Introduction

HBV is an infectious disease that attacks the liver. Some patients may have no symptoms or mild flu-like symptoms; some develop fulminant hepatitis (Link to Fulminant Hepatitis under Module 4: Manifestations) or chronic active hepatitis, sometimes progressing to cirrhosis.

Link to pathology images - cirrhotic liver: www-medlib.med.utah.edu/WebPath/LIVEHTML/LIVER001.html

Historical Perspective

HBV hepatitis has been referred to by several names throughout history - serum hepatitis, type B hepatitis, homologous serum jaundice, Australia antigen hepatitis, and HBV.

Hippocrates described a condition known as “epidemic jaundice” in the 5th century BC. It is likely that many of these cases of epidemic jaundice were caused by HAV and some caused by HBV.

In 1883 in Germany, serum hepatitis was reported in 15% of shipyard workers who received smallpox vaccine containing lymph fluid.

In the early 1900s, serum hepatitis was associated with the use of contaminated needles, and in 1943 it was reported in blood transfusion recipients.

The Australia antigen, later called hepatitis B surface antigen (HBsAg), was first described by an American research physician - Dr. Baruch Blumberg - in 1965. Dr. Blumberg isolated the antigen in the serum of an Australian aborigine.

In 1970, the complete hepatitis B virus (HBV) particle was identified by electron microscopy and named the Dane particle after the investigator who discovered it.

HBV can be seen as spherical shapes and filamentous shapes.

A few years later antigens and antibodies specific to HBV infection were discovered in the serum of infected individuals (serologic markers), which led to the identification of serologic markers and the use of the HbsAg in vaccine for prevention of HBV infection.
HBV Structure

HBV is a small virus in the Hepadnaviridae family. The Hepadnaviridae family also includes duck hepatitis virus, ground squirrel hepatitis virus, and woodchuck hepatitis virus. Humans are the only known host for HBV.

HBV can withstand extreme temperatures and humidity and can survive for up to 7 days in a dry state on environmental surfaces such as counter-tops and hypodermic needles.

The complete functional hepatitis B viral particle is called the Dane particle. HBV consists of an outer envelope and an inner core, and has three major antigens – surface antigen (HBsAg), ‘e’ antigen (HBeAg), and core antigen (HBcAg).

The outer envelope contains the surface antigen (HbsAg), and consists of protein, lipid and carbohydrate.

The inner section, known as the core, contains DNA and DNA-polymerase enclosed in a protein shell – the core antigen (HbcAg) is the protein that encloses the DNA. HBeAg can be expressed on the surface of hepatocytes, initiating a cellular immune response. The ‘e’ antigen is considered a marker of active viral replication. HBeAg can usually be detected in patients with circulating serum HBV-DNA, as HBV-DNA indicates active viral replication.

Life cycle

HBV primarily invades the liver. HBV binds to a receptor on the surface of the hepatocyte. When the virus enters liver cells, it “un-coats”, or removes its envelope exposing the HBV DNA in the cytoplasm of the hepatocyte.

The HBV core is replicated in the nucleus of the host cell and the surface antigen is produced in the hepatocyte cytoplasm.

The HBV DNA enters the nucleus of the cell and uses the host cell resources to synthesizes messenger RNA (early mRNA) that carry codes for proteins needed for HBV to replicate.

HBV DNA in the cytoplasm then synthesizes late mRNA, which codes for viral structural proteins - HBsAg and HBcAg. Viral components are then assembled into particles, which bud from the host cell membrane using a portion of the membrane as an outer envelope. The viral particle then matures into the infectious Dane particle.

For reasons unknown, much more surface antigen than is necessary to coat the virus particles is produced and the excess is released into the blood stream.
Epidemiology

Global
Hepatitis B is one of the world’s most common and serious infectious diseases, affecting approximately 33% of the world’s population. Approximately 5% of the world’s total population are chronic carriers of HBV.

