Mandated, Highly Recommended, and Other Vaccines for Oral Healthcare Personnel

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Conflict of Interest Disclosure Statement

- Dr. Huber is a member of the dentalcare.com Advisory Board. He has no relevant financial relationships to disclose.
- Dr. Terézhalmy has done consulting work for Procter & Gamble and has served on the dentalcare.com Advisory Board. He has no relevant financial relationships to disclose.

Introduction - Vaccines for Oral Healthcare Personnel

Mandated, Highly Recommended, and Other Vaccines for Oral Healthcare Personnel presents currently available knowledge essential for the development and implementation of an effective vaccination strategy in an oral healthcare setting.

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Overview

Immunization strategies for oral healthcare personnel (OHCP) are predicated on (1) vaccines mandated or strongly recommended at the time of employment, (2) vaccines recommended for adults in general, and (3) vaccines recommended when other risk factors (other than occupation) are also present. Currently available knowledge related to vaccination strategies in healthcare settings is supported by data derived from well-conducted trials or extensive, controlled observations, or, in the absence of such data, by best-informed, most authoritative opinions available.

Learning Objectives

Upon completion of this course, the dental professional should be able to:

- Discuss the pharmacology of immunobiologicals.
- Discuss vaccine safety and adverse effects.
- Identify vaccine-preventable diseases.
- Develop vaccination strategies appropriate for the oral healthcare setting.
- Discuss strategies to determine and document evidence of immunity to vaccine-preventable diseases.

Introduction

Immunization programs in the United States have markedly reduced the incidence of vaccine-preventable diseases in children. Today, a substantial percentage of the remaining morbidity and mortality from several of these diseases occurs in older adolescents and adults who escaped natural infection or immunization during childhood and who are now at increased risk of these diseases because of lifestyle, advanced age, the presence of certain chronic diseases, or occupation (e.g., healthcare workers).[1-3] Other vaccine-preventable diseases primarily affect persons older than 20 years of age; for these diseases, the targeted risk groups for immunization are predictably adults.[4]

The Occupational Safety and Health Administration's final rule regarding bloodborne pathogens mandates that all OHCP who may be exposed to blood or other potentially infectious material (OPIM) in an occupational setting be vaccinated against the hepatitis B virus.[5] Furthermore, the Advisory Committee on Immunization Practices (ACIP) highly recommends routine vaccination against influenza, varicella, zoster, measles/mumps/rubella, tetanus-diphtheria, pertussis, and the human papillomavirus (HPV).[4,6] The vaccination of OHCP against meningococcus, pneumococcus, and the hepatitis A virus are recommended under special circumstances.[4,6]

Vaccine Characterization

Vaccines may be categorized as whole-pathogen vaccines, subunit vaccines, or nucleic acid vaccines.[7] Whole-pathogen vaccines consist of either live attenuated or inactivated microorganisms. Live attenuated vaccines use a weakened form of the pathogen, which after administration replicates and induces an immune response.

Subunit vaccines are prepared from fractional antigenic components of an organism and

may be protein-based, pure polysaccharide-based, conjugate polysaccharide-based, or recombinant protein-based.[7] Subunit vaccines typically incorporate adjuvants (e.g., alum, AS04, AS01B, others) to generate a stronger immune response because subunit vaccines alone are not effective in inducing adequate long-term immunity.[8]

Nucleic acid vaccines (e.g., mRNA vaccines, DNA plasmid vaccines, recombinant vector vaccines) introduce the specific genetic material encoding the target antigen or antigens against which an immune response is sought.[7] Once introduced, the body's own cells then use the genetic material to produce the antigens. Potential advantages of this approach include no risk of infection; improved vaccine stability; stimulation of broad long-term immunity; and rapid, inexpensive, and scalable vaccine manufacturing.[9]

All vaccines initiate immune responses mediated by macrophages and lymphocytes, i.e., they induce active immunity. Antibodies are produced against specific infective agents or their toxins. Protective antibodies, which may be produced in response to vaccines and their mechanisms of action, are listed in Box 1.[10]

Neutralizing antibodies cannot readily diffuse into infected cells; they must interact with the target-organism before initial intracellular penetration. However, sensitized lymphocytes acting alone or antibodies interacting with lymphoid K-cells may recognize surface changes in infected cells and target them for destruction. Immunization with live attenuated organisms is more predictable than immunization with inactivated microorganisms in inducing long-term immunity.[7]

Immunogenic responses to live attenuated and inactivated microorganisms develop more slowly than the incubation period of most pathogens. Therefore, vaccines must be administered prior to exposure to a specific etiologic agent. By contrast, "booster" re-immunization in a previously immune individual provides a rapid secondary (anamnestic) increase in immunity. The persistence of immunity may also be prompted by natural re-exposure to microorganisms and the presence of latent infections.

Immunoglobulins

Immunoglobulins (IGs), predominantly IgG antibodies, may be obtained from human or animal donors who have recovered from an infectious disease or who have been previously immunized.[11] IGs provide immediate, short-term protection, i.e., passive immunity, for those who might develop infection before a vaccine could induce active immunity. Passive immunity is also useful when a vaccine is unavailable or contraindicated, or when an individual cannot produce antibodies.

Box 1. Protective Antibodies and their Mechanisms of Action.[10]

Antitoxins	Inactivate toxic microbial protein products
Opsonins	Facilitate phagocytosis of microorganisms
Lysins	Damage microbial cell membrane
Antiadhesins	Prevent adhesion of microorganisms to host cell components
Neutralizing antibodies	Prevent the proliferation of microorganisms

Vaccine Safety and Adverse Effects

The National Childhood Vaccine Injury Act of 1986 requires that healthcare providers report to the United States Department of Health and Human Services post-immunization events serious enough to require medical attention.[12] Based on all available data, vaccines licensed in the U.S. are remarkably safe and effective.

