvae). Examples of geohelminthiasis are ascariasis, trichocephalosis, strongyloidiasis, ankylostomiasis.

2. Biohelminthiasis - invasions, the pathogens of which develop with the participation of intermediate hosts and are transmitted to humans through their tissues or other transmission factors. This group includes teniarinchiasis and teniasis, opisthorchiasis, diphyllobothriasis, clonorchiasis, fascioliasis, paragonimiasis, trichinosis, echinococcosis.

3. Contagious helminthiases - invasions, the causative agents of which can be transmitted directly from one person to another without the participation of intermediate hosts. These include hymenolepiasis, enterobiasis, in some cases strongyloidosis and cysticercosis. In childhood, helminthiases pose a significant health hazard. The impact of helminths on the child's body is very diverse. Most of them parasitize in the intestine, causing a traumatic effect on the mucous membrane, disrupting the motor and secretory function of the intestine, the digestion process. Helminths can coagulate into balls and cause mechanical intestinal obstruction, can penetrate into the biliary tract and clog them. For their life, helminths absorb nutrients from food gruel passing through the intestines, which can lead to malnutrition, weight loss. The products of metabolism and decay of helminths have a toxic-allergic effect on the body of a child with a complex pathogenesis, which leads to chronic diseases.

II. METHODS

Worms are parasites that live not only in the gastrointestinal tract, they live in the respiratory organs, liver, spleen, muscles, blood, brain, eyes and other organs. They feed on the outer shell of proteins, fats and carbohydrates. During digestion, most of the nutrients are absorbed by helminths. The development of such symptoms of the disease, in turn, leads to weakness and chronic fatigue. First of all, it requires parents to pay attention to their child in order to prevent the growth of helminths in young children. Complications of the disease negatively affect the growth of children, the ideal development of the body.

History and clinical picture of the disease

Primary clinical and epidemiological diagnosis of helminthiasis in comparison with bacterial and viral infections is especially difficult. This is due to the fact that the clinical symptoms are mostly erased and, moreover, are of the same type with different helminthiasis. This refers to the data of the epidemiological history, since the sources of infection and transmission routes for many helminthic invasions are identical or close. In addition, clinical manifestations depend on the phase of the disease. Many helminthiases are characterized by a chronic course, and the early and late periods of the disease are not the same. In addition, helminthiases often develop as concomitant diseases, which significantly modifies their clinical manifestation. Finally, with helminthiasis, to an even greater extent than with bacterial infections, the course of the disease depends on the initial state of the body's reactivity. Severe forms of some helminthiasis are mainly observed in persons with immunodeficiency states. Frequent polyinvasions of helminths are especially difficult for clinical diagnosis (they are also often characteristic of immunodeficient patients).
Therefore, the diagnosis of helminthiasis is most often made in the chronic stage. She manifests herself clinically with the following syndromes:

1) Abdominal (including dyspepsia);
2) Allergic (rash, eczema, bronchospasm, eosinophilic infiltrates in the lungs).
3) Chronic toxicosis (anorexia, weakness, lethargy, polyhypovitaminosis, chronic fatigue syndrome).
4) Anemic (more often iron deficiency anemia, with diphyllobothriasis - pernicious anemia).

**Laboratory diagnostics.**

Diagnosis of helminthiasis is carried out on the basis of the clinical picture of the disease, as well as laboratory data - the detection of eggs, larvae or mature helminths and their fragments in the blood, vomit, urine, the contents of abscesses and punctates; skin research.

**Special diagnostic laboratory methods** are divided into the following groups:

- **Helmintic ovoscopic** (with and without enrichment):
  - Microheliminhtoscopic (enterobiasis, teniasis).
  - Helmintholarvoscopic (vomit, bile, urine, sputum, duodenal contents).
  - Muscle biopsy (teniasis).
  - Scrapings (enterobiasis).