Unsafe injections account for 33% of new HBV infections in developing and transitional countries resulting a total of 21.7 million people infected each year.


Hepatitis B is highly prevalent (10-20% of population) in Africa, Latin and South America, Alaska, northern Canada, parts of Greenland, eastern and northern Europe, the eastern Mediterranean basin, south-east Asia, Indonesia, China, Japan, Pacific Islands, sub-Saharan Africa, (WHO). The lifetime risk of HBV infection is >60% in these areas, and perinatal transmission is the main mode of transmission in high prevalence areas.


There is low-prevalence of HBV (0.1-2%) in Canada, western Europe, Australia, and New Zealand. Transmission in low prevalence areas is primarily due to sexual and percutaneous transmission in adults.

Moderate prevalence (rate of 3-5%) is seen in areas such as eastern and northern Europe, Japan, the Mediterranean basin, the Middle East, Latin and South America, and Central Asia. Sexual and percutaneous transmissions are the main sources of exposure in moderate prevalence areas.

United States
The number of new cases of HBV in the U.S. has decreased from approximately 260,000 in the 1980s to 78,000 in 2001, due to the initiation of HBV vaccine immunization programs. Currently, there are approximately 1,250,000 carriers of the HBV virus, and 20-30% of carriers acquired the infection during childhood.

Approximately 5000 deaths each year in the U.S. are attributable to HBV infection.
Disease prevalence is higher among African-Americans, Hispanics, and Asians. Higher prevalence rates are also seen Alaskan Eskimos, Asian Pacific islanders, and Australian aborigines.

Prevalence is low in those under 12 years of age. Increased prevalence seen in persons older than 12 years of age is associated with sexual contact, multiple sexual partners and early age of first intercourse. The highest rates of disease occur in 20-49 year-olds, while the greatest declines have been seen among children and adolescents due to initiation of vaccine programs for the general population.


Canada

Canada is an area of low endemicity for hepatitis B – less than 5% of Canadians are hepatitis B antibody-positive indicating that they have been exposed to the virus or vaccine, and less than 0.5% are HBsAg-positive indicating that they are currently infected with HBV.

The annual rate of new cases of acute hepatitis B reported in Canada doubled from 1980 to 1990 and has since remained stable at approximately 10 cases per 100,000. Recognizing that there are approximately 10,000,000 people living in Canada, approximately 1000 new cases occur each year.

Prevalence varies from a low of 0.7 cases per 100,000 in Newfoundland to a high of 33.9 cases per 100,000 persons in British Columbia. Therefore, there is a greater overall risk of acquiring HBV in British Columbia than in Newfoundland.


Transmission

The initiation of vaccine programs in the general population will eventually reduce the overall prevalence of HBV transmission.

In areas of low to moderate HBV prevalence (North America), the risk of transmission is highest in injection drug users (IDU)(83%), followed by people
with multiple sexual partners (34%) and/or a previous sexually transmitted disease (35%).

HbeAg carriers are highly infectious, while HBsAg carriers are considered less infectious.

High concentrations of HBV are found in:
- blood
- body fluids containing serum

Lower concentrations of HBV are found in:
- saliva
- semen

HBV infection can be transmitted from exposure to small amounts of contaminated blood. HBV was transmitted to 26 patients in 1990 in a California diabetic clinic following a skin puncture with a spring-loaded lancet device where the platform was not changed after each use.


In addition, 9 of 67 patients in an Ohio nursing home and 14 patients in a New York City hospital contracted HBV infection associated with spring-loaded skin puncture devices related to exposure to contaminated lancet caps or use of a common lancet device that was not cleaned between patients.

Reference: CDC. Nosocomial hepatitis B virus infection associated with reusable fingerstick blood sampling devices —Ohio and New York City 1996. MMWR 1997;47:217-21

Transmission through exposure to saliva is possible, but less likely than other modes of transmission. A teacher who suffered two puncture wounds on her finger from the bite of a child became infected.