Live Attenuated versus Inactivated Vaccines

Compared to inactivated vaccines, live attenuated vaccines tend to have higher rates of adverse effects (particularly fever).[13] Potentially, vaccines containing live attenuated viruses can also infect the fetus. Vaccines containing live attenuated viruses should only be administered to pregnant women if there is a high immediate risk of infection by a specific pathogen, e.g., a poliomyelitis epidemic. The same precaution applies to individuals with a compromised immune system (Box 2).

Allergic Reactions

In addition to the desired antigen, live attenuated and inactivated vaccines almost always contain other components such as residual animal or human proteins, antibacterial agents, and preservatives or stabilizers, which may cause allergic reactions. The most common allergenic component of vaccines is egg protein found in vaccines prepared in chicken eggs or chicken embryonic cultures, e.g., measles, mumps, and influenza.

Egg allergy is very common, affecting 1 to 2 percent of children.[14,15] However, with the exception of those with a high titer of egg IgE antibodies, most children are likely to develop egg tolerance by late childhood.[16] Adults who can eat eggs or egg-containing products can receive these vaccines safely. On rare occasions, patients will have an anaphylactic reaction to baker's yeast found in HBV vaccines and to neomycin found in trace amounts in the measles, mumps, rubella, and varicella vaccines.

Administration-related Problems

The recommended route of administration and dosages for each vaccine are specified on package inserts. Most vaccines for adults are given by subcutaneous (SC) or intramuscular (IM) injection. When administering vaccines, it is imperative to aspirate before depressing the plunger to make certain that the product is not injected intravenously. Intravascular injection can result in increased adverse effects and may also reduce the immune response.

It is also important that a needle 1-1.5 inches long be used for IM delivery of vaccines

Box 2. Contraindications to the Administration of Vaccines Containing Live-attenuated Viruses.[13]

- Individuals receiving cancer chemotherapy
- Organ transplant recipients
- Corticosteroid therapy
- Known or suspected congenital or acquired defects in cell-mediated immunity
    - Severe congenital immunodeficiency disease
    - Leukemia
    - Lymphoma
    - Hodgkin's disease
    - Acquired immunodeficiency syndrome

containing aluminum phosphate (e.g., HBV, Td, and Tdap vaccines). Subcutaneous administration of such vaccines can lead to local tissue necrosis. Intramuscular injections should be given in the deltoid muscle. Studies with the hepatitis B vaccine have shown that its immunogenicity is significantly reduced when given in the buttocks. This observation may apply to other vaccines as well.

Mandated, Highly Recommended, and Other Vaccines

Immunization strategies (active and passive) for OHCP are predicated on:

1. vaccines mandated or strongly recommended at the time of employment,
2. vaccines recommended if another risk factor is present, and
3. the availability of immunoglobulins, which are administered to susceptible persons in the event of inadvertent exposure to blood or OPIM.

Hepatitis B Infections

HB viral infection is the major vaccine-preventable health hazard for OHCP. The virus is transmitted primarily through contact with blood and OPIM (also sexual contact and perinatal exposure). Acute infection is characterized by anorexia, nausea, vomiting, malaise, and fever. After 3 to 10 days, the urine darkens. Jaundice, if present, usually peaks in 1-2 weeks and fades during a 2- to 4-week recovery phase. Following acute infection, up to 10% of those infected become chronic carriers. They may be asymptomatic or develop chronic active hepatitis, cirrhosis, and primary hepatocellular carcinoma.[11,12]

Active Immunization: HBV Vaccines[4-6]

It is mandated that all OHCP be vaccinated against the HBV. Among OHCP, the risks for percutaneous and permucosal exposures to blood vary during training and work career of each person, but the risks are highest during the professional training period. Therefore, vaccination should be completed during training. Those who decline the hepatitis B vaccination series must sign a copy of the Mandatory Hepatitis B Vaccination Declination Form (Box 3).[5]

Hepatitis B vaccines (Table 1) contain hepatitis B surface antigen (HBsAg) protein grown in baker's yeast using recombinant DNA technology. It is subsequently purified and adsorbed to aluminum hydroxide. Primary immunization with hepatitis B vaccine consists of two or three IM doses. The deltoid muscle is the preferred site because injections given into the buttocks yield lower seroconversion rates.[19]

While pre-vaccination serologic screening for previous HBV infection is not indicated for persons being vaccinated because of occupational risk, post-vaccination confirmation of seroconversion is strongly recommended 1-2 months after the 3rd dose (Box 4).

Box 3. Mandatory Hepatitis B Vaccination Declination Form.[5]

I understand that due to my occupational exposure to blood or other potentially infectious materials I may be at risk of acquiring Hepatitis B virus (HBV) infection. I have been given the opportunity to be vaccinated with Hepatitis B vaccine, at no charge to myself. However, I decline Hepatitis B vaccination at this time. I understand that by declining this vaccine, I continue to be at risk of acquiring Hepatitis B, a serious disease. If in the future I continue to have occupational exposure to blood or other potentially infectious materials and I want to be vaccinated with Hepatitis B vaccine, I can receive the vaccination series at no charge to me.

_____ _____

Employee Signature Date

Table 1. HBV Vaccines.[20]

Vaccines	Indications	Schedules	Adverse Effects
Engerix-B *Recombivax-HB*	Preexposure	3 IM doses at 0, 1, and 6 months	Pain at injection site (most common); fever; anaphylaxis in persons with history of allergic reaction to baker's yeast.
Heplisav-B	Preexposure	2 IM doses at 0 and 1 month	Pain at injection site (most common); fever; anaphylaxis in persons with history of allergic reaction to baker's yeast.
Engerix-B	Postexposure	4 IM doses at 0, 1, 2 and 12 months	Pain at injection site (most common); fever; anaphylaxis in persons with history of allergic reaction to baker's yeast.