**Immunological methods.**

**Epidemiological methods.**

It is especially important to collect an epidemiological anamnesis to identify natural focal helminths and to diagnose the early phase of helminthiasis, when the patient has not yet excreted eggs or larvae of parasites. In the early phase of helminthiasis, as well as with larval helminthiasis (echinococcosis, alveococcosis), an important role is played by immunological research methods: serological reactions or allergic diagnostic tests with helminth antigens (most effective in intestinal helminthiasis, when secretions and excretions of helminths that directly enter antigenic activity host's blood). In many helminthiases, a general blood test, serological reactions - RNGA, RSK, REMA (with enzyme-labeled antibodies), ELISA, skin-allergic tests have a certain diagnostic value.

Currently, the dynamics of the development of helminths is being carefully studied. In this process, approaches using the method of mathematical analysis in order to increase the body's immunity give positive results. The term mathematical immunology is widely used in science. In turn, the analysis of systems proposed in the field of biomedicine is called "systems biology".

At the same time, medicine uses the largest sections of modern mathematics, such as mathematical modeling, the theory of differential equations. For example, differential equations were used in the process of creating an artificial kidney, since the process of hemodialysis (blood purification using an artificial kidney) is described by a system of differential equations.

Today, the elaboration of mathematical models and computational algorithms for a system of functional differential equations in the treatment of helminths, as well as the development of information technology programs for the prevention and treatment of helminthsin children is an important task.

It is known that for research, helminths were previously determined primarily on an expert model, that is, using laboratory testing methods. This formula, which we recommend, allows you to determine the dynamics of the growth of helminths, the occurrence of undesirable phenomena in the human body through the latent course of the disease, using mathematical formulas (theory of differential equations).

By reviewing and analyzing the characteristics of the susceptibility of the mathematical model of helminthic disease, one can find similarities corresponding to the parameters or conditions of the system, which allow the
development of effective parasitological methods. The main goal is to study the possibility of determining a compensatory effect on the immune system in the late stages of helminthic disease using mathematical modeling methods. Immediate optimal conditions in the theory of aerodynamic stability can be used as a violation of the steady state of the disease in the framework of models.

The mathematical model of the disease will allow studying the characteristics of susceptibility, taking into account the spread, speed and time of spread of parasites. Previously, the expert model was mainly used to study diseases. Using this formula, it is possible to reveal the latent manifestations of this disease in the linear differential of the dynamics of a simple mathematical model of worms.

Here \( V \)-time spread of worms, \( E_p \)-active worms, \( E_e \)-effectiveness of worms, \( W \)-reproductive worms.

\[
\frac{d}{dt} V(t) = \beta V(t) \left( 1 - \frac{V(t)}{V_{in}} \right) - \gamma V E_e(t) V(t),
\]

\[
\frac{d}{dt} E_p(t) = \alpha E_p \left( E_p^0 - E_p(t) \right) + \beta_p g_p(W)V(t - \tau)E_p(t - \tau) - \alpha_{Ap}V(t - \tau_A)V(t)E_p(t),
\]

\[
\frac{d}{dt} E_e(t) = b_d g_e(W)V(t - \tau)E_p(t - \tau) - \alpha_{AE}V(t - \tau_A)V(t)E_e(t) - \alpha_{Ee}E_e(t),
\]

\[
\frac{d}{dt} W(t) = b_w V(t) - \alpha_w W(t), (1)
\]

Herein \( g_p(W) = 1/(1 + W/\theta_p)^2 \), \( g_e(W) = 1/(1 + W/\theta_e)^2 \)

The biological meaning of the size of the system is given in the above formula. To calculate this \( \tau > 0 \) and \(-\tau_A \leq t \leq 0 \) in this interval it is enough to calculate the meaning \( V(t) \), \(-\tau \leq t \leq 0 \) in this interval, the meaning \( E_p(t) \), when \( t \leq 0 \) the meaning \( E_e(0) \) and \( W(0) \).