Transmission of HBV infection through kissing is unlikely.

HBV infection can also be passed from mother to infant at birth (perinatal). Infants of mothers positive for HBsAg and HbeAg are much more likely to become infected at birth than those from mothers positive for HbsAg alone (70-90% vs. 20%). As many as 90% of infected infants will become HBV carriers and
15-20% of these will go on to develop chronic active hepatitis, cirrhosis or hepatic cancer.

Other body fluids such as tears, sweat, urine and stool have not been associated with HBV transmission.

HDV infection can also be acquired as a co-infection with HBV or as a superinfection in individuals with chronic HBV infection. There is some evidence that HBV-HDV infected individuals may develop more severe acute disease and a higher risk of fulminant hepatitis (2%-20%) in comparison to infection with HBV alone. (Link back to Manifestations of Liver disease in Module 2) Individuals with HBV-HDV coinfection are less likely to develop chronic HBV than those infected with HBV alone.

Chronic HBV carriers who acquire HDV superinfection usually develop chronic HDV infection associated with a higher risk of chronic liver disease with cirrhosis (70-80%) than seen in chronic HBV infection alone (15-30%).

**Occupational Exposure**

Significant occupational exposures that place a worker at risk of HBV infection include percutaneous injury, contact of mucous membranes, or contact of non-intact skin (chapped, abraded, afflicted with dermatitis, or the contact is prolonged or involves an extensive area) with blood, tissues, or other body fluids (semen, vaginal secretions, other body fluids contaminated with visible blood, CSF, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid, and amniotic fluid, and laboratory samples that contain HBV (e.g., suspensions of concentrated virus).

**Occupational HBV Transmission**

Studies have shown that 10-30% of HCW and dental workers have antibodies indicating past or present HBV infection.

Emergency medical workers have an increased risk for hepatitis B infection, which varies with the frequency and extent of blood exposure during routine work, as well as the prevalence of HBV in the population.

Although there are few studies involving the risk of HBV transmission for public-safety workers (law-enforcement personnel and correctional-facility workers), available reports do not document increased risk for HBV infection. However, it must be assumed that any worker whose job involves exposure to blood or body fluids has an increased risk of infection. In addition, situations that increase the likelihood of bite wounds must be assumed to have the potential for transmission of HBV.
Most occupational exposures do not result in infection. The risk of infection varies depending on:
- type of exposure
- amount of blood involved in the exposure
- amount of virus in the infected individual’s blood at the time of exposure

Routes of occupational HBV transmission:
- percutaneous exposure (needle-sticks, sharps injuries)
- mucosal exposure (mouth pipetting, eye splashes, direct contact of eyes or mouth with HBV infected blood, serum or plasma, or items contaminated with blood, serum or plasma)
- exposure of non-intact skin (scratches, abrasions, burns, or other lesions) with blood and body fluids containing blood

Risk to Health-Care Workers
The annual number of occupational infections has decreased 95% since 1982 when HBV vaccine became available. The CDC estimated that HCW infected with HBV due to occupational exposure dropped from 10,000 in 1983 to less than 400 in 2001.


In 1998 in Canada, there were three cases of occupational hepatitis in which nurses and/or nursing supervisors were compensated, although specifics related to the exposure are unknown.


Health Canada reported the risk of occupational HBV infection in HCW to be 3-4 times higher in surgeons, nurses, pathologists, blood bank staff and surgical house officers, than in other HCW, increasing with the number of years worked.

1,436 occupational exposures were reported to the Canadian Needle Stick Surveillance Network between April 2000 and March 2001. 15 (1.8%) of the 1025 source patients tested were positive for HBV. Of the 15 HBV positive source patients, 3 were co-infected with HCV and/or HIV.

