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Mathematical Modeling of Hepatitis B Virus Dynamics at the Molecular Genetic Level

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Abstract: The main processes of infection of liver cells with hepatitis B viruses occur in the cross-interaction of the genome of liver cells and the genome of hepatitis B viruses. Mathematical modeling and analysis of the infectious process at the molecular genetic level are necessary. In this article, a class of functional differential equations of the Goodwin type was used to mathematically simulate the dynamics of hepatitis B virus in liver cells, and a qualitative analysis was performed using the isocline method and some results obtained in a computational experiment.

Key points: liver cell, hepatitis B virus, molecular genetic process, functional differential equations of the Goodwin type, isocline method.

Hepatitis B is a viral disease that, when the virus enters the body, begins to negatively affect vital internal organs. The greatest damage due to this disease reaches the liver, which is damaged at the microcellular level. The disease may be asymptomatic or manifest with pronounced symptoms. During the transition to the chronic stage, this viral infection often leads to the development of cirrhosis and liver cancer.

The probability of the disease passing from an acute form to a chronic stage can be differentiated depending on the specific characteristics of the body:

In newborns — in 90% of cases;

In young people with normal immunity — 1% of cases;

In adults — in 10% of cases.

People who receive the vaccine become immune to this disease:

After the first vaccination — 50%;

After the second vaccination — 75%;

After the third vaccination-100%.

Indications for the diagnosis of the chronic form of the disease in children:

In children 1-5 years old — in 25-50% of cases;

In babies infected at birth — in 90% of cases.

Classification

Hepatitis B is classified as:

Lightning fast. Patients experience brain swelling for several hours and may fall into a coma. In many cases, the patient's life tragically ends in the short term when the disease enters the clinical stage. This form of the disease is extremely rare (less than 1%).

Sharp. In the acute form of hepatitis B, the patient has several stages of the disease. At first, the main symptoms appear, then the skin turns yellow. The last stage of the pathology is characterized by liver failure.

Chronic. The disease becomes chronic 1-6 months after human infection. These few months are the incubation period of the virus, after which certain symptoms and signs begin to appear.

Incubation period

After the virus enters the patient's body, the incubation period of hepatitis begins. Its duration ranges from 30 to 180 days, with an average of 75 days.

The acute form of hepatitis can occur as follows:

The stage of the attack;

Long-term illness;

Relapses;

Rarely — coma.

Risk

When hepatitis B is diagnosed late or not treated on time, as a result, the likelihood of developing cirrhosis of the liver or hepatocellular cancer increases.

In this category of patients, other serious consequences of the disease may occur:

Myocarditis (inflammation of the heart muscle);

Arthritis, osteoarthritis and other joint diseases;

Stroke, kidney disease, etc.

The probability of death from the above complications increases significantly.

Currently, a list of categories of people in need of mandatory hepatitis B vaccination has been approved at the state level.:

Schoolchildren and students;

Kindergarten students;

Medical professionals who may come into contact with patients' biological materials;

Patients in need of hemodialysis;

Patients requiring intravenous injections;

Persons serving time in places of deprivation of liberty;

Family members and relatives of a patient suffering from a chronic form of hepatitis;

Those who engage in promiscuous sex;

These are tourists planning trips to settlements where an epidemic of the disease has been recorded.

Reasons

The cause of the development of hepatitis B is the ingestion of the causative agent of the disease — the virus. The disease is especially common in people with weakened immune systems due to a number of negative factors (exposure to alcohol, nicotine, chemical and toxic substances, drugs).

Patients are not required to be socially isolated, since the virus is not spread by airborne droplets. Anyone who comes into contact with the patient must follow the necessary precautions and rules of personal hygiene. According to data obtained as a result of many years of research around the world, the course of this disease depends on how the patient was infected, as well as on his age.

If the patient has contracted hepatitis B naturally (for example, during sex), in this case there is a high risk that the disease will go into a chronic stage. This form of hepatitis often occurs in young people because they do not pay serious attention to their health and do not respond to the body's alarm signals.

Hepatitis B transmission routes

The hepatitis B virus can enter the human body only through contact with the biological material of the patient:

Sexually. The virus is present not only in the blood, but also in all body fluids (including vaginal secretions and male sperm), so unprotected sex increases the risk of transmission of the disease;

Through saliva. A person can get the disease from kissing if there are cuts or wounds on his tongue;

Through the blood. This is considered one of the most common ways of infection. Many patients have contracted hepatitis B through the use of non-sterile syringes and blood transfusions. Contact with the infected biological material of the patient can also lead to infection in beauty salons where proper sanitary measures are not carried out.;

In the process of giving birth. Despite the fact that the patient's pregnancy proceeds without complications, during childbirth the child is in direct contact with the biological material of the mother, and for this reason it is highly likely to be infected. To prevent this from happening, such babies are vaccinated immediately after birth.

Hepatitis B virus is highly resistant to aggressive temperature conditions, acids and alkalis. The virus can be stored in dried blood for a long time. For this reason, it is important that everyone be very careful and take all necessary precautions for their safety when visiting relevant institutions.

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