However, for consistency, the initial value of all variables in the range \(-\tau_A \leq t \leq 0 \). The biological meaning of this formula is as follows: \( \beta \)-The speed of worms in this range; \( \gamma V \)-Loss of constant speed of worms due to cellular results; \( V_{in} \)-the number of the most common worms in the interstitial space; \( \tau \)-classificaion of the duration of recurrence of cytotoxic lymphocytes; \( \beta_p \)-constant cytotoxic lymphocyte rate; \( b_d \)-differentiation of cytotoxic lymphocytes; \( \theta_p \)-state of the border of treatment of worms; \( \theta_e \)-limit of worms for converting results into energy state; \( \alpha_{Ap} \)-a constant rate of natural death during treatment for worms; \( \alpha_{Ee} \)-the result of permanent natural death when treated for worms; \( E_p^0 \)-non-helminthic concentration of spleen muscles; \( \tau_A \)-persistent transition of cytotoxic lymphocytes to apoptosis; \( \alpha_{Ap} \)-constant rate of precursors of apoptosis; \( \alpha_{AE} \)-constant rate of performer apoptosis; \( b_w \)-growth rate of cumulative worm load; \( \alpha_w \)-constant rate of recovery of the body under the influence of a worm load.

(1) determination of the vector of system variables by the formula

\[
U(t) = (V(t), E_p(t), E_e(t), W(t))^T, (2)
\]

This formula can also be written in the following form

\[
\frac{d}{dt} U(t) = F(U(t), U(t - \tau), U(t - \tau_A)). \quad (3)
\]

Based on the above, we consider the variable as a vector in \( U(t) \) given \(-\tau_A \leq t \leq 0 \)

(3) the formula was calculated by Newton's method to a nonlinear equation in stationary cases.

For different sets of parameters, formula (3) has constant states. In this study, we used two sets of parameters, for each of which a steady state was found. Stationary states were calculated using Newton's method to the nonlinear equation: \( F(U) = 0, F(U) = F(U, U, U) \)
III. RESULT

The stationary states of the model (3) are based on the search for sets of parameters with the required properties and the results of the analysis of numerical bifurcations (“bifurcus” comes from the Latin word for division) at initial values corresponding to the Newtonian method.

The above formula was developed in Matlab program.

We can see the results of the values in this graph.

In addition to the above, the only way to prevent the development of symptoms is to see a doctor, who will prescribe tests and medications for the treatment of enterobiasis in childhood and follow the doctor's instructions:

- Store baby clothes separately, do not put on each other's clothes;
• toys children play should be washed with soap from time to time;
• disinfection of children's toilets, toilet floors, doors and gutters, window sills, tables and chairs with boiling water, 5% lysol solution, creolin, bleach, etc.;
• regularly decontamination (disinfection), cleanliness and replacement of sand in the play sandbox;
• wash fruits and vegetables thoroughly in clean water and then consume;
• do not eat meat that has not been fully cooked or fried;
• regularly talk about the prevention of helminthic diseases with parents;
• boil children's bedding and underwear before washing, iron and change every day, in the morning wash the anal area with soap and warm water.

Also use natural ways to treat worms, eat pumpkin seeds and garlic in food. Of course, with these natural methods, we cannot completely get rid of parasites, but we can get rid of some.

General principles for the treatment of helminthiasis:

• the adequacy of the drug, dose, course.
• preparation of the patient for specific treatment, where necessary (giving laxatives, enemas, enterosorbsents, diet).
• antihistamines and hyposensitizing agents as a background of treatment, especially in children with a burdened allergic history.
• reorganization of the environment, family and children's team visited by the child,
• syndrome therapy,
• at the end of the treatment, its effectiveness must be monitored.

With a visual assessment, it takes into account the presence of whole helminths (pinworm, roundworm) or their segments, scraps (teniarinchiasis, teniasis, diphyllobothriasis). Visual assessment is especially helpful after anthelmintics followed by laxatives. It is useful to use a magnifying glass to identify small helminths. Microscopic detection of helminth eggs (coproovoscopy) is carried out in the laboratory. It should be noted that helminthiasis can be a concomitant disease. Therefore, when establishing a diagnosis, a comprehensive examination of the patient is necessary.

IV. CONCLUSION

Helminthiases are diseases that result from the introduction of helminths (parasitic worms) into the human body. A feature of such diseases is the complex interaction between two living organisms - the parasite and the host. In this article, we reviewed the results obtained using a mathematical model and differential equations based on experiments with helminthic diseases, as well as the results in Matlab. The main objective of the study was to uncover the hidden arguments underlying this disease.Differential equations were used to calculate the prevalence, reproduction and adverse effects of ascaris on the human body.

REFERENCES