Most of the exposures occurred in teaching hospitals among nurses, phlebotomists, medical residents, nuclear medical technicians and sterilization attendants.
All HCWs exposed to HBV infected blood had been vaccinated against HBV. HCW who have received HBV vaccine and developed immunity are not at risk of infection. However, at baseline testing, only 6 of the 15 healthcare workers exposed to HBV infected blood expressed antibodies to HBV. To date, no HCW exposed to HBV have become infected as a result of their exposure.


Percutaneous injury (sharps)

Blood contains the highest concentration of HBV of all body fluids and is the most important mode of transmission in the health-care setting.

Health Canada estimated the overall risk of HBV transmission following needle-stick exposure to HBeAg negative patients at 1-6% if the HCW is susceptible, and 19-40% if the HCW is susceptible and the source patient is HBeAg positive. HBeAg positive individuals have more virus in their blood and are more likely to transmit HBV than those who are HBeAg negative.


The risk of hepatitis B infection following a parenteral (i.e., needle stick or cut) exposure to blood is directly related to:

- the probability that the blood contains hepatitis B surface antigen (HBsAg)
- the immunity status of the recipient
- the efficiency of transmission
The probability that the source blood is HBsAg positive varies from 1-3 per 1000 individuals in the general population to 5-15% in groups at high risk for HBV infection. Individuals at high risk for HBV infection include:

- immigrants from areas of high endemicity (China and Southeast Asia, sub-Saharan Africa, most Pacific islands, and the Amazon Basin)
- clients in institutions for the mentally challenged
- intravenous drug users
- homosexually active males
- household (sexual and non-sexual) contacts of HBV carriers

The risk of acquiring HBV infection from a needle-stick exposure for individuals who have not received HBV vaccine or have not received post-exposure prophylaxis, ranges from 6-30%.


**Mucous membrane exposure**

The risk of transmission following mucous membrane exposure is unknown.

**Non-intact skin exposure**

The risk of transmission following exposure to non-intact skin is unknown. There is no known risk for HBV infection from exposure to intact skin.

**Exposure to body fluids and tissues**

HBsAg is found in several other body fluids, including breast milk, bile, cerebrospinal fluid, feces, nasopharyngeal washings, saliva, semen, sweat, and synovial fluid; however, the concentration of HBsAg in body fluids is much higher (100-100 times) than the concentration of actual infectious HBV particles.

Because of low concentrations of infectious HBV particles, most body fluids are not efficient sources of transmission.
Risk to Emergency Responders and Public Safety Workers

Emergency medical service (EMS) providers are at increased risk of contracting HBV with exposure risks similar to those of hospital-based HCW.

Although other public safety workers are at lower risk, those who perform tasks that may result in exposure to blood and body fluids are at increased risk of HBV infection. Tasks with greater risk include care of open wounds, insertion of intravenous catheters, and rescue or recovery of severely injured individuals. The risk is greatest in those who may have percutaneous exposure to blood (needle-stick, sharps injury, bite wounds, etc.).

Public safety workers in urban areas with higher disease prevalence are at higher risk of exposure to HBV.

The risk of infection will be higher in workers who are not immunized or have not developed immunity to vaccine.


HBV Disease Progression

The damage caused to the liver during HBV infection is a result of the interaction of the virus and the host immune system. Activated CD4 and CD8 lymphocytes recognize HBV protein on the surface of hepatocytes resulting in a T-cell response against HBV-infected hepatocytes.

An incubation period lasting anywhere from 45 to 180 days following exposure to HBV represents a period of immune tolerance. Although there are no symptoms of illness or signs of liver damage during this period, the virus is actively replicating. Hepatitis B surface antigen (HbsAg) can be detected in the serum of infected individuals during the first 2 to 3 weeks of infection.

An inflammatory reaction to infected hepatocytes follows the incubation period. The host begins to produce antibodies to the core of the virus (anti-HBc), the surface antigen (anti-HBs), and the "e" antigen (anti-Hbe), which can be detected in the serum. The inflammatory reaction is the symptomatic period and lasts approximately 3-4 weeks.

