© National HIV Curriculum
PDF created January 13, 2026, 3:12 pm

Immunizations in Adults

This is a PDF version of the following document:
Module 2: Basic HIV Primary Care
Lesson 4: Immunizations in Adults

You can always find the most up-to-date version of this document at https://www.hiv.uw.edu/go/basic-primary-care/immunizations/core-concept/all.

Background

Background

Providing appropriate immunizations is an important component of comprehensive HIV clinical care, but immunizing persons with HIV poses several challenges and concerns related to safety and efficacy. The Advisory Committee on Immunization Practices (ACIP) provides annual recommendations for routine immunizations of adults, including specific recommendations for persons with HIV. These recommendations are summarized in the table below.[1] In addition, the Adult and Adolescent OI Guidelines provide recommendations for Immunizations for Preventable Diseases in Adults and Adolescents Living with HIV.[2] This topic review will focus on immunization recommendations for adults with HIV.[1,2,3] The individual immunization topics discussed in this review are ordered alphabetically based on the vaccine.[4]

Table 1.

2025 ACIP Recommended Immunizations for Adults with HIV, United States

Vaccines	Abbreviations	CD4 count <15% or <200 cells/mm^3	CD4 cou ≥15% and ≥20
COVID-19	1vCOV-mRNA 1vCOV-aps	**Recommended** Number of doses depends on vaccine and prior COVID immunization history	**Recommended** Number of doses depends on vaccine and prior COVID immunization history
Haemophilus influenza type b	Hib	No Guidance/Not Applicable	
Hepatitis A	HepA	**Recommended** 2 or 3 doses depending on vaccine	
Hepatitis B	HepB	**Recommended** 2 or 3 doses depending on vaccine	
Human papillomavirus	9vHPV	**Recommended** 3 doses through age 26 years (0, 1-2, and 6 months)	
Influenza inactivated 3, or Influenza recombinant 3	IIV3 RIV3	**Recommended** 1 dose annually	

Vaccines	Abbreviations	CD4 count <15% or <200 cells/mm^3	CD4 cou ≥15% and ≥20
Influenza live, attenuated	LAIV3	**Contraindicated**	
Measles-mumps-rubella	MMR	**Contraindicated**	*With no evidence of* [&]**Recommend** 2 doses (at least 4 we
Meningococcal serogroups A, C, W, Y	MenACWY-CRM MenACWY-TT	**Recommended** 2 doses (at least 8 weeks apart), then revaccinate every 5	
Meningococcal serogroup B	MenB-4C MenB-FHbp	No Guidance/Not Applicable	
Mpox		**Recommended for Persons at Risk** 2 doses (28 days apart)	
Pneumococcal	PCV15 PCV20 PCV21 PPSV23	**Recommended** 1 dose PCV20 or PCV21 or 1 dose PCV15 followed ≥8 weeks by 1 dose PPSV23	
Respiratory Syncytial Virus	RSV	**Recommended for the Following Persons** 1 dose in adults aged ≥75 years 1 dose in adults aged 60-74 years if at increased risk	
Tetanus-diphtheria-acellular pertussis Tetanus-diphtheria	Tdap Td	**Recommended** 1 dose Tdap then Td or Tdap booster every 10 years	
Varicella	VAR	**Contraindicated**	*With no evidence of* **Consider** 2 doses (3 months
Zoster, recombinant	RZV	**Recommended** 2 doses (2-6 months apart) at age ≥19 years	

[†] This table is based on the 2025 ACIP Recommended Adult Immunization Schedule by Medical Condition and Other States.
[&] Recommended if CD4 count greater than 200 cells/mm^3 for at least 6 months with no evidence of immunity to me or rubella

Source:

- Advisory Committee on Immunization Practices (ACIP). Recommended Immunization Schedule for Ages 19 Years or Older, United States, 2025. [ACIP]

Risk of Live Vaccines in Persons with HIV

Immunizations are generally safe in individuals with HIV, except for live virus vaccines in persons with low CD4 counts. In those individuals with HIV who have advanced immunosuppression, live vaccines can cause a potentially life-threatening disseminated infection with the live pathogen in the vaccine.[5]

Challenges with Efficacy

Current or past advanced immunosuppression in persons with HIV is often associated with suboptimal responses to standard recommended vaccine doses; for several vaccines, the response appears to depend on current and nadir CD4 cell counts.[6,7,8,9] In general, responses to immunization are better when the vaccine is given in persons with higher CD4 cell counts, including after immune reconstitution that has resulted from

antiretroviral therapy. Nevertheless, in most circumstances, vaccine administration is not delayed until the CD4 count increases to greater than 200 cells/mm^3.

Adult Immunizations

There are numerous vaccines that are addressed in the adult immunization schedule and these are summarized in the table below.[1] Table 2.