Box 4. Post-vaccination Confirmation of Seroconversion.[6,20]

I. Post-vaccination confirmation of seroconversion is strongly recommended 1-2 months after the final dose.

A. A HBsAb titer >10 mIU/mL is considered adequate

II. OHCP who do not develop an adequate antibody response to the primary vaccine series shall undergo a second 2 or 3-dose vaccine series.

A. Retesting for HBsAb is strongly recommended 1-2 months after the 3rd dose of the second vaccine series.

1. If no antibody response occurs, testing for HBsAg is strongly recommended.

a. Those who are HBsAg-negative shall be counseled about precautions to prevent HBV infection and the need to obtain HBIG prophylaxis for any known or probable parenteral exposure to HBsAg-positive blood.

b. Those who are HBsAg-positive shall be counseled about how to prevent the transmission of HBV to others and about the need for medical consultation.

It is well-established that over time the HBsAb titer falls, often below the currently accepted threshold value of 10 mIU/mL. However, there is no evidence that vaccinated persons lose their immunity simply because the anti-HBsAb titer drops below the arbitrary threshold. Currently, the U.S. Public Health Service does not recommend routine booster doses of the hepatitis B vaccine.[20]

Passive Immunization: Hepatitis B Immune Globulin[4,6]

OHCP who either declined vaccination or failed to seroconvert are at risk of HBV infection. Hepatitis B immune globulin (HBIG), if administered within 1 week of exposure (ideally within 24 hours), is 75% effective in preventing infection. In addition to HBIG prophylaxis, an alternate 4-dose series of the vaccine should also be offered to those who in the past declined the vaccine (see Table 1). If the person chooses not to take the vaccine, a second dose for HBIG should be administered 30 days after the first dose.

Influenza

Human influenza is caused by two influenza viruses, types A and B. They are spread by airborne droplets generated when an infected person coughs and sneezes, by direct contact with nasal or throat secretions of infected persons, and less frequently by freshly contaminated articles. Uncomplicated influenza is characterized by the abrupt onset of fever, myalgia, headache, nonproductive cough, sore throat, and rhinitis. Complications include secondary bacterial sinusitis and otitis, and primary viral and secondary bacterial pneumonia.[21]

Active Immunization: Influenza Vaccines[4,6,22]

It is strongly recommended that all OHCP, including those in training, be vaccinated annually against influenza. Vaccination not only protects the provider, but very likely reduces the risk of healthcare-associated transmission. The annual trivalent influenza vaccines are antigenic equivalents of influenza-A (H3N2), influenza-A (H1N1), and an influenza-B virus. Each year one or more virus strains in the vaccine might change on the basis of global surveillance and the emergence and spread of new strains.[22]

Three types of influenza vaccines are available in the U.S.: multiple inactivated influenza vaccines (IIVs) one recombinant influenza vaccine (RIV), and one live attenuated influenza vaccine (Table 2).[22] The live attenuated intranasal vaccine (Flumist™) is approved for use by healthy persons between the ages of 19-49 years. OHCP who choose to use Flumist™ in lieu of an inactivated influenza vaccine should refrain from contact with immunosuppressed persons for 7 days. Three IIVs are specifically formulated for patients ≥65 years of age.

Antiviral Chemoprophylaxis: Antiviral Agents

Four antiviral agents are available to treat influenza: the neuraminidase inhibitors (oral oseltamivir [Tamiflu], inhaled zanamivir [Relenza], IV peramivir [Rapivab]) and the oral polymerase acidic endonuclease inhibitor baloxavir [Xofluza]. All of these agents are active against influenza A and B viruses and are most effective if initiated within 48 hours of the onset of symptoms.[23]

Measles, Mumps, and Rubella

The measles virus is spread by airborne droplets, direct contact with nasal or throat secretions of infected persons, and less frequently by freshly contaminated articles. Following an incubation period of 7 to 18 days, the infected person experiences a prodrome of malaise, fever, coryza, and conjunctivitis before a generalized rash appears. The period of communicability is from the beginning of the prodromal period to about 4 days after the appearance of the rash.[24]

The mumps virus spreads by airborne droplets and direct contact with saliva of infected persons. It has an incubation period of 12 to 25 days, and the virus may be shed into saliva 6 to 7 days before the onset of clinical illness. Mumps characterized by acute onset of unilateral or bilateral tender swelling of the parotid and/or other salivary glands. It is typically self-limiting and lasts two or more days. In the United States, a substantial number of mumps cases occur among adults 18-25 years old.[25]

The rubella (German measles) virus is transmitted by airborne droplets and direct

Table 2. Influenza Vaccines.[4,22]

Vaccine Type	Vaccines	Schedules	Adverse Effects
IIV	Afluria Quadrivalent Fluarix Quadrivalent FluLaval Quadrivalent Fluzone Quadrivalent Flucelvax Quadrivalent * Fluzone High-Dose Quadrivalent Fluad Quadrivalent Fluad	1 IM dose annually	Pain at injection site (most common); fever; anaphylaxis in persons with history of allergic reaction to baker's yeast.
RIV	Flublok Quadrivalent †	1 IM dose annually	Pain at injection site (most common); fever; anaphylaxis in persons with history of allergic reaction to baker's yeast.
LAIV	Flumist Quadrivalent	1 intranasal dose annually	Mild rhinorrhea, nasal congestion, and sore throat; may exacerbate asthma; anaphylaxis in persons with history of allergic reaction to egg.
* cell culture-based † recombinant, egg-free			

contact with nasopharyngeal secretions. An incubation period of about 18 days is followed by fever, conjunctivitis, lymphadenopathy, a generalized maculopapular rash, arthralgia, and arthritis. The period of communicability is from 7 days before to 4 days after the onset of rash. Congenital rubella syndrome in the U.S. is rare, but immunity in women of childbearing age remains a special concern.[26]

Active Immunization: Measles, Mumps, and Rubella Vaccines[4,6]

It is strongly recommended that OHCP be immune to measles, mumps, and rubella. OHCP are considered immune only if they have documentation of:

1. physician-diagnosed measles, mumps, or rubella infection, or

Table 3. Measles, Mumps and Rubella Vaccine.[4,6]

Vaccines	Indications	Schedules	Adverse Effects
MMR II	Preexposure	2 SC doses 28 days apart	Pain and erythema at the site of injection (7-29%); transient arthralgia (25%); fever and rash (5%); anaphylaxis in persons with history of allergic reaction to egg, neomycin, or gelatin.

