

Hepatitis B Immunization Among Healthcare Students: What Do We Really Know

by Lorenzo Ippoliti*

Abstract

Hepatitis B virus (HBV) infection remains a relevant global health issue despite the availability of effective vaccines and the implementation of widespread immunization programs. Recent international strategies have set ambitious goals for the elimination of viral hepatitis, with vaccination representing the cornerstone of prevention. Healthcare personnel are at increased risk of occupational exposure to HBV, making immunization a key component of infection control policies. Healthcare students represent a particularly important group, as they begin to face these risks during clinical training, often many years after completing primary vaccination in childhood. Although vaccination coverage is generally high, protective antibody levels may decline over time, and some students may show low or undetectable anti-HBs titers during pre-clinical screening. The increasing internationalization of universities further complicates this scenario, as students may come from diverse backgrounds with different vaccination schedules and documentation practices, potentially affecting their immunization status. This article reviews the current evidence on hepatitis B vaccination among healthcare students, focusing on occupational risk, long-term immunity, and the challenges associated with multicultural academic settings. Strengthening vaccination assessment and surveillance strategies is essential to ensure adequate protection for future healthcare professionals.

Keywords

Hepatitis B, HBV Vaccination, Healthcare Students, Occupational Risk.

1. Introduction

Hepatitis B virus (HBV) infection remains a major global health concern. According to the World Health Organization, hundreds of mil-

lions of people worldwide live with chronic HBV infection [1], which may lead to severe complications such as liver cirrhosis and hepatocellular carcinoma [2]. Despite the availability of an effective vaccine for more than four decades,

HBV continues to represent a significant public health issue, particularly in populations at increased risk of exposure [3,4].

Healthcare workers are among the professional groups most frequently exposed to HBV infection due to their

* UniCamillus International Medical University of Rome.

occupational contact with blood and biological fluids [5]. For this reason, hepatitis B vaccination has long been recognized as a cornerstone of occupational health policies in healthcare settings [6]. Universal vaccination programs introduced in many countries since the 1990s have significantly reduced the incidence of HBV infection and have contributed to the decline of chronic liver disease associated with the virus [7,8].

Within this context, healthcare students represent a specific population of interest. During their clinical training, students in medical and health-related programs may be exposed to the same occupational risks faced by healthcare professionals, particularly through contact with patients, blood samples, and medical instruments. Ensuring adequate protection against HBV infection before the start of clinical activities is therefore essential both for the safety of students and for the protection of patients [9].

However, several issues remain under discussion. Although many students received the hepatitis B vaccine during childhood through national immunization programs,

long-term immunity and the persistence of protective antibody levels may vary over time [10]. Several studies have shown that anti-HBs titres may decrease after primary vaccination. However, long-term follow-up studies have demonstrated that a significant proportion of vaccinated individuals maintain protective antibody levels even after decades. For instance, persistence of anti-HBs up to 30 years after vaccination has been reported in healthcare workers, although antibody levels tend to decline progressively over time. Moreover, international universities increasingly host students from different countries with heterogeneous vaccination histories and documentation practices, which may complicate the assessment of immunization status [11].

For these reasons, understanding the current evidence regarding hepatitis B immunization in healthcare students is crucial. This article aims to review the main aspects related to HBV vaccination in this population, including occupational risk, long-term immune protection, and the challenges faced by universities in ensuring adequate immunization coverage.

2. Global Elimination of Hepatitis B

The Hepatitis B Virus (HBV), a prototype member of the *Hepadnaviridae* family (genus *Orthohepadnavirus*), possesses a unique genomic architecture characterized by a small, circular, and partially double-stranded DNA molecule. This genome is sequestered within an icosahedral nucleocapsid, which is further encapsulated by a lipid envelope. The replication cycle of HBV is highly tissue-tropic, with hepatocytes serving as the primary site for viral synthesis and assembly [12].

While closely related HBV genotypes have been identified in non-human primates, humans remain the sole known reservoir for human-specific HBV genotypes. This restricted host range presents a significant epidemiological opportunity: because the virus lacks a zoonotic reservoir capable of re-infecting human populations, HBV is theoretically amenable to global eradication [12].

Unlike pathogens that circulate in wildlife – where “spillover” events can trigger recurrent outbreaks – the survival of human HBV is entirely dependent on its continued

transmission within the human population. Therefore, if the chain of transmission can be broken through universal vaccination and the suppression of viral loads in chronic carriers, the human-specific genotypes of HBV could be permanently eliminated.

In fact, in recent years the global approach to hepatitis B virus (HBV) infection has shifted from simple disease control to the more ambitious goal of elimination. The World Health Organization (WHO) has identified viral hepatitis as a major public health priority and has launched a global strategy aimed at eliminating hepatitis B and C as public health threats by 2030 [13]. This objective is defined by measurable targets, including a 90% reduction in new infections and a 65% reduction in hepatitis-related mortality compared to 2015 levels.