Vaccines in the Adult Immunization Schedule

Vaccines	Abbreviations	Trade Names
COVID-19	1vCoVmRNA	Pfizer-BioNTech (*Comirnaty*) Moderna (*Spikevax*)
	1vCoVaPS	Novavax
Haemophilus influenzae type b	Hib	*ActHIB* *Hiberix* *PedvaxHIB*
Hepatitis A vaccine	HepA	*Havrix* *Vaqta*
Hepatitis A and hepatitis B vaccine	HepA-HepB	*Twinrix*
Hepatitis B vaccine	HepB	*Engerix-B* *Heplisav-B* *Recombivax HB*
Human papillomavirus vaccine	HPV	*Gardasil* 9
Influenza vaccine (inactivated, egg-based)	IIV3	Multiple
	aIIV3	*Fluad*
	HD-IIV3	*Fluzone* High-Dose
Influenza vaccine (inactivated, cell culture)	ccIIV3	*Flucelvax*
Influenza vaccine (recombinant)	RIV3	*Flublok*
Influenza vaccine (live, attenuated)	LAIV3	*FluMist*
Measles, mumps, and rubella vaccine	MMR	M-M-R II *Priorix*
Meningococcal serogroups A, C, W, Y vaccine	MenACWY-CRM	*Menveo*
	MenACWY-TT	*MenQuadfi*
Meningococcal serogroup B vaccine	MenB-4C	*Bexsero*
	MenB-FHbp	*Trumemba*
Meningococcal serogroups A, B, C, W, Y vaccine	MenACWY-TT/Men B-FHbp	*Penbraya*
Mpox vaccine	Mpox	*Jynneos*
Pneumococcal conjugate vaccine	PCV15	*Vaxneuvance*
	PCV20	*Prevnar* 20

Vaccines	Abbreviations	Trade Names
	PCV21	*Capvaxive*
Pneumococcal 23-valent polysaccharide vaccine	PPSV23	*Pneumovax* 23
Respiratory syncytial virus vaccine	RSV	*Abrysvo* *Arexvy* *mResvia*
Tetanus and diphtheria toxoid vaccine	Td	*Tenivac*
Tetanus and diphtheria toxoids and acellular pertussis vaccine	Tdap	*Adacel* *Boostrix*
Varicella vaccine	VAR	*Varivax*
Zoster vaccine, recombinant vaccine	RZV	*Shingrix*

Source:

- Centers for Disease Control and Prevention. Vaccines in the Adult Immunization Schedule. [CDC]

COVID-19 Vaccination

Background

Persons living with HIV are at elevated risk for significant morbidity and mortality from COVID-19 infection, particularly persons who have untreated or advanced HIV (as evidenced by a low CD4 T-cell count or detectable HIV RNA) or other medical comorbidities.[10,11,12,13] Limited data exist on the specific safety and efficacy of COVID-19 vaccination for people living with HIV, but, based on available data and clinical experience, it is generally accepted that the benefits for reducing COVID-related morbidity and mortality far outweigh any vaccine-related risks.[14,15] In the United States, the FDA approved three updated COVID-19 vaccine options for adults: Pfizer-BioNTech 2024-2025 (*Comirnaty*), Moderna 2024-2025 (*Spikevax*), and the 2023–2024 Novavax, adjuvanted 2024-2025.

COVID Vaccines

mRNA Vaccines

The United States Food and Drug Administration (FDA) has approved two COVID-19 mRNA vaccines: Pfizer-BioNTech mRNA and the Moderna mRNA COVID-19 vaccine. Both of these vaccines employ novel mRNA technology—the mRNA is delivered in a lipid nanoparticle to express a full-length viral spike protein (Figure 1).[16] These mRNA vaccines stimulate vigorous SARS-CoV-2 B-cell mediated neutralizing antibody responses and T-cell augmentation and memory immune responses against SARS-Co-V2.[16] The most recent 2024-2025 mRNA vaccines are monovalent and target the Omicron variant KP.2 strain.[17]

Protein Subunit Vaccines

The Novavax COVID-19 vaccine has received an emergence use authorization from the FDA for individuals 12 years of age and older. This vaccine contains pieces of the SARS-CoV-2 spike protein as well as an adjuvant to boost immunogenicity.[18] The most recent 2024-2025 Novavax COVID-19 vaccine targets the Omicron variant JN.1, which is a closely-related predecessor of the Omicron KP.2 strain.

Adenovirus Vaccine

The Johnson & Johnson/Janssen COVID-19 vaccine, which utilizes a replication incompetent adenovirus vector that encodes viral spike protein, is no longer available in the United States and all remaining United States government stock of this vaccine expired on May 7, 2023.[18]

Recommendations for COVID-19 Vaccines In Persons with HIV

The Centers for Disease Control and Prevention (CDC) recommends that all adults with HIV receive COVID-19 vaccination, regardless of viral load or CD4 count.[18] The number of vaccines recommended depends on the immune status of the person receiving the vaccine, typically with more doses given for persons considered to have moderate or severe immunocompromising conditions.

Moderate or Severe Immunocompromising Conditions

The following conditions are considered moderate or severe immunocompromising conditions as listed below by the CDC.

- Advanced HIV (people with HIV and CD4 cell counts less than 200/mm^3, history of an AIDS-defining illness without immune reconstitution, or clinical manifestations of symptomatic HIV) or untreated HIV
- Active treatment for solid tumor and hematologic malignancies
- Hematologic malignancies associated with poor responses to COVID-19 vaccines regardless of current

treatment status (e.g., chronic lymphocytic leukemia, non-Hodgkin lymphoma, multiple myeloma, acute leukemia)
- Receipt of a solid-organ transplant or an islet transplant and taking immunosuppressive therapy
- Receipt of chimeric antigen receptor (CAR)-T-cell therapy or hematopoietic cell transplant (HCT) (within 2 years of transplantation or taking immunosuppressive therapy)
- Moderate or severe primary immunodeficiency (e.g., common variable immunodeficiency disease, severe combined immunodeficiency, DiGeorge syndrome, Wiskott-Aldrich syndrome)
- Active treatment with high-dose corticosteroids (i.e., 20 mg or more of prednisone or equivalent per day when administered for 2 or more weeks), alkylating agents, antimetabolites, transplant-related immunosuppressive drugs, cancer chemotherapeutic agents classified as severely immunosuppressive, tumor necrosis factor (TNF) blockers, and other biologic agents that are immunosuppressive or immunomodulatory (e.g., B-cell-depleting agents)