2. laboratory evidence of measles, mumps, or rubella immunity, or
3. appropriate vaccination against measles, mumps, and rubella.

While separate monovalent formulation vaccines for measles, mumps, and rubella are available, the trivalent MMR vaccine (Table 3) is the vaccine of choice for routine adult vaccination. The MMR vaccine contains live attenuated measles and mumps virus grown in chick embryo and live attenuated rubella virus grown in human diploid cell culture. There is no evidence to support a causal association between the MMR vaccine and autism.[27,28]

Varicella and Herpes Zoster Infections

The *varicella zoster* virus (VZV) is transmitted from person-to-person by airborne droplets; contact with vesicular fluid, skin and mucous membranes; and freshly contaminated articles. The VZV is responsible for both chickenpox and herpes zoster (HZ) infections. Following initial exposure, after an incubation period of 14-16 days the patient develops a generalized papulovesicular rash. The period of communicability is 1 to 2 days before the onset of rash to 4-7 days after the appearance of the vesicles.[29]

Primary infection usually occurs in childhood. Adults are at a much higher risk than children of developing serious complications, which include cerebellar ataxia, encephalitis and bacterial superinfections. Varicella in pregnant women is associated with a risk of intrauterine VZV infection, which might result in congenital varicella syndrome (highest risk during the 13-20 weeks of gestation), neonatal varicella, or herpes zoster during infancy and early childhood.[29]

After primary infection, VZV remains dormant in sensory ganglia. When reactivated, the virus causes HZ, a painful vesicular rash typically appearing in a dermatomal distribution affecting one or two sensory nerve roots. The incidence and severity of HZ is age related, with over 50% of cases occurring in persons over 60 years of age. While patients with HZ may transmit the virus for one week after the lesions erupt, the risk for transmission is much lower than with chicken pox.[30]

Active Immunization: Varicella Zoster Vaccines[4,6]

It is strongly recommended that all OHCP be immune to the VZV. OHCP are considered immune only if they have documentation of:

1. physician-diagnosed varicella (chickenpox) or
2. physician-diagnosed herpes zoster, or
3. laboratory evidence of VZV immunity, or
4. age-appropriate vaccination against the VZV.

There is one monovalent varicella vaccine (*Varivax*) licensed for use in adults (Table 4). It is derived from the Oka strain live attenuated VZV grown sequentially in cultures of human embryonic lung cells, embryonic guinea-pig cells, and human diploid cells. *Zostavax* is a high-potency formulation *Varivax* vaccine (Table 4) for the prevention of HZ in adults older than 60 years of age. A new adjuvanted recombinant subunit zoster vaccine (Shingrix) has superseded *Zostavax* as the vaccine of choice for HZ prevention and is recommended for immunocompetent adults ≥50 years age. Of note, individuals previously vaccinated with *Zostavax* are recommended to receive *Shingrix* vaccination.[20]

Table 4. Varicella Zoster Vaccines.[4,6,20]

Vaccines	Indications	Schedules	Adverse Effects
Varivax	Preexposure	2 SC doses 4-8 weeks apart	Injection site or generalized varicella-like rash (1-5%); fever (10%); anaphylaxis in persons with history of allergic reaction to neomycin or gelatin.
Zostavax	Prevention of HZ infection is susceptible patients ≥ 60 years old	1 SC dose	
Shingrix	Prevention of HZ infection in susceptible patients ≥ 50 years old	2 IM doses at 0 and 2-6 months	Myalgia (45%), fatigue (45%), fever (21%), and injection-site pain (78%), redness (38%), and swelling (26%).

Passive Immunization: Varicella Zoster Immune Globulin[4,6]

ACIP recommends that varicella zoster immune globulin (VZIG) be administered within 96 hours of exposure for post-exposure prophylaxis in susceptible persons at high risk for varicella complications. This recommendation applies to women exposed to the VZV at any stage of pregnancy. The VZIG product currently used in the United States is *VariZIG*.

Tetanus, Diphtheria, and Pertussis

Tetanus is a bacterial infection caused by *Clostridium tetani*. The organism is found in soil, dust and animal feces. When *C. tetani* enter a deep wound, its spores produce tetanospasmin, a powerful toxin. Tetanospasmin actively impairs motor neurons. "Hallmark" manifestations of tetanus include muscle stiffness and spasms in jaw, neck, and abdominal muscles, and difficulty swallowing. Other signs and symptoms may include fever, sweating, elevated blood pressure, and rapid heart rate.[31]

Diphtheria is caused by the bacterium *Corynebacterium diphtheriae*. The organism is transmitted by airborne droplets and contaminated personal and household items. Signs and symptoms usually begin two to five days after a person becomes infected. The "hallmark" sign of diphtheria is a thick, gray membrane covering the throat and tonsils. Other clinical manifestations may include a sore throat, hoarseness, enlarged lymph nodes, difficulty breathing, nasal discharge, fever, and chills.[32]

Pertussis is a highly contagious bacterial (*Bordetella pertussis*) infection. It is transmitted by direct contact with respiratory secretions or by airborne droplets. The incubation period is about 7 to 10 days. Early symptoms are indistinguishable from those of other respiratory infections. "Hallmark" signs of pertussis are paroxysms (fits) of rapid coughs, followed by a high-pitched "whoop" and vomiting. The period of communicability starts with the early symptoms and extends into the paroxysmal stage.[33]