Most HBV infected individuals eliminate the virus from the bloodstream within a few weeks and recover completely. Approximately 1-2% will proceed to fulminant hepatitis with mortality rates of 63-93%. Approximately 250 people die in the U.S. of fulminant disease each year.
Approximately 10% of HBV infected individuals become chronic carriers of the virus – some of these carriers develop chronic hepatitis, while others remain asymptomatic but infectious. Most of the serious complications associated with HBV infection are due to chronic infection.

**Acute infection**

The CDC case definition of acute hepatitis B includes an acute illness with jaundice and elevated aminotransferase activity at least 5 times the upper limit of the laboratory normal value, and positive IgM antibody to the hepatitis B core antigen (anti-HBc IgM) test.

Infection generally occurs following an incubation period that ranges from 45 days to 180 days.

Symptoms of acute infection, if present, are often flu-like:

- loss of appetite
- loss of energy
- muscle and joint pain
- nausea and vomiting
- stomach pain
- fever

It is estimated that one-third of HBV infected individuals will have no symptoms, one-third will have flu-like symptoms, and one-third will have severe symptoms requiring hospitalization. In severe cases, symptoms may include dark urine, light-colored bowel movements and jaundice (yellowing of the skin and eyes).

In a small number of cases, acute infection causes rapid fatal liver failure (fulminant liver disease).

Most adults with acute HBV infection will recover completely with clearance of the virus from the blood and production of antibodies protecting against future infection; however, approximately 2-10% of adults and 30-90% of children will proceed to chronic hepatitis with recurring episodes of the disease for life.

Individuals with chronic infection remain infectious and can pass the infection on to others. Although chronic HBV infection is usually asymptomatic, it can lead to scarring of the liver (cirrhosis), liver cancer and liver failure (Link back to Module 2). Approximately 15-25% of individuals with chronic infection die from cirrhosis or liver cancer.
Link to: Chronic HBV infection – Chronic Liver Disease Foundation - http://www.chronicliverdisease.org/library/hbv/natural_history.asp

**Chronic infection**

Approximately 10% of HBV infected adults and up to 90% of infants who acquire infection during childbirth become HBV carriers, and currently in the U.S., there are 1,250,000 people who are chronically infected with HBV (20-30% infections occurred in childhood). Approximately 25% of the HBV carriers will proceed to chronic hepatitis B virus (HBV) infection and cirrhosis, while some remain asymptomatic, and in some cases, unaware that they are infected. Carriers, whether symptomatic or not, remain infectious.


All persons chronically infected with HBV should have their aminotransferase (ALT/AST) levels evaluated every 6 to 12 months.

Chronic infection is responsible for most HBV-related liver damage and complications including chronic hepatitis, cirrhosis, liver failure, and hepatocellular carcinoma. People with chronic HBV infection have 12-300 times more risk of developing hepatocellular carcinoma, and approximately 15-25% of chronically infected patients die as a result of chronic liver disease in the United States.

Each year in the U.S., approximately 3,000-4,000 people die of hepatitis B-related cirrhosis and 1,000-1,500 die of hepatitis B-related liver cancer.

Link to: Chronic HBV infection – Chronic Liver Disease Foundation - http://www.chronicliverdisease.org/library/hbv/natural_history.asp
Laboratory Testing

Diagnosis of HBV infection cannot be made based on clinical findings alone. Laboratory testing is necessary to diagnose hepatitis and to differentiate the source of infection (HBV, HCV or HIV).