Recommendations for COVID Vaccine Dosing in Adults with HIV

The following summarizes updated CDC recommendations for the use of the 2024-2025 Pfizer-BioNTech, Moderna, and Novavax vaccines in adults with HIV.[18] Because COVID vaccine recommendations frequently change and may be complex for moderately or severely immunocompromised persons, we recommend always referring to reviewing updated recommendations on the CDC website—Use of COVID-19 Vaccines in the United States: Interim Clinical Considerations and the ACIP updated immunization schedules.[1,18]

Haemophilus influenzae type b (Hib) Vaccination

Background

Haemophilus influenzae infection is more common in adults with HIV than in the general population, but the annual incidence remains relatively low at 41/100,000 adults with HIV.[19] Only about one-third of cases of invasive *H. influenzae* involve type b, which is the type in the currently licensed vaccines. Multiple identifiable subtypes of *H. influenzae* and other unidentifiable types (called nontypeable *H. influenzae*) can cause a wide range of clinical diseases, including bacteremia, meningitis, pneumonia, epiglottitis, cellulitis, and infectious arthritis. Infants and children younger than five years of age, adults over the age of 65, and Native American and Alaskan Indian populations are all at higher risk of disease.[20] Certain medical conditions also predispose individuals to *H. influenzae* disease, such as HIV, sickle cell disease, asplenia, complement and antibody deficiency syndromes, and receipt of chemotherapy, radiation, or hematopoietic stem cell transplant. The conjugate *H. influenzae* type b vaccine is safe and effective in all age groups.[21]

Vaccines

There are three licensed *Haemophilus influenzae* type b (Hib) monovalent conjugate vaccines: *Hiberix*, *ActHIB*, and *PedvaxHIB*. In addition, there are four licensed combination conjugate vaccines that contain Hib:*Comvax* (Hib combined with hepatitis B vaccine), *Pentacel* (Hib combined with DTaP and inactivated poliovirus), *MenHibrix* (Hib combined with meningococcal vaccine), and *Vaxelis* (Hib combined with DTaP, inactivated poliovirus and hepatitis B vaccine IPV). Although none of these vaccines have FDA approval for use in adults, the ACIP has recommended that any of the monovalent conjugate Hib vaccines can be used for adults who have a specific indication to receive this vaccine.[20]

Recommendations

- Due to the low incidence of *H. influenzae* type b infections among adults with HIV, *H. influenzae* type b immunization is not recommended for routine administration to adults with HIV.[22]
- Per the ACIP Adult Immunization Schedule, any of the monovalent Hib vaccines should be administered to adults with HIV only if they have an indication for the vaccine, including hematopoietic stem cell transplant, anatomic asplenia, or functional asplenia (including sickle cell disease).[1] Persons who have undergone hematopoietic stem cell transplant should receive a 3-dose series (4 weeks apart starting 6 to 12 months after successful transplant), regardless of Hib vaccination history. For persons with functional or anatomic asplenia, one dose of Hib should be given if they have not previously received the vaccine; for persons undergoing elective splenectomy, the Hib vaccine should be administered, preferably at least 14 days prior to surgery.[1]

Hepatitis A Virus (HAV) Vaccination

Background

Hepatitis A virus (HAV) is transmitted through food, water, or objects contaminated with fecal matter.[23] Infection with HAV is usually an acute, self-limiting condition that does not require treatment, though it can rarely cause fulminant liver failure.[23] Following the widespread use of the hepatitis A vaccine beginning in 1995, the number of HAV infections in the United States declined for nearly 2 decades, rose again from 2015-2019, but then declined during 2020-2022 (Figure 2).[24,25] For persons with HIV, the hepatitis A vaccines are safe and usually effective, though seroconversion rates may be diminished for individuals with lower CD4 cell counts.

- One randomized control study found seroconversion rates of 94% in persons with HIV compared to 100% in persons without HIV, though rates were only 87% in patients with CD4 counts less than 300 cells/mm^3.[26]
- In another randomized control trial, after two doses of hepatitis A vaccine, seroconversion rates were observed in 68% of persons with HIV who had a CD4 count greater than or equal to 200 cells/mm^3 compared to only 9% of those with CD4 counts less than 200 cells/mm^3.[6]

Vaccines

Hepatitis A vaccine is an inactivated vaccine that can be given as one of the single-antigen preparations (*Havrix* or *Vaqta*) or as a combination vaccine (*Twinrix*). The two single-antigen brands of hepatitis A vaccine are potentially interchangeable, but ideally, all doses in a vaccine series should be from the same manufacturer (Figure 3).[27]

- ***Havrix***: this single-antigen vaccine contains 1,440 ELISA units (EL.U) of hepatitis A antigen and is administered as a 2-dose schedule, with the second dose given 6 to 12 months after the initial dose.
- ***Vaqta***: this single-antigen vaccine contains 50 units (U) of inactivated hepatitis A and is administered as a 2-dose schedule, with the second dose given 6 to 18 months after the initial dose.
- ***Twinrix***: this combination vaccine contains 720 EL.U of hepatitis A antigen (antigen component from *Havrix,* one-half amount) combined with 20 mcg of hepatitis B antigen (antigen component from *Engerix-B* standard dose); it is administered as a 3-dose series (0, 1, and 6 months).