Despite these ambitious goals, HBV remains a significant global burden, with hundreds of millions of people living with chronic infection and over one million deaths each year due to complications such as cirrhosis and hepatocellular carcinoma. However, unlike many other chronic viral infections, hepatitis B is largely pre-

ventable through vaccination, and effective antiviral treatments are available to control disease progression. For this reason, elimination is considered an achievable target, provided that preventive strategies – particularly universal vaccination, early diagnosis, and access to care – are adequately implemented worldwide [14].

3. Hepatitis B Vaccination: General Aspects

Hepatitis B vaccination represents the cornerstone of global HBV prevention strategies and is widely regarded as one of the most effective vaccines currently available [1]. Since its introduction in the 1980s and subsequent inclusion in national immunization programs, the vaccine has dramatically reduced the incidence of HBV infection, particularly in countries that have implemented universal childhood vaccination [8,15]. The standard vaccination schedule typically consists of a three-dose series administered during infancy, often beginning within the first year of life, although alternative schedules may be adopted depending on national policies [16], such as accelerated schedules (e.g., 0, 1, 2, and 12 months) or vaccination during

adolescence in countries where infant immunization was not initially implemented.

The vaccine induces the production of hepatitis B surface antibodies (anti-HBs), which are considered a marker of protective immunity. An antibody level equal to or greater than 10 mIU/mL is generally accepted as the threshold for protection [17]. In most vaccinated individuals, this immune response is highly effective and long-lasting, with protection persisting for decades even in the presence of declining antibody levels. This long-term protection is largely attributed to immunological memory, which enables a rapid immune response upon exposure to the virus [18].

The widespread implementation of hepatitis B vaccination has not only reduced transmission in the general population but has also played a crucial role in preventing vertical transmission from mother to child and in protecting high-risk groups, including healthcare workers. As a result, vaccination remains the central pillar of all global strategies aimed at reducing HBV transmission and achieving long-term disease control.

4. Hepatitis B Vaccination for Healthcare Personnel

Healthcare personnel represent one of the professional groups most exposed to blood-borne pathogens, including hepatitis B virus (HBV) [19]. Occupational exposure may occur through needlestick injuries, contact with contaminated sharp instruments, or exposure of mucous membranes and damaged skin to infected biological fluids [20]. Because HBV can be efficiently transmitted through blood and other body fluids, healthcare settings have historically been considered high-risk environments for viral hepatitis transmission [21].

For this reason, hepatitis B vaccination has become a fundamental component of occupational health programs in healthcare institutions worldwide. International guidelines consistently recommend that all healthcare workers with potential exposure to blood or body fluids receive the complete hepatitis B vaccination series and undergo post-vaccination testing to document protective antibody levels [16].

The introduction of hepatitis B vaccination among healthcare personnel has significantly reduced the in-

cidence of occupational HBV infections. In many countries, vaccination is offered free of charge to workers at risk and is often required before employment in clinical environments. Vaccination policies are usually combined with additional preventive strategies, including standard infection control precautions, safe handling of needles and sharps, and appropriate management of occupational exposures.

Protection after vaccination is generally defined by the presence of anti-HBs antibody levels above 10 mIU/mL [17]. Individuals who achieve this level of response are considered protected against HBV infection, and long-term immunity is believed to persist even when antibody titres decline over time. However, a small proportion of vaccinated individuals may fail to develop an adequate immune response, requiring additional vaccine doses or alternative immunization strategies [18].

Overall, hepatitis B vaccination represents one of the most effective preventive measures for protecting healthcare personnel from occupational infection and for reducing the risk of transmission within healthcare settings.

5. Vaccination Among Healthcare Students

Healthcare students constitute a specific subgroup within the broader category of healthcare personnel. During their training, students in medical, nursing, dental, and other health-related programs progressively engage in clinical activities that may expose them to blood, biological samples, and invasive procedures. For this reason, the risk of HBV exposure may begin even before graduation, during the period of clinical training.

Most healthcare students in many countries today have received hepatitis B vaccination during infancy or childhood as part of national immunization programs. This widespread childhood vaccination has significantly reduced the prevalence of HBV infection among younger generations entering health professions. Nevertheless, the persistence of protective antibody levels over time remains a subject of ongoing discussion.

Several studies have shown that anti-HBs titres may decrease years after the completion of the primary vaccination series [10,17]. As a result, a proportion of healthcare students undergoing occupational

health screening before clinical training may show antibody levels below the commonly accepted protective threshold [22]. In most cases, however, this decline does not necessarily indicate loss of immune memory, since vaccinated individuals may still develop a rapid anamnestic response following booster doses.

Because of these factors, many universities and healthcare institutions implement screening programs to assess hepatitis B immunization status in students before they begin clinical placements [22]. Occupational health services may verify vaccination records, measure anti-HBs antibody levels, and administer booster doses when necessary. These preventive strategies aim to ensure adequate protection for students while also reducing the potential risk of HBV transmission in healthcare environments.

6. Management of Low or Absent Anti-HBs Titres in Healthcare Students

One of the most frequently encountered issues during occupational health screening of healthcare students is the detection of low or absent anti-HBs antibody titres de-

spite a documented history of hepatitis B vaccination. Because many students received the primary vaccination series during infancy or early childhood, several years or even decades may pass before antibody levels are measured again during university health surveillance programs [10,22].