Diagnosis depends on the results of serologic testing and serologic markers of HBV infection vary depending on whether the infection is acute or chronic:

- hepatitis B surface antigen (HBsAg)
- antibodies to the hepatitis B core antigen (core antibody/anti-HBc)
- hepatitis B “e” antigen (HBeAg)
- antibodies to the “e” antigen (anti-Hbe)
- antibodies to the hepatitis B surface antigen (HbsAb) – provide protective immunity

**HbsAg**

- commonly used for diagnosing acute HBV infections or detecting chronic carriers detected as early as 1-2 weeks and as late as 11-12 weeks after exposure to HBV
- indicates that a person is infectious (does not differentiate acute and chronic infection)
- levels that persist 8-10 weeks after symptoms have resolved more likely to become carriers and developing chronic liver disease

**Anti-HBc**

- develops in all HBV infections
- appears shortly after HBsAg in acute disease
- indicates HBV infection at some undefined time in the past
- occurs after HBV infection, but does not develop in vaccine immune individuals
- persists for life
- not a serologic marker for acute infection

**IgM anti-HBc**

- subtype of anti-HBc
- indicative of acute infection or reactivation
- appears in acute disease at the time of onset of illness
- indicates recent infection with HBV
- usually detectable for 4-6 months after onset of illness
- best serologic marker of acute HBV infection
• negative IgM-anti-HBc test and positive HBsAg test indicates chronic HBV infection

IgG anti-HBc
• subtype of anti-HBc
• indicative of chronic infection
• detectable for life

HBeAg
• related number of infectious HBV particles in the serum and higher risk of infectivity

Anti-HBe
• appears after anti-HBc
• presence correlates to a decreased infectivity
• replaces HBeAg as disease is resolved

Anti-HBs
• provides protective immunity
• replaces HbsAg as acute infection resolves
• indicates recovery and immunity from reinfection following acute infection, immune response to HBV vaccine, or passive immunity following receipt of antibodies to HBV (HBIG)
• persists for life in > 80% of patients
• 10 mIU/mL indicates a protective level of immunity
### Table 1: Hepatitis Serology

<table>
<thead>
<tr>
<th>Immune Status</th>
<th>HbsAg</th>
<th>Anti-HBc</th>
<th>Anti-HBs</th>
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<tbody>
<tr>
<td>Susceptible</td>
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<tr>
<td>Immune due to vaccination</td>
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<td></td>
<td>≥10 mIU/mL</td>
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<tr>
<td>Immune due to natural infection</td>
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<tr>
<td>Acute infection</td>
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<tr>
<td>Chronic infection</td>
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<td><code>gm anti-HBc negative Anti-HBs negative</code></td>
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<tr>
<td>Recovering from acute HBV infection, distant immunity, toxic injury, immune disorder, hereditary liver disease, biliary tract disease, chronic infection with undetectable levels of HbsAg, and false positive results</td>
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Biochemical testing is performed to assess liver function. Testing may include total and direct bilirubin, ALT, AST, ALP, prothrombin time, total protein, albumin, serum globulin, complete blood count, and coagulation studies. High levels of bilirubin, AST, and ALT in the blood suggest hepatitis.

**Treatment**

There is no specific therapy for acute HBV infection - treatment is generally supportive.

Current treatment of chronic HBV has limited long-term efficacy; therefore, physicians must balance the timing of drug intervention with issues of patient age, severity of liver disease, likelihood of response, and potential adverse events and complications.

**Interferon** is the most effective treatment for chronic HBV infection and is successful in 25% to 50% of cases, although antiviral drugs such as lamivudine and adefovir may also be used. Advantages of interferon include defined treatment duration (1-2 years), response rates, and lack of resistant mutants.

Disadvantages of interferon therapy include the cost and side effects associated with its use.
Interferon is a synthetic form of a protein normally produced by the immune system to fight viruses.

**Lamivudine** is a nucleoside analogue, which interrupts the viral replication process. Nucleoside analogues are nucleoside “look-alikes” that get incorporated into the HBV viral genome during replication blocking further replication.

Lamivudine is cheaper and better tolerated than interferon, has similar response rates to interferon (17-33%), and fewer side-effects; however, its use is associated with drug-resistant viral mutants. Experience with lamivudine is still young so that long-term benefits are unknown and guidelines have not been developed on when to end treatment.