Recommendations

The following summarizes the ACIP Adult Immunization Schedule and Adult and Adolescent OI Guidelines recommendations for administering the hepatitis A vaccine to persons with HIV who are not immune to HAV.[2,3,27]

- **General Approach and Timing of Administration**: The Hepatitis A vaccine series should be administered to all adolescents and adults with HIV if they are not immune to HAV, with the timing of vaccine administering possibly depending on their CD4 count (Figure 4).[2,3,27] For persons with a CD4 count of less than 200 cells/mm^3 and an ongoing risk of acquiring HAV infection, the HAV vaccine series should be administered without delay.[2] If the individual has a CD4 count of less than 200 cells/mm^3 and no active risk of acquiring HAV, two options exist: either administer without delay or wait to give the vaccine series until the CD4 is greater than 200 cells/mm^3.[2,27,28]
- **Recommended Dosing Schedule**: Hepatitis A vaccine should be administered in two doses at 0 and 6-12 months (*Havrix*) or 0 and 6-18 months (*Vaqta*); the minimum interval before the first and second dose of these vaccines is 6 months.[1,2,27] The combined hepatitis A-hepatitis B vaccine (*Twinrix*) can also be administered as a 3-dose series (0, 1, and 6 months); for this combined vaccine, the minimum intervals are 4 weeks between the first and second doses and 5 months between the second and third doses.[1,2,27] For non-immunized persons traveling to countries endemic for HAV, an accelerated

dosing schedule with the combined hepatitis A-hepatitis B vaccine can be administered on days 0, 7, 21 to 30 days, with a booster dose given at 12 months.[1,2]

- **Postvaccination Serologic Testing and Revaccination**: Since persons with HIV may have an attenuated response to the vaccine, postvaccination serologic testing should be performed in these individuals at least 1-2 months after completing the HAV vaccination series.[2,27] If there is no evidence of immunity against HAV (e.g., antibody titer of at least 10 mIU/mL), then revaccination is recommended with the entire HAV vaccine series, preferably when the CD4 count is greater than 200 cells/mm^3.[2,27] Postvaccination serology testing should be done again at least 1-2 months after completion of the additional HAV vaccination series.[27] If there is still no evidence of an adequate immune response, then further vaccination is not recommended, but the individual should receive counseling on the need to receive immune globulin after an exposure to HAV.[27]
- **Counseling**: Regardless of the initial immune response to the HAV vaccine series, all individuals with HIV should be counseled that the vaccine might not provide long-term protection against HAV infection.[27] Hence, immune globulin may need to be administered after a high-risk HAV exposure.[27,29,30]

Hepatitis B Virus (HBV) Vaccination

Background

Hepatitis B virus (HBV) is transmitted through percutaneous and mucosal exposure to infected blood or body fluids. Chronic HBV infection can cause cirrhosis, liver failure, hepatocellular cancer, and death. Individuals with HIV have an increased risk of acquiring HBV through injection drug use and/or condomless sex. When compared to persons with HBV monoinfection, those with HIV and HBV coinfection have an increased likelihood of establishing chronic HBV after initial infection, accelerated progression of liver disease, and significantly higher rates of liver-related mortality compared with individuals without HIV.[31,32] Thus, vaccination against HBV is very important for persons with HIV.

Vaccines

For adults, there are three U.S. Food and Drug Administration (FDA)-approved recombinant HBsAg single antigen recombinant hepatitis vaccines: *Recombivax HB*, *Engerix-B*, and *Heplisav-B*. All hepatitis B vaccines are administered as intramuscular vaccines. The triple antigen *PreHevbrio* vaccine was discontinued in November 2024 and is no longer available.

- *Recombivax HB*: This vaccine is a recombinant, single-antigen that is available as an adult standard formulation (10 µg HBsAg per dose) and a high-dose dialysis formulation (40 µg per dose). Double-dose *Recombivax-HB* is 20 µg per dose.
- *Engerix-B*: This vaccine is a single-antigen, recombinant vaccine, available as a standard 20 µg HBsAg per dose; double-dose *Engerix*-B is 40 µg per dose).
- *Heplisav-B*: This vaccine consists of recombinant HBsAg conjugated to the cytosine phosphoguanine oligonucleotide (CpG 1018) adjuvant, and is available in doses that each contain 20 µg of HBsAg and 3,000 µg of the 1018 adjuvant.[33]
- *Twinrix*: This combined hepatitis A-hepatitis B vaccine contains 720 EL.U of hepatitis A (antigen component from *Havrix*) and 20 µg per dose of HBsAg (antigen component from *Engerix-B*). It is important to note that administering the *Twinrix* vaccine provides standard-dose, not double-dose strength hepatitis B antigen.