Active Immunization: Tetanus, Diphtheria and Pertussis Vaccines[4,6,34]

Vaccine formulations (Table 5) contain either inactivated adsorbed (aluminum-salt-precipitated) tetanus and diphtheria toxoids (Td) or tetanus and diphtheria toxoids and protein components of acellular pertussis (Tdap). OHCP with an uncertain history of primary vaccination should receive an initial dose of Tdap. All OHCP should receive a Td or Tdap booster every 10 years. Tdap is also recommended as part of wound management.[34]

Table 5. Tetanus, Diphtheria and Pertussis Vaccines.[4,6,35]

Vaccines	Indications	Schedules	Adverse Effects
Td *Tenivac*	Preexposure	1 IM booster dose every 10 years	Injection-site reactions such as pain, swelling, and erythema. Fever. Arthus-type reactions.
Tdap *Adacel* *Boostix*	Preexposure	1 IM booster dose every 10 years	

Table 6. HPV Vaccines.[20,36,37]

Vaccines	Indications	Schedules	Adverse Effects
Gardasil9	Preexposure*	3 IM doses at 0, 1-2, and 6 months	Injection-site reactions such as pain, swelling, and erythema. Syncope in adolescents and young adults.
* Previously unvaccinated females 15 - 26 years old and males 15 - 21 years old should receive a 3-dose series (0, 1-2, and 6 months). Unvaccinated females 27 -45 years old and males 21 – 45 years old should consider vaccination based on behavioral risk for HPV exposure.			

HPV Infection

HPV, the most common cause of a sexually transmitted infection, is transmitted when the virus enters the body through a cut, abrasion or small tear in the outer layer of skin and genital or oral mucous membranes. Some HPV infections may cause papillomatous, warty lesions on the tongue, tonsils, soft palate, or within the larynx and nose. High-risk HPV strains include HPV 16 and 18, which cause cervical cancer and contribute to cancer in the mouth and upper respiratory tract.[28]

Active Immunization: HPV Vaccines[4,6,36,37]

A recombinant 9-valent vaccine (*Gardasil 9*) protects against diseases associated with HPV types 6, 11, 16, 18, 31, 33, 45, 52, and 58, including genital warts and cervical, vulvar, vaginal, and anal precancerous lesions and cancer. On June 12, 2020, *Gardasil 9* was approved for the prevention of oropharyngeal and other head and neck cancers caused by HPV types targeted by the vaccine. It is licensed by the FDA for use in both men and women between 9-45 years of age. The bivalent vaccine (*Cervarix*), which protected against HPV types 16 and 18, and the quadrivalent vaccine (*Gardasil*), which protected against HPV types 6, 11, 16, and 18, have been discontinued. The duration of immunity is not known; however, booster doses are not currently recommended.

SARS-CoV-2

SARS-CoV-2, the highly contagious virus that causes COVID-19, is spread predominantly through respiratory droplets produced when an infected person coughs, sneezes, or talks.[38] Symptoms vary widely from mild to severe and include loss of taste or smell, fever, chills, muscle or body aches, sore throat,

nausea or vomiting, cough, and breathing difficulties. Symptoms may appear 2-14 days after exposure to the virus; however, some infected patients never develop symptoms and asymptomatic spread is significant.[39,40] Infected patients who are older and / or have certain medical conditions (Box 5) are at higher risk of developing severe or fatal disease.[41]

Active Immunization: SARS-CoV-2[42]

The first two COVID-19 vaccines (Pfizer-BioNTech [BNT162b2] and Moderna [mRNA-1273]) developed to prevent SARS-CoV-2 infection received Emergency Use Authorizations from the FDA in December 2020 (Table 7). Both vaccines employ the mRNA technology platform and appear to

Box 5. Age and Conditions Associated with Increased COVID Disease Severity.[41]

Age	Risk of Hospitalization	Risk of Death
18-29 years	Comparison Group	Comparison Group
30-39 years	2x higher	4x higher
40-49 years	3x higher	10x higher
50-64 years	4x higher	30x higher
65-74 years	5x higher	90x higher
75-84 years	8x higher	220x higher
85+ years	13x higher	630x higher
Conditions associated with increased severity COVID-19		
Cancer Chronic kidney disease Chronic obstructive pulmonary disease (COPD) Down Syndrome Heart conditions (e.g., heart failure, coronary artery disease, or cardiomyopathies) Immunocompromised state from solid organ transplant Obesity (BMI of 30 - 40) Severe Obesity (BMI ≥ 40) Pregnancy Sickle cell disease Smoking Type 2 diabetes mellitus		

Table 7. SARS-CoV-2 Vaccines.[4,42]

Vaccines	Indications	Schedules	Adverse Effects
BNT162b2	Preexposure	2 IM doses, 0 and 21 days*	Injection site pain, erythema and swelling, fatigue, axillary swelling / tenderness, fatigue, chills, headache, fever, muscle and joint pain, nausea / vomiting. Adverse effects more frequent after second dose. Anaphylaxis and anaphylactoid reactions (~11.1 / million doses) have been reported.
mRNA-1273		2 IM doses, 0 and 28 days*	
JNJ-778436735		1 IM dose	Injection site pain, erythema and swelling, fatigue, fatigue, headache, myalgia, fever, nausea. Thrombo-thrombocytopenia syndrome (~3.1 / million doses) and anaphylaxis have been reported.

* Second doses should be administered as close to the recommended interval as possible. There is no maximum interval between the first and second dose.

be very efficacious in generating immunity. BNT162b2 is approved for use in persons ≥12 years of age and mRNA-1273 is approved for persons ≥18 years of age. On February 27, 2021, the FDA issued Emergency Use Authorization of the single-dose COVID -19 vaccine (Johnson & Johnson [JNJ-778436735]). It is an adenovirus serotype 26 vector-based vaccine and is for persons ≥18 years of age. The safety of these vaccines for pregnant and breast-feeding women has not been officially established; however, the American College of Obstetricians and Gynecologists recommend otherwise eligible pregnant or lactating women be vaccinated. Other manufacturers (e.g., AstraZeneca/Oxford, Novavax, others) are aggressively developing additional candidate vaccines.