**Adefovir** is active against lamivudine-resistant mutants and has low rates of resistance during initial therapy; however, it is much more expensive than lamivudine.

Duration of treatment is dependent on the drug used, serological markers, HBV viral load, and the results of liver enzyme testing.

Side effects of anti-HBV medications

Interferon

Side effects are common with interferon therapy. The most common side effect is a flu-like syndrome consisting of fever, chills, fatigue, myalgias, anorexia and headache.

Other common side effects include nausea and vomiting, skin rash, and a metallic taste.

More severe side effects are seen less commonly and include back pain, blurred vision, diarrhea, dizziness, dry mouth, increased sweating, joint pain, leg cramps, mouth sores, temporary hair loss, weight loss, anemia, leukopenia, thrombocytopenia and platelets, bleeding, “easy bruising”, depression, brain fog, anxiety, irritability, suicidal thoughts, sleep disturbance, delirium, psychosis, hearing loss, and seizures.

Approximately 3% of people will be unable to continue treatment because of the severity of the side effects.

HBV Vaccine

Universal immunization against HBV is now part of the publicly funded vaccine programs offered in all provinces and territories in Canada and in all States in the U.S.

All workers who perform tasks or activities involving exposure to blood or other potentially infectious body fluids should be immunized with HBV vaccine - health care, mortuary, laboratory, laundry, waste management, housekeeping, personal service and public safety settings.

Since 1987 in the U.S., HBV vaccine has been available to all workers who may be exposed to blood and body fluids capable of transmitting blood-borne pathogens at no charge to the worker (The Department of Health and Human Services and the Department of Labor).

In Canada, most workers are covered by federal or provincial health and safety legislation and/or regulations to prevent injury or disease resulting from occupational exposure to blood-borne pathogens. Protection is provided by a combination of acts and regulations in occupational health and safety and should be provided at no cost to the worker.
**Recommended dose**

Vaccine is administered at 0, 1 and 6 month intervals to achieve optimal immune response. If the vaccination series is interrupted after the first dose, the second dose should be administered as soon as possible, and the third dose should not be given for at least 2 months following the second dose. If the first two doses have been administered according to the recommended schedule, but the third dose is delayed, it should be administered as soon as possible.

**Immunization site**

HBV vaccine should be injected into the deltoid muscle of children and adults, and into the thigh muscle of infants.

Gluteal injection is not recommend due to poor immune response.

The effectiveness of intra-dermal injection is variable. If vaccine is administered by intra-dermal injection, post-immunization testing should be performed to determine whether immune response is adequate.

**Vaccine effectiveness**

HBV vaccination is safe and effective for prevention of HBV infection following exposure to HBV infected or contaminated blood and body fluids. HBV has been available since 1982 and is reportedly 90-95% effective in conferring immunity in adults and 98% effective in children.

Protection following one dose of HBV vaccine is approximately 20-30% in adults, and 75-80% following two doses; therefore, it is important to complete the vaccine series to achieve optimal vaccine response.

Re-immunization in individuals who failed to demonstrate protective antibody levels following the first 3-dose series of vaccine have been shown to develop a protective antibody response in 50% to 70% of cases. Individuals who do not respond to three additional vaccine doses are unlikely to develop an antibody response following further immunization.

**Booster doses**

Routine boosters are generally not required as immunity lasts for at least 15 years, and people who showed protective antibody levels following immunization do not develop markers of infection when exposed to HBV, even when antibody levels have decreased. However, studies of long-term vaccine protection are required to determine the need for boosters or re-immunization.
Post-immunization testing

Post-immunization testing (HbsAb levels) for universal programs is not necessary due to the high immune response rate following vaccine administration. However, post-immunization testing is recommended in infants born to infected mothers, sexual partners and household contacts of chronic carriers, and individuals who were immunized for occupational exposure.