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HEPATITIS B VIRUS INFECTION: A COMPREHENSIVE REVIEW OF VIRAL BIOLOGY, CLINICAL SPECTRUM, AND PREVENTIVE STRATEGIES

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ВИРУСНАЯ ИНФЕКЦИЯ ГЕПАТИТА В: ВСЕСТОРОННИЙ ОБЗОР ВИРУСНОЙ БИОЛОГИИ, КЛИНИЧЕСКОГО СПЕКТРА И ПРОФИЛАКТИЧЕСКИХ СТРАТЕГИЙ

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Abstract. Infection with hepatitis B virus (HBV) is a serious health issue around the world, and one of the most common causes of long-term liver problems such as chronic liver disease and cirrhosis, and liver cancer. HBV is caused by the hepatitis B virus, which is part of the family of viruses called Hepadnaviridae and consists of a partially double-stranded DNA genome. Transmission occurs primarily through the exchange of blood and body fluids. The objective of this study was to collect available information about HBV infections and assess that information with respect to the following areas: epidemiology of HBV infection, viral biology, clinical features of HBV infection, diagnosis and treatment of HBV infection, and prevention of HBV infection. This study is a descriptive literature review based on the secondary research data acquired from the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and peer-reviewed literature. A qualitative analysis process was used to extract the relevant information contained in the published literature. There are many different types of HBV infections. There are individuals who are asymptomatic carriers of HBV; individuals who have an acute HBV infection; individuals with chronic HBV infection; and individuals with cirrhosis and/or liver cancer caused by HBV. The diagnosis of HBV infection is determined by the presence of serological markers associated with the infection, such as HBsAg, HBeAg, anti-HBc, anti-HBs, and HBV DNA levels. These markers also assist in determining whether or not the individual is infectious and how far progressed the disease is. Antiviral therapies available for treating HBV infection include tenofovir and entecavir which have been shown to effectively suppress viral replication but are unable to eliminate the covalently closed circular (ccc) DNA of the virus. Vaccination against HBV has demonstrated a reduction in the incident cases and remains the most effective means of prevention. The burden of HBV infection as a preventable global health issue continues. Properly diagnosing someone infected with HBV, treating the individual with an antiviral agent, and providing universal vaccination will be necessary to decrease the morbidity and mortality associated with HBV infection.

Аннотация. Заражение вирусом гепатита В (ВГВ) является серьезной проблемой здравоохранения во всем мире и одной из наиболее распространенных причин долгосрочных проблем с печенью, таких как хронические заболевания печени и цирроз печени, а также рак печени. HBV вызывается вирусом гепатита В, который является частью семейства вирусов, называемых Hepadnaviridae, и состоит из частично двухцепочечного генома ДНК. Передача происходит в основном через обмен крови и жидкостей организма. Цель этого исследования

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состояла в том, чтобы собрать доступную информацию об инфекциях ВГВ и оценить эту информацию в отношении следующих областей: эпидемиология инфекции ВГВ, вирусная биология, клинические особенности инфекции ВГВ, диагностика и лечение инфекции ВГВ и профилактика инфекции ВГВ. Это исследование представляет собой описательный обзор литературы, основанный на данных вторичных исследований, полученных от Всемирной организации здравоохранения (ВОЗ), Центров по контролю и профилактике заболеваний (CDC), и рецензируемой литературы. Процесс качественного анализа был использован для извлечения соответствующей информации, содержащейся в опубликованной литературе. Существует много различных типов инфекций HBV. Есть люди, которые являются бессимптомными носителями ВГВ; лица, которые имеют острую инфекцию HBV; лица с хронической инфекцией ВГВ; и люди с циррозом и/или раком печени, вызванным HBV. Диагноз инфекции HBV определяется наличием серологических маркеров, связанных с инфекцией, таких как HBsAg, HBeAg, анти-HBc, анти-HBs и уровни ДНК HBV. Эти маркеры также помогают определить, является ли человек инфекционным и насколько прогрессирует заболевание. Противовирусная терапия, доступная для лечения инфекции HBV, включает тенофовир и энтекавир, которые, как было показано, эффективно подавляют репликацию вируса, но не могут устранить ковалентно закрытую кольцевую (ccc) ДНК вируса. Вакцинация против ВГВ продемонстрировала сокращение случаев инцидентов и остается наиболее эффективным средством профилактики. Бремя инфекции ВГВ как предотвратимой глобальной проблемы здравоохранения продолжается. Правильная диагностика человека, инфицированного ВГВ, лечение человека противовирусным агентом и обеспечение универсальной вакцинации будут необходимы для снижения заболеваемости и смертности, связанных с инфекцией ВГВ.