Meningococcal Disease

Neisseria meningitidis or *meningococcus* (serogroups A, B, C, Y, and W-135) is a leading cause of bacterial meningitis. The infection is highly contagious and is spread by airborne droplets and contact with respiratory secretions. Meningococcal meningitis occurs when *N. meningitidis* from an upper respiratory tract infection enters the bloodstream and causes inflammation of the meninges surrounding the brain and spinal cord. "Hallmark" signs and symptoms include headache, fever and a stiff neck.[43]

Active Immunization: Meningococcal Vaccines[4,6,44]

Three quadrivalent vaccines against *N. meningitidis* serogroups A, C, Y, and W0135

and two serogroup B meningococcal vaccines are available (Table 8). Vaccination is not recommended for an OHCP unless they have a certain risk: 1) asplenia or persistent complement component deficiencies, 2) travel to countries in which meningococcal disease is hyperendemic or epidemic, 3) participate in research OHCP and research microbiologists who might be exposed routinely to isolates of *N. meningitides*, or 4) any OHCP aged >55 years who have any of the aforementioned risk factors for meningococcal disease are recommended for vaccination.

Pneumococcal Disease

Most serious pneumococcal infections are caused by *Streptococcus pneumoniae (pneumococci)* serotypes 4, 6B, 9V, 14, 18C, 19F, and 23F. They commonly colonize the respiratory tract and are spread is via airborne droplets. Primary infection usually results in otitis media (most common) and pneumonia (most serious). Other pneumococcal infections include sinusitis, meningitis, endocarditis, and septic arthritis. Adults with a compromised immune system and the elderly are at high risk.[45]

Active Immunization: Pneumococcal Polysaccharide Vaccine[46]

There are two pneumococcal vaccines: a conjugated vaccine against 13 serotypes (PCV13 [*Prevnar 13*]) and a polyvalent polysaccharide vaccine against 23 serotypes (PPSV23 [*Pneumovax 23*]) (Table 9). Current ACIP guidance recommends a single dose of *Pneumovax 23* be administered to all adults ≥65 years of age. The routine use of *Prevnar 13* in adults ≥65 years of age without increased susceptibility is no longer recommended. Instead, shared clinical decision-making for the use of *Prevnar 13* is recommended for these patients. *Prevnar 13* continues to be recommended in series with *Pneumovax 23* for adults at increased susceptibility ≥19 years of age. Persons who received a *Pneumovax 23* vaccine prior to age 65 and those at increased susceptibility should be revaccinated 5 years after the first dose.

Hepatitis A Viral Infection

The hepatitis A virus (HAV) is primarily transmitted by the fecal-oral route, either by person-to-person contact or consumption of contaminated food or water. It has an

Table 8. Meningococcal Vaccines.[20,44]

Vaccines	Indications	Schedules	Adverse Effects
ACWY *Menactra* *Menveo* *MedQuadfi*	Preexposure	2 IM doses, 0 and 8 weeks.*	Redness, induration, and pain, at the site of injection. Headache, fatigue, and malaise.
B *Trumenba* *Bexsero*	Preexposure	3 IM doses, 0 1-2, and 6 months.† 2 IM doses, 0 ≥1month.†	Erythema, induration, and pain at the site of injection. Headache, fatigue, and myalgia

* Revaccination every 5 years if risk criteria persist.
† Single dose boost at 1 year post-initial series and every 2-3 years thereafter if risk criteria persist.

Table 9. Pneumococcal Polysaccharide Vaccine.[46]

Vaccines	Indications	Schedules	Adverse Effects
Pneumovax 23	Preexposure	1 IM dose	Mild to moderate erythema and soreness at the site of injection.

Table 10. Hepatitis A Vaccines.[4,6,20]

Vaccines	Indications	Schedules	Adverse Effects
Vaqta *Havrix*	Pre- and post-exposure	2 IM doses at 0 and 6-18 months 2 IM doses at 0 and 6-12 months	Erythema, edema, pain at injection site; malaise, fever, and fatigue may occur.
Twinrix	Preexposure	3 IM doses at 0, 1, and 6 months	As above plus anaphylaxis in persons with history of allergic reaction to baker's yeast.

incubation period of about 28 days (range: 15–50 days). Among adults the infection is typically symptomatic with fever, fatigue, loss of appetite, nausea, vomiting, abdominal pain, dark urine, clay-colored bowel movements, joint pain, and jaundice. HAV infection is self-limiting and does not result in chronic liver disease.[47]

Active Immunization: Hepatitis A Vaccine[4,6,20]

There are two inactivated hepatitis A whole-virus vaccines (*Vaqta, Havrix*) and a combination hepatitis A and B vaccine (*Twinrix*) available (Table 10). *Twinrix* contains the same hepatitis A component as *Havrix*, but half the dose. Hepatitis A vaccination is recommended for adults with chronic liver disease, illicit drug users, and those at risk of healthcare-associated exposure. Vaccination with *Vaqta* and *Havrix* consists of 2 doses; vaccination with *Twinrix* requires 3 doses.

Passive Immunization: Immune Globulin

Immune globulin is available for short-term pre- and post-exposure protection (approximately 3 months) against hepatitis A. Immune globulin must be administered within 2 weeks after exposure for maximum protection.[6]

Documenting Immunization Compliance

An immunization record should be established for each OHCP at the time of initial employment.[4,6,13] The most reliable way to determine immunity is to obtain documentation of:

1. physician-diagnosed infection or
2. laboratory evidence of immunity, or
3. age-appropriate vaccination.