Using standard doses of older single antigen hepatitis B vaccines in adults with HIV generated significantly lower seroprotective response rates than in adults without HIV.[34,35] Lower HBV vaccine responses in persons with HIV have been associated with a recent or nadir CD4 count of less than 200 cells/mm^3, detectable HIV RNA levels, coinfection with hepatitis C virus, occult HBV, and overall health of the vaccine recipient.[9,34,36] Past attempts to improve hepatitis B vaccine response rates have included giving a double dose, an increased number of doses, and the use of intradermal vaccines.[37,38] The BEe-HIVe clinical trial compared three doses (0, 1, and 6 months) of the *Heplisav-B* vaccine to placebo in persons with HIV who were hepatitis B vaccine naive and found 100% of those who received the vaccine had protective antibody levels (anti-HBs greater than 10 mIU/mL) at 28 weeks; in addition, at week 8 (4 weeks after the second dose), 87% had protective antibody titers and this number increased to 98.5% at week 24, which was prior to receipt of the third vaccine dose (Figure 5).[39] A second arm of the BEe-HIVe trial enrolled people with HIV, on antiretrovirals, who were previous hepatitis B vaccine non-responders and compared the effectiveness of a 2-dose and 3-dose series of *Heplisav-B* vaccine against a conventional 3-dose hepatitis B vaccine (*Engerix-B*).[40] Results showed superior protection with the *Heplislav*-B vaccine (93.1% seroprotection rate with the 2 dose series and 99.4% with the 3-dose series) compared with the 3-dose *Engerix-B* vaccine regimen(seroprotective rate of 80.6%).[40]

Recommendations

The recommendations for hepatitis B immunization in persons with HIV are outlined as follows and are based on recommendations from the Adult and Adolescent OI Guidelines.[2,32]

- **General Approach and Timing of Administration**: All persons with HIV who do not have active HBV or evidence of immunity to HBV should receive the hepatitis B vaccine series if they have ongoing risks of acquiring HBV.[2,32] Although HBV non-immune individuals with a CD4 count less than 350 cells/mm^3 may have decreased response to HBV vaccination, the deferring vaccination until CD4 rises to greater than 350 cells/mm^3 is not recommended since many individuals with a CD4 of less than 350 cells/mm^3 will mount an adequate antibody response to the HBV vaccine series.[2,32] For hepatitis B vaccine nonresponder who have a CD4 count of less than 200 cells/mm^3, some experts would delay revaccination until after a CD4 count of 200 cells/mm^3 or greater is achieved and sustained on antiretroviral therapy,[2,32]
- **Prevaccine Screening**: Prevaccine screening should include HBsAg, anti-HBs, and anti-HBc. A positive HBsAg indicates active infection, and no vaccine is indicated. If the individual has a positive test for both anti-HBs and anti-HBc, there is no need for hepatitis B immunization. In addition, if the anti-HBs alone is positive (with a titer greater than 10 mIU/mL), the person is considered immune and has no need for hepatitis B immunization.[32] The approach to patients with isolated anti-HBc is addressed below.

- **Dosing and Schedule for Hepatitis B Immunization**: The following are recommended options for hepatitis B immunization in persons with HIV (Figure 6):[2,32]
    - Preferred
        - *Heplisav-B* given as a 2-dose series at 0 and 4 weeks (**AII**)
    - Alternative
        - *Engerix-B* 40 mcg (two simultaneous injections of 20 mcg each) at 0, 1, and 6 months (these doses are considered a “double-dose,” three-dose series) (**AII**)or
        - *Recombivax HB* 20 mcg (two injections of 10 mcg each) at 0, 1, and 6 months (these doses are considered a “double-dose,” three-dose series) (**AII**); or
        - *Twinrix* combined HepA and HepB vaccine (1 mL IM) as a three-dose series (at 0, 1, and 6 months) (**AII**). Note that administering the *Twinrix* vaccine provides standard-dose, not double-dose strength of hepatitis B antigen).
- **Post-vaccine Antibody Testing**: Given the decreased response rate to hepatitis B vaccine among persons with HIV, post-vaccine testing for antibody to hepatitis B surface antigen (anti-HBs) should be performed 4 weeks after completing the final dose of the vaccine series, with a titer of at least 10 mIU/mL considered protective; individuals who have a postvaccine anti-HB less than 10 mIU/mL are considered vaccine nonresponders.[28,32] Due to concerns of waning immunity, some experts recommend checking anti-HBs annually and giving a booster dose of hepatitis B vaccine if anti-HBs levels fall below 10 mIU/L, especially for individuals with ongoing risk of acquiring HBV who are not taking tenofovir DF or tenofovir alafenamide as part of their combination antiretroviral regimen.[32]
- **Vaccine Nonresponders**: If a post-vaccine anti-HBs concentration of at least 10 mIU/mL is not attained, the following are considered as options for hepatitis B vaccine nonresponder:
    - If vaccine nonresponse occurs after receipt of either the *Engerix-B* or *Recombivax HB* series, administer *Heplisav-B* at 0 and 4 weeks (AI) with consideration for a third dose of *Heplisav-B* at 24 weeks (BIII)
    - If vaccine nonresponse occurs after receipt of a two-dose *Heplisav-B* series, there are no data, but clinicians can consider a third dose of *Heplisav-B*, given 24 weeks after first dose (BIII)
- **Isolated Core Antibody**: The optimal approach for persons with HIV who have isolated anti-HBc (positive anti-HBc, negative anti-HBs, and negative HBsAg) is unclear, since this pattern may signify a false-positive result, an exposure in the distant past with waning anti-HBs, or occult HBV infection. Note, with this approach for persons with isolated core antibody, the cutoff representing immunity after the one vaccine dose (100 mIU/mL) is 10-fold higher than the 10 mIU/mL used to represent immunity following receipt of the HBV immunization series in persons who do not have isolated hepatitis B core antibody.[41] The recommended approach for persons with HIV is outlined below (Figure 7).[2,32]
    - Administer one standard dose of any hepatitis B vaccine and then test for anti-HBs titer 1-2 months post vaccine dose.
        - If the anti-HBs titer is greater than 100 mIU/mL, then no additional hepatitis B vaccine

doses are needed, and the person is considered immune to HBV.