Keywords: Hepatitis B virus, HBV, Chronic hepatitis B, Liver cirrhosis, Hepatocellular carcinoma, HBsAg,

Ключевые слова: вирус гепатита B, ВГВ, хронический гепатит B, цирроз печени, гепатоцеллюлярная карцинома, HBsAg,

Hepatitis B virus (HBV) infection has become one of the most serious global health issues, and it is also one of the most common causes of both acute and chronic liver disease. HBV is a partially double-stranded DNA virus that belongs to the Hepadnaviridae family of viruses. Hepatocytes are primarily affected by the virus, resulting in inflammation, necrosis, and chronic liver complications, including cirrhosis and hepatocellular carcinoma (HCC).

There are many different types of HBV infections, with an asymptomatic carrier state, acute hepatitis, fulminant hepatic failure, and chronic hepatitis being four examples of how the infection may manifest clinically. Chronic HBV infection is defined by the presence of the surface antigen (HBsAg) in serum beyond six months post-infection. The age at which an individual is infected has a profound effect on the chance of becoming chronically infected with HBV; the risk is highest for neonates and young children.

The virus spreads through contact with infected blood and other bodily fluids. The primary modes of transmission are vertical (mother-to-child at the time of delivery), horizontal (young children/infants from close contact with infected people), parenteral (unsafe injections or transfusions), and sexual contact in adults. In areas where HBV is endemic, mother-to-child and early childhood transmissions account for a significant percentage of chronic HBV carriers.

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Cytopathic damage does not occur directly from HBV; instead, the liver is injured, or the immune system is triggered to injure the liver by HBV. The body's immune response, mainly mediated by cytotoxic (killer) T-cells, damages the liver, thus driving the process through which the liver is damaged. Whether or not the infection is cleared by the immune system, or the patient develops chronic liver disease, depends on the immune system's ability to clear or destroy infected liver cells (hepatocytes).

Since HBV vaccination is available, it remains a high priority for health policymakers. Low- and middle-income countries are at the greatest risk for HBV infection, and despite widespread vaccination, HBV continues to be a major public health issue, as it is a leading cause of liver cirrhosis, liver failure, and liver cancer worldwide. Early diagnosis, prevention, and treatment of HBV infection are of paramount importance in clinical practice.

The collected literature was reviewed critically in terms of quality and organized thematically. For the purposes of this study, qualitative analysis was utilized in order to integrate information from multiple sources and provide a comprehensive understanding of HBV infection. Statistical analysis of the data was not performed in the current investigation because the information was obtained through secondary sources (no primary patient data were available).

Hepatitis B virus (HBV) infection, as per scientific literature, is an ongoing international public health problem and continues to be problematic in low- and middle-income countries where there are still barriers to vaccination and screening programmes. The geographic regions of similarly high endemicity, particularly Southeast Asia and Sub-Saharan Africa, have high levels of hepatitis B virus (HBV) transmission shortly after birth, and thus a high proportion of their cumulative cases are chronic infections. According to epidemiological data, it is estimated that approximately 296 million people are chronic carriers of HBV infection worldwide. The risk of developing a chronic HBV infection is primarily an age-based risk; 90% of newborn infants born to infected mothers will develop chronic HBV, while typically less than 5% of immunocompetent adults will develop a chronic HBV infection.

Pathogenesis studies have shown that HBV does not cause liver cell death directly. Instead, the pathogenesis of HBV is due to host immune activation against HBV-infected hepatocytes by cytotoxic T lymphocytes, which results in the immune-mediated destruction of hepatocytes, leading to inflammation, cell death, and progressive liver fibrosis (in chronic HBV pathogenesis).

Diagnosis remains predominantly via serologic assays; when a patient has HBsAg present, they are considered to be actively infected, while the presence of antibodies (anti-HBs) indicates the patient has attained immunity to HBsAg infection. The positivity of HBeAg in a chronically HBV-infected patient is indicative of high infectivity (high potential to infect) and active viral replication, while HBV DNA levels are the most precise measurement of HBV viral load and response to antiviral therapy.

HBV infection has a broad range of clinical manifestations, from asymptomatic carriers to acute hepatitis, fulminant (sudden onset) hepatic failure, chronic hepatitis, cirrhosis, or hepatocellular carcinoma. Many individuals with early chronic HBV infection remain asymptomatic, delaying their diagnosis.

Clinical evidence shows anticancer treatment options, such as the nucleos/tide analogues tenofovir and entecavir, reduce liver inflammation and poor health outcomes; however, despite treatment, finding a cure for HBV infection is highly unlikely due to the presence of covalently closed circular DNA (cccDNA) in hepatocytes.

In terms of disease prevention, universal vaccination programs are the best way to prevent new cases of HBV; success has been demonstrated in various countries with universal hepatitis B vaccination programs.

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Post-exposure prophylaxis with hepatitis B immunoglobulin (HBIG) plus vaccination significantly decreases the risk of HBV transmission after exposure.

In general, these findings support that early detection, sustained antivirals, and universal vaccination programs are necessary to control HBV infections worldwide.

There are limited options for the treatment of hepatitis B virus (HBV); however, HBV remains a significant global public health issue despite having an effective vaccine and effective antiviral treatments available. The continued existence of HBV as a public health issue is attributed to a lack of appropriate screening measures, a lack of adequate vaccination rates in endemic areas, and high rates of vertical transmission of HBV from mother to child.

The pathophysiology of HBV is distinctive because the virus itself has no cytopathic effect on cells – the damaging effects of HBV are due to the host's immune response (most typically the cytotoxic T-lymphocyte response to the infected hepatocyte). This immunological effect also accounts for why individuals with a strong immune response will have acute symptomatic hepatitis and can achieve resolution of their infection; individuals with poor, immature immune responses (e.g., neonates) are at greater risk for developing chronic infections.

Chronic HBV has clinical significance because it is a progressive disease. Persistent HBV replicates continuously and causes persistent inflammation and damage to the liver, eventually leading to cirrhosis or HCC. The integration of HBV DNA into the host DNA and the persistence of cccDNA within the hepatocytes are the main contributors to the virus's ability to persist, as well as why it is difficult to eradicate completely.

There are many factors that influence how a person naturally develops an HBV (Hepatitis B virus) infection after getting infected, including the age at which they were infected, viral load, the person's immune response (that is, whether their body can fight off the virus), and the type of HBV strain (there are at least ten different strains).

The likelihood that someone who is infected with HBV at birth will develop a chronic HBV infection is much greater than for someone who has recently acquired an HBV infection as an adult, which will likely resolve without the use of medications.

The most common ways your doctor will diagnose an HBV infection are by performing laboratory tests (serology) for HBV (HBsAg is the most important marker to identify the presence of the virus), measuring the amount of HBV (HBV DNA) in your blood (this will help your doctor determine how active your virus is), measuring your liver enzymes (ALT/AST) to assess the degree of inflammation caused by the infection, and conducting imaging studies to determine if you have any complications related to HBV.

Current treatment options for HBV help your body reduce the amount of HBV that you have (via nucleos(t)ide analogues known as tenofovir and entecavir) and help improve the overall health of your liver. In addition, these medications decrease the risk of cirrhosis and the development of primary liver cancer (known as hepatocellular carcinoma or HCC). However, continued treatment throughout your life may be required due to the fact that HBV will never be eliminated from your body.

The most effective way to globally control HBV infection is through prevention. Vaccination is a universal method that has helped to significantly reduce the number of new HBV infections in many countries. In addition to vaccination, other key preventive measures include implementing safe injection practices, screening blood products, and providing post-exposure prophylaxis for individuals who are exposed to HBV as described above.

Hepatitis B virus (HBV) infection is still a major public health concern throughout the world, with high prevalence rates, ranking third as a cause of chronic liver disease, cirrhosis, and hepatocellular carcinoma (HCC). Although there are currently effective vaccines that prevent HBV

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infection, HBV continues to thrive due to limited vaccination access in many endemic regions and ongoing vertical (from mother to child) and horizontal (from person to person) modes of transmission.

The clinical spectrum of HBV infection can range from asymptomatic, chronic carriers through to acute hepatitis, fulminant liver failure, and chronic liver diseases. Chronic HBV infection is especially important because of its various long-term complications and increase in mortality. The presence of covalently closed circular DNA (cccDNA) in hepatocytes makes it very challenging to completely eradicate the virus, even with very effective antiviral therapy.

The diagnosis of hepatitis B virus (HBV) involves determining whether a person has been infected with the virus and how to treat it. Serologic markers (blood tests that identify specific HBsAg, an antigen produced when someone is infected with the virus) and HBV DNA quantity (a test that measures the amount of virus in the blood) both play important roles in determining whether someone has an active HBV infection and how to treat it once diagnosed. Treatment options are usually antiviral medications, which suppress the replication of the virus and decrease the risk of liver disease progression (the time from infection until the person develops complications). Most patients will require long-term or lifelong therapy using these medications.

Prevention through vaccine programs, especially giving the “birth dose” (the first hepatitis B vaccination) to newborns, is the best way to lower the incidence of HBV infections worldwide. Other public health measures, such as safe injection practices, screening of blood products for HBV, and the use of post-exposure prophylaxis (PEP), are also important in controlling HBV.

In summary, HBV is a preventable disease that causes significant morbidity and mortality when not treated. To eliminate HBV, global strategies including vaccination, early diagnosis using HBV serology and viral load, and the provision of safe and effective antiviral therapy are needed.

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