If there is any doubt as to the immune status of an OHCP, it is best to assume that the person is non-immunized. Following each subsequent immunization encounter, the record should be updated. The information recorded should include the type of vaccine; the dose, route, and site of administration; the name of the person who gave the vaccine; the

date the vaccine was given; the manufacturer and lot number; and the date the next dose is due.

A Summary of Infection Prevention Practices in Dental Settings: Basic Expectations for Safe Care was published by the CDC in 2016. This guide is based on elements of Standard Precautions and represents a summary of basic infection prevention expectations for safe care in oral healthcare setting as recommended in the Guidelines for Infection Control in Dental Health-Care Setting – 2003.[48,49] However, this document includes an Infection Prevention Checklist for Dental Settings (*Appendix A*). The Infection Prevention Checklist, Section I: Policies and Practices provides a tool to monitor and document institutional compliance with Dental Health Care Personnel Safety (Section I.3), i.e., compliance with current CDC recommendations for immunizations.

Summary

The goal of immunization of population groups is the eradication of disease. The goal of immunization in any one individual, e.g., an oral healthcare provider, is the prevention of disease. The decision to immunize OHCP against a specific pathogen is based on:

1. an assessment of the risk of infection,
2. the consequences of natural unmodified illness,
3. the availability of a safe and effective vaccine, and
4. the duration of immunity.

The cost-effectiveness of disease prevention by immunization rather than by disease treatment is unequivocal. This should prompt an acute interest in developing and implementing immunization strategies in all oral healthcare settings.

Course Test Preview

To receive Continuing Education credit for this course, you must complete the online test. Please go to: *www.dentalcare.com/en-us/professional-education/ce-courses/ce479/test*

1. All of the following statements are correct in reference to vaccine-preventable diseases in the United States, EXCEPT for one. Which one is the exception?

A. Immunization programs in the U.S. have markedly reduced the incidence of vaccine-preventable diseases in children.
B. Healthcare workers are at a lower risk of vaccine preventable disease than the general public.
C. Today, a substantial percentage of morbidity and mortality from vaccine-preventable childhood diseases occurs in older adolescents and adults.
D. Adults who escaped natural infection or immunization during childhood may be at increased risk of vaccine-preventable disease because of advanced age, the presence of certain chronic diseases, or occupation.

2. All of the following statements are correct with respect to vaccines EXCEPT for one. Which one is the exception?

A. Whole pathogen vaccines consist of either live-attenuated or inactivated microorganisms.
B. Subunit vaccines contained fractionated antigenic components of a microorganism and typically require the incorporation of an adjuvant to generate a sufficient immune response.
C. Vaccines provide immediate protection for the host.
D. Alum is an example of an adjuvant.

3. All of the following statements regarding nucleic acid vaccines are true EXCEPT for one. Which one is the exception?

A. Nucleic acid vaccines provide the specific genetic material encoding the target antigen or antigens against which an immune response is sought.
B. Once introduced, the body's own cells use the genetic material to produce the desired antibody.
C. Once introduced, the body's own cells use the genetic material to produce the desired antigen.
D. Potential advantages of this approach include no risk of infection; improved vaccine stability; stimulation of broad long-term immunity; and rapid, inexpensive, and scalable vaccine manufacturing.

4. Neutralizing antibodies readily diffuse into infected cells to interact with the target-organism, while lymphoid K-cells recognize target organisms before initial intracellular penetration.

A. The first part of the statement is true, but the second part of the statement is false.
B. The first part of the statement is false, but the second part of the statement is true.
C. Both parts of the statement are true.
D. Both parts of the statement are false.

5. All of the following statements are correct with respect to passive immunization EXCEPT which one?

A. Immunoglobulins may be obtained from human or animal donors who have recovered from an infectious disease or who have been previously immunized.
B. Passive immunity against specific microorganisms may be conferred with the administration of immunoglobulins.
C. Passive immunization usually affects an immune response in about 7-10 days.
D. Passive immunization is useful when active immunization is unavailable or contraindicated, or when an individual cannot form antibodies.

6. All of the following statements in relation to live attenuated vaccines are correct EXCEPT which one?

A. Live attenuated vaccines, because of their potential for infecting the fetus, should not be administered to pregnant women unless there is a high immediate risk of infection.
B. The administration of live attenuated vaccine is highly recommended for patients undergoing cancer chemotherapy, post-organ transplantation, and those on corticosteroids.
C. The administration of live attenuated vaccines is contraindicated to persons with known or suspected congenital or acquired immunodeficiency.
D. Live attenuated vaccines tend to have higher rates of adverse effects (particularly fever).

7. All of the following statements are true in relation to potential adverse reaction to vaccines EXCEPT which one?

A. Vaccines may contain residual animal or human proteins, antibiotics (neomycin), preservatives (thimerosal) and stabilizers (aluminum phosphate), which may cause allergic reactions or toxicity.
B. The most common allergic component of vaccines is egg proteins found in vaccines prepared in chicken eggs or chicken embryonic cultures.
C. Subcutaneous administration of some vaccines, such as those containing aluminum phosphates can lead to local tissue necrosis.
D. Most adult vaccines are given by SC or IM injection, intravascular administration tends to reduce adverse effects and increase the immune response.

8. Immunization strategies for OHCWs are predicated on all of the following considerations, EXCEPT for one. Which one is the exception?

A. Vaccines mandated or strongly recommended at the time of employment.
B. Vaccine recommended if another risk factor is presents.
C. The availability of immunoglobulins, which are administered to susceptible persons only in the event of inadvertent exposure to blood or OPIM.
D. The cost of the vaccine.

9. All of the following statements are correct in relation to the hepatitis B vaccine, EXCEPT for one. Which one is the exception?

A. HB viral infection is a minor vaccine preventable health hazard for the OHCP.
B. Universal immunization is mandated for all OHCP.
C. Persons who decline the hepatitis B vaccination series must sign a copy of the Mandatory Hepatitis B Vaccination Declination Form.
D. Vaccination should be completed during training.

10. All of the following statements in relation to hepatitis B vaccination are correct EXCEPT which one?

A. Primary immunization with hepatitis B vaccine consists of two or three IM injections at 0, 1, and 6 months or 0 and 1 month, respectively.
B. Post-vaccination confirmation of seroconversion is mandated 1-2 months after the final dose.
C. OHCP who do not develop an adequate antibody response to the primary vaccination series shall be offered a second 2 or 3-dose vaccine series.
D. If no antibody response occurs to the second hepatitis B vaccination series, testing for HBsAg is strongly recommended.

11. All of the following statements in relation to OHCP who failed to seroconvert following two HBV vaccination series are correct, EXCEPT for one. Which one is the exception?

A. They are at risk of HBV infection after percutaneous or permucosal exposure.
B. They should be administered hepatitis B immune globulin within a week of exposure (ideally within 24 hours).
C. In addition to HBIG, they should receive an alternate 4-dose series of vaccine.
D. They should not receive a second dose of HBIG 30 days after the first dose if the HB vaccine is declined.

12. All of the following statements are correct in relation to the influenza prevention, EXCEPT for one. Which one is the exception?

A. It is strongly recommended that all OHCP, including those in training, be vaccinated annually against influenza.
B. The virologic basis for the annual influenza vaccine is the emergence of new influenza virus variant from frequent antigenic change.
C. The live attenuated intranasal influenza vaccine is specifically approved for individuals >65 years of age.
D. Antiviral agents with activity against influenza are most effective if provided within 48 hours of symptom onset.

13. All of the following statements are correct in relation to the MMR vaccine EXCEPT which one?

A. It is strongly recommended that all OHCP be immune to measles, mumps, and rubella.
B. Immunity to rubella in women of childbearing age should not be a concern in healthcare setting because congenital rubella in the US is no longer considered a public health threat.
C. The trivalent MMR vaccine is the vaccine of choice for routine adult vaccination.
D. The MMR vaccine contains live attenuated measles, mumps, and rubella viruses.

14. Immunity to the varicella-zoster virus can be confirmed by all of the following methods EXCEPT which one?

A. Physician-diagnosed varicella (chickenpox) or herpes zoster.
B. Laboratory evidence of VZV immunity.
C. Age-appropriate vaccination against VZV.
D. Evidence based on maternal recollection.

15. Which of the following vaccines is now considered the vaccine of choice to prevent HZ?

A. Varivax
B. Zostavax
C. Shingrix
D. VariZIG

16. All of the following statements are correct relative to tetanus, diphtheria, and pertussis, EXCEPT for one. Which one is the exception?

A. Tetanus, diphtheria, and pertussis are bacterial infections.
B. The Td vaccine contains tetanus and diphtheria toxoids and protein components of acellular pertusus.
C. OHCP with uncertain history of primary vaccination should receive and initial dose of Tdap followed by a Td or Tdap booster every 10 years.
D. Tdap is recommended as part of wound management.

17. All of the following statements regarding HPV are correct, EXCEPT for one. Which one is the exception?

A. The HPV may be acquired occupationally by OHCP through a cut, abrasion, or small tear in the outer layer of skin or mucous membranes.
B. High-risk strains of HPV may cause cervical cancer and oropharyngeal cancer.
C. The recommended HPV vaccine for OHCP is the quadrivalent vaccine *Gardasil*.
D. Vaccine naïve OHCP <45 years of age deemed at risk for HPV are recommended for vaccination.

18. All of the following statement regarding SARS-CoV-2 are true, EXCEPT for one. Which one is the exception?

A. The risk of asymptomatic spread is considered nil.
B. It is predominately spread via droplets produced when an infected patient coughs, sneezes, or talks.
C. An increased risk of death is associated with increasing age and the presence of certain co-morbidities.
D. The mRNA vaccines BNT162b2 and mRNAA-1271 received Emergency Use Authorization from the FDA in December 2020.

19. All of the following statements are correct with respect to Neisseria meningitidis, EXCEPT for one. Which one is the exception?

A. Neisseria meningitidis is transmitted from the respiratory tract into the bloodstream and causes inflammation of the meninges surrounding the brain and spinal cord.
B. OHCP who meet certain risk criteria are recommended for vaccination.
C. All OHCP adults should receive vaccination once they are >55 years of age.
D. Booster vaccinations are recommended as long as the risk criteria persist.

20. All of the following statements are correct with respect to Streptococcus pneumoniae, EXCEPT for one. Which one is the exception?

A. Streptococcus pneumoniae organisms commonly colonize the respiratory tract and are spread via airborne droplets.
B. All adults with compromised immune system and the elderly are high risk of infection.
C. The conjugated vaccine (*Prevnar 13*) is routinely recommended for individuals ≥65 years old.
D. The polysaccharide vaccine (*Pneumovax 23*) is indicated for all adults ≥65 years old.

21. All of the following statements are correct with respect to the hepatitis A virus, EXCEPT for one. Which one is the exception?

A. The HAV is transmitted primarily by the fecal-oral route, either person-to-person contact or consumption of contaminated food or water.
B. HAV vaccination is recommended for all adults with chronic liver disease, illicit drug users, and those at risk of healthcare-associated exposure.
C. There are two inactivated hepatitis A whole-virus vaccines and a combination hepatitis A and B vaccine.
D. If indicated, immune globulin should be provided after 3-4 weeks of exposure for maximum protection.

22. All of the following statements are correct in relation to documentation of vaccination and immune status of OHCP, EXCEPT for one. Which one is the exception?

A. Documentation of pre-employment vaccination is mandatory.
B. An immunization record should be established for each OHCP at the time of initial employment.
C. At each subsequent immunization encounter, the record should be updated.
D. If there is any doubt as to the immune status of an OHCP, it is best to assume that the person is not immune.

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Additional Resources

- No Additional Resources Available

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