A decline in circulating anti-HBs antibodies over time is a well-known phenomenon and does not necessarily indicate loss of protection. In individuals who initially responded to vaccination, immunological memory may persist for many years, allowing the immune system to mount a rapid and effective response following exposure to the virus [16,18]. For this reason, the presence of anti-HBs levels below the conventional protective threshold does not automatically imply susceptibility to infection.

Nevertheless, in healthcare settings it is essential to ensure a clear and documented immune status, particularly for individuals who will be exposed to blood or biological fluids during clinical activities. Many occupational health protocols therefore recommend measuring anti-HBs titres before students begin their clinical training. When antibody

levels are found to be below the protective threshold, a booster dose is often administered to evaluate the presence of immune memory.

In most previously vaccinated individuals, this booster dose induces a rapid increase in antibody levels, confirming the persistence of immunological memory. In some cases, clinical management protocols for these individuals follow a structured revaccination strategy. Persons unresponsive to an initial three-dose series are recommended to complete a second full course of the vaccine [23]. However, a small proportion of individuals may fail to develop an adequate antibody response even after additional vaccine doses. These subjects are generally classified as “non-responders” and may require further clinical evaluation and specific preventive measures in case of occupational exposure.

To address this challenge, advanced prophylactic strategies have evolved to include glycosylated preS1/preS2/S-containing vaccines produced in mammalian cell lines. Currently licensed in Israel and parts of East Asia, these multivalent formulations are increasingly utilized both

for universal neonatal immunization and as a corrective intervention for the aforementioned non-responders. Specifically, these vaccines are indicated for individuals whose anti-HBs antibody concentrations fail to reach the protective threshold of 10 mIU/mL following a standard three-dose regimen of conventional yeast-derived vaccines. By incorporating additional antigenic components, these mammalian-derived vaccines aim to bypass the limitations of traditional formulations and ensure broader population-wide protection [24].

The management of low antibody titres therefore represents an important component of preventive strategies in healthcare education. By combining vaccination records, antibody testing, and booster policies when appropriate, universities and occupational health services can ensure that healthcare students enter clinical training with adequate protection against hepatitis B infection.

7. Challenges in Multicultural Student Populations

In recent decades, universities and medical schools have become increasingly interna-

tional. Many academic institutions now host students from a wide range of geographical regions, each with different vaccination histories, healthcare systems, and immunization policies. While this diversity represents an important educational and cultural strength, it may also create challenges for occupational health management.

One of the main difficulties concerns the heterogeneity of vaccination schedules. Countries introduced universal hepatitis B vaccination at different times and sometimes adopted different strategies, such as vaccination at birth, during infancy, or during adolescence. Consequently, healthcare students entering international universities may have received the vaccine at different ages or according to different dosing schedules.

Another challenge is the variability in vaccination documentation. Students coming from different healthcare systems may not always have complete or reliable vaccination records, making it difficult for occupational health services to determine their immunization status. In such cases, antibody testing is often required to assess whether pro-

TECTIVE immunity is present.

Furthermore, differences in healthcare infrastructure and vaccine coverage between countries may influence the proportion of students with adequate long-term protection. Students vaccinated in regions with limited access to healthcare services or inconsistent vaccination programs may have a higher probability of incomplete vaccination or lower antibody titres.

For these reasons, universities hosting international healthcare students must often adopt standardized screening and vaccination protocols. These measures allow institutions to ensure adequate protection against HBV infection while accommodating the diversity of vaccination backgrounds present in modern academic environments.

8. Conclusions

Hepatitis B vaccination represents one of the most successful preventive interventions in modern medicine and has played a crucial role in reducing the global burden of HBV infection. For healthcare personnel, vaccination remains a fundamental component of occupational health policies aimed at preventing exposure

to bloodborne pathogens and ensuring safe healthcare environments.

Healthcare students occupy a unique position within this framework. As future healthcare professionals, they begin to face occupational risks during their clinical training, often many years after receiving the primary hepatitis B vaccination series in childhood. For this reason, assessing their immunization status before the start of clinical activities is essential to guarantee adequate protection both for the students themselves and for the patients with whom they interact.

The progressive internationalization of universities

has further increased the complexity of this issue. Students from different geographical regions may have been vaccinated according to diverse immunization schedules, may present variable documentation of their vaccination history, and may show different patterns of long-term antibody persistence. These factors highlight the importance of standardized occupational health protocols capable of addressing the needs of increasingly multicultural academic communities.

Regular evaluation of vaccination history, targeted measurement of anti-HBs antibody levels, and appropriate booster strategies when needed repre-

sent practical tools that universities can implement to ensure adequate protection against HBV infection. Strengthening these preventive measures within academic institutions contributes not only to the safety of healthcare students but also to the broader goal of maintaining high standards of infection control in healthcare systems.

In this context, hepatitis B immunization among healthcare students remains a relevant topic for both public health and occupational medicine, requiring continuous attention as healthcare education and global mobility continue to evolve.

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