- If the anti-HBs titer is less than 100 mIU/mL (or if quantitative antibody titers are not available), then administer a full hepatitis B vaccine series (using a 3-dose series of double-dose vaccine with *Engerix-B* or *Recombivax HB* or a 2-dose series with standard doses of *Heplisav-B*. At 1-2 months after completion of the vaccine series, a repeat anti-HBs titer should be ordered.

Human Papillomavirus (HPV) Vaccination

Background

Individuals with HIV have a high burden of human papillomavirus (HPV)-associated disease compared to persons who do not have HIV: genital warts are more common in women and men, abnormal cervical cytology is nearly 11 times more common in women, and anal cancer is approximately 30-fold higher among men.[42,43,44] Human papillomavirus vaccines are prepared from recombinant noninfectious virus-like particles and are considered safe for immunocompromised individuals since they do not pose any risk of transmitting infection (Figure 8).[45] Population-level analyses of large HPV vaccination programs have demonstrated a reduced prevalence of HPV subtypes responsible for cervical cancer and genital warts in adolescent girls and boys, thereby signaling a significant future benefit, both directly from immunization and indirectly through herd immunity.[46] Another study that examined the prevalence of vaccine-type oral HPV in a large sample of unvaccinated men, aged 18 to 59 years, noted a 37% decline between 2009-2010 and 2015-2016.[47] A population based study from Sweden found that quadrivalent HPV vaccination was associated with a substantially reduced risk of invasive cervical cancer in women between 10 and 30 years of age.[48] The study reported that the incidence of cervical cancer was reduced by 88% among women who were immunized before the age of 17 years, and by 53% in women immunized at 17 to 30 years of age, validating the benefit of HPV immunization.[48]

Vaccines

In the United States, the 9-valent (9vHPV) vaccine is the only HPV vaccine currently manufactured; this vaccine provides protection against 7 cancer-causing HPV serotypes (16, 18, 31, 33, 45, 52, and 58) and the 2 HPV serotypes 6 and 11, that cause genital warts (Figure 9).[49] The HPV serotypes 16 and 18 account for approximately 66% of cases of cervical cancer; the HPV serotypes 31, 33, 45, 52, and 58 combined account for approximately 15% of cervical cancers and 10% of invasive HPV-associated cancers.[49] The HPV serotypes 6 and 11 account for approximately 90% of genital warts.[49] The 9vHPV vaccine is FDA-approved for use for ages 9 through 45 years.[50] The use of HPV vaccination in persons with HIV is safe and effective, with seroconversion rates of 95% in men 18 years of age and older who received the quadrivalent vaccine and seroconversion rates of 92.3 to 100% among women with HIV aged 16 to 23 years who received the quadrivalent vaccine.[51,52]

Recommendations

The following summarizes the ACIP Adult Immunization Schedule and Adult and Adolescent OI Guidelines recommendation for administering the HPV vaccine to persons with HIV.[2,3]

- **General Approach**: The 9vHPV vaccine series should be given to all persons with HIV who are 9 through 26 years of age.[2,3] The 9vHPV vaccine is not routinely recommended for persons with HIV who are older than 26 years of age, but it can be considered in this age group using a shared decision-making process.[2]
- **Dosing Recommendation**: For persons with HIV, the HPV vaccination should be given in a 3-dose series (given at 0, 1-2, and 6 months).[2] A 2-dose schedule should not be used in persons with HIV.[2,3,53]
- **HPV Vaccine in Pregnancy**: The HPV vaccine is not recommended for pregnant women, but pregnancy testing is not needed prior to vaccination.[49] If a woman is found to be pregnant after receiving a dose of the HPV vaccine while she is pregnant, no intervention is needed. In addition, if a woman has started the vaccine series and becomes pregnant, the remainder of the 3-dose series should be delayed until completion of pregnancy. The largest HPV vaccine pregnancy registry to date shows no adverse signals, and at this time, pregnancy registries for the bivalent and quadrivalent vaccines have been closed.[49,54]
- **Use as Therapeutic Vaccine**: The HPV vaccine is not recommended for therapeutic purposes for

persons with HPV-related abnormal cervical or anal cytology.

Influenza Vaccination

Background

Influenza viruses typically circulate widely in the United States annually from the late autumn through early spring. Influenza A and influenza B are the types of viruses that cause human epidemic disease. New variants emerge due to frequent antigenic change (i.e., antigenic drift) resulting from point mutations and recombination events that occur during viral replication; antigenic drift is the virologic basis for seasonal epidemics and necessitates adjustment of the vaccine components each year.[55] Larger antigenic change, termed antigenic shift, has the potential to cause a worldwide pandemic since there is no preexisting immunity among humans to the novel virus in this situation. Annual influenza vaccination is the primary means of preventing influenza and its complications. Persons with HIV have a higher risk of influenza-associated morbidity and mortality compared to persons without HIV.[56] Studies in individuals with HIV suggest a single dose of inactivated vaccine generates a good humoral immune response, except in those with a low CD4 cell count.[7]

Vaccines

All adults with HIV, including pregnant women, can receive inactivated influenza vaccine (IIV4) or recombinant quadrivalent influenza vaccine (RIV4). The recommended inactivated and recombinant influenza vaccines are quadrivalent vaccines (containing two strains of both influenza A and B).[57] All influenza vaccines expected for availability in the United States for the 2024–25 season are trivalent vaccines containing hemagglutinin derived from (1) an influenza A/Victoria virus (for egg-based vaccines) or influenza A/Wisconsin (for cell culture-based and recombinant vaccines); (2) an influenza A/Thailand (for egg-based vaccines) or an influenza A/Massachusetts (for cell culture-based and recombinant vaccines); and (3) an influenza B/Austria (for both egg-based and cell culture-based).[58] In addition, a high-dose inactivated influenza vaccine (HD-IIV3) and a modified adjuvant inactivated influenza vaccine (aIIV3) are approved only for persons 65 years of age and older.[3,58] The live attenuated influenza vaccine (LAIV3), also known as the nasal spray flu vaccine, is not recommended for persons with HIV due to concern that attenuated virus could lead to influenza virus infection.

Recommendations

The following summarizes updated ACIP recommendation for administering influenza vaccine in the 2024-2025 season, including for persons with HIV.[58]

- **General Approach**: All people with HIV should receive a single annual dose of a trivalent influenza vaccine. In general, administering vaccine during July and August should be avoided, unless there is a concern that the person will not receive influenza vaccination later in the season.
- **Recommended Vaccines for People Younger than 65 Years of Age**: Recommended routine influenza vaccines for people with HIV who are younger than 65 years of age include any of the trivalent vaccines, except for those vaccines approved only for persons 65 years of age and older and the live attenuated influenza vaccine (LAIV3).
- **Pregnant Women**: Pregnant women with HIV can receive inactivated influenza vaccine or recombinant influenza vaccine at any time during pregnancy. Pregnant women in their third trimester can receive influenza vaccine in July or August.
- **Recommended Vaccines for persons 65 Years of Age and Older**: People with HIV who are 65 years of age and older should receive one of the following three vaccines: trivalent high-dose inactivated influenza vaccine (HD-IIV3), trivalent recombinant influenza vaccine (RIV3), or trivalent adjuvanted inactivated influenza vaccine (aIIV3). If none of these preferred vaccines are available, then any other age-appropriate influenza vaccine may be used, except for the live attenuated influenza vaccine (LAIV3).
- **Contraindicated Vaccine**: The live attenuated influenza vaccine (LAIV3) is contraindicated in all

people with HIV.

- **Persons with Egg Allergy**: The updated recommendations from ACIP now state that for persons with a history of egg allergy, any influenza vaccine (egg based or nonegg based) can be used, as long as the vaccine is otherwise appropriate for the recipient's age and health status.

Measles-Mumps-Rubella (MMR) Vaccination

Background

Measles, mumps, and rubella are highly contagious viruses that can cause a wide range of clinical manifestations, including congenital syndromes. Since the introduction of the measles-mumps-rubella (MMR) vaccine, the incidence of these viral diseases has decreased by 99%.[59] Nevertheless, despite good MMR vaccine coverage in the United States, outbreaks continue to occur. Between January 1 and December 31, 2019, more than 1,200 cases of measles were diagnosed in the United States, which is the largest number of annual cases reported in the United States since 1992 (Figure 10).[60] In the United States, for the years 2022 and 2023, there were 121 and 58 confirmed measles cases, respectively.[60]

Impact of Measles in Persons with HIV

Measles can cause significant morbidity and mortality in healthy individuals, and the impact is even greater in immunosuppressed persons, with one case report citing 40% mortality in patients with HIV.[59] Studies suggest that most individuals with HIV in the United States have adequate antibody titers to measles, although data from an ongoing observational cohort of United States Department of Defense beneficiaries found a seroprevalence of measles immunity of only 67%.[61] Adults born before 1957 are considered immune to measles.[62] Based on limited available data, the immunologic responses to the MMR vaccine among individuals with HIV are modest at best, and the protection of the vaccine in persons with HIV is not well established; MMR does not appear to have any significant detrimental impact on either CD4 count or HIV RNA levels.[61]

Measles Vaccines

In the United States, the MMR vaccine became available in 1971 and is still widely used. There is also an FDA-approved quadrivalent measles-mumps-rubella-varicella (MMRV) vaccine, but it is rarely used in adults. All currently used measles vaccines contain live attenuated measles virus, and thus pose a significant risk to severely immunocompromised individuals, including persons with HIV who have low CD4 cell counts. There have been case reports of fatal pneumonitis in persons with HIV and advanced immunosuppression who received the MMR vaccine.[63]

Recommendations

The following summarizes the ACIP Adult Immunization Schedule and Adult and Adolescent OI Guidelines recommendation for administering the MMR vaccine to persons with HIV.[2,3]

- **General Approach**: The MMR vaccine should only be administered to adults with HIV if (1) they lack immunity to measles, mumps, and rubella and (2) for at least 6 months, they have a CD4 count of at least 200 cells/mm^3 and a CD4 percentage of at least 15%.[3] Persons are considered to have immunity to measles if any of the following are met: they were born before 1957; they have documentation of receipt of the MMR vaccine, or they have laboratory evidence of immunity (**AIII**).[2]
- **Recommended Dosing Schedule**: Give the two-dose MMR vaccine series, with the doses administered at least 4 weeks apart.[2,3]
- **Quadrivalent Measles-Mumps-Rubella-Varicella (MMRV) Vaccine**: The quadrivalent MMRV vaccine is not recommended in persons with HIV, regardless of CD4 cell count.[28]
- **Persons with Advanced Immunodeficiency**: The MMR and MMRV vaccines are contraindicated in adults with HIV who have a CD4 count of less than 200 cells/mm^3 or a CD4 percentage of less than 15%.[2,3]
- **MMR in Pregnancy**: The MMR vaccine is contraindicated during pregnancy, and pregnancy should be avoided for 28 days after vaccination to minimize the theoretical risk of congenital rubella syndrome.[2] Pregnant women without evidence of rubella immunity who have a CD4 count of at least

200 cells/mm^3 and a CD4 percentage of at least 15% should receive the MMR vaccine upon completion of pregnancy.[2]

- **Persons who Received Measles Vaccine During 1963-1967**: Receipt of an inactivated measles vaccine, which was an option during 1963-1967 but was ineffective, does not count as a dose of measles vaccine.[62] In addition, if the type of measles vaccine received during 1963-1967, is not known, then it does not count as a dose.[62]
- **Vaccine Nonresponders**: There are some data that suggest persons with HIV have an attenuated antibody response to the MMR vaccine.[61,64,65] Currently, there is no guidance on whether to obtain post-MMR vaccine serologic titers to document vaccine response. If post-MMR vaccine titers are checked and demonstrate a lack of immunity, the recommendation is to consider repeating the 2-dose MMR series, especially if the person did not have suppressed HIV RNA levels at the time they received the MMR vaccine.[2]

Meningococcal Vaccination

Background

Meningococcal meningitis, which is caused by *Neisseria meningitidis*, can cause severe complications, including hearing loss, brain damage, and death. Available data from population studies suggest that persons with HIV have a 5- to 24-fold higher risk of developing meningococcal disease than persons without HIV; the highest risk in persons with HIV occurs in those with low CD4 cell counts and high HIV RNA levels.[2,66,67] In addition, several local outbreaks of meningococcal meningitis have been reported in the United States involving gay and bisexual men.[68,69,70] In 2023, the CDC reported an increase in meningococcal disease in persons with HIV, noting 29 cases in 2022 alone, with most of these cases involving persons who had not received meningococcal vaccination (Figure 11).[71] As with other vaccines given to individuals with HIV, a low CD4 count at the time of meningococcal immunization has been associated with decreased vaccine response rates.[72,73]

Vaccines

There are two quadrivalent meningococcal conjugate vaccines (MenACWY) covering groups A, C, W-135, and Y are licensed and available for use in the United States: MenACWY-CRM (*Menveo*) and MenACWY-TT (*MenQuadfi*).[67] The MenACWY vaccine is approved for use in persons 2 months through 55 years of age, and MenACWY-TT is approved for persons at least 2 years of age.[1,67] Two serogroup B meningococcal vaccines (MenB) are now available, including MenB-4C (*Bexero*), given as a 2-dose series and MenB-FHbp (*Trumemba*) given as a 3-dose series). Both of the MenB vaccines are approved for persons aged 10 years and older who have an increased risk for meningococcal disease. If both the Men-ACWY and Men-B vaccines are indicated for an individual with HIV, the vaccines can be administered simultaneously, but, if feasible, they should be administered at 2 different anatomic sites.[2,3]. In 2023, the FDA approved the first and only meningococcal pentavalent conjugate vaccine covering groups A, B, C, W and Y (*Penbraya*).

Recommendations

The following summarizes recommendations from the ACIP Adult Immunization Schedule and the Adult and Adolescent OI Guidelines for administering conjugate meningococcal vaccines to adolescents and adults with HIV (Figure 12).[2,3]

Meningococcal Conjugate Vaccine (A, C, W, Y)

- **General Approach**: Routine administration of either of the quadrivalent meningococcal conjugate vaccines (MenACWY-CRM and MenACWY-TT) is recommended for persons with HIV who are 18 years of age and older (**AII**).[2] If possible, the same meningococcal vaccine product should be used for all doses.[2,3,67]
- **Recommendations for Primary Vaccine Series**: For adults with HIV, the primary meningococcal vaccine series should consist of 2 doses given at least 8 weeks apart (**AII**).[2,3,67]
- **Previously Immunized Persons (Booster Recommendations)**: For individuals with HIV who have previously received the primary conjugate meningococcal vaccine series and are at least 7 years of age, a booster dose of the conjugate meningococcal vaccine should occur every 5 years (and not given within 5 years of the last dose of the primary meningococcal vaccine series) (**BIII**).[2]

Meningococcal B Vaccine

- **General Approach**: Administration of conjugate meningococcal B (MenB) vaccine is not routinely recommended for adults with HIV. The MenB vaccine may be administered to individuals with HIV if they have an additional indication for receiving meningococcal B vaccine, such as functional or anatomic asplenia,[3] persistent complement component deficiency, or receipt of a complement

inhibitor (e.g., eculizumab, ravulizumab).[2,3] The MenB vaccine should be avoided during pregnancy unless the woman is at increased risk of meningococcal infection. In addition, for those individuals 16–23 years of age with HIV, Men B vaccination may be given (using shared clinical decision-making) for short-term protection against most strains of serogroup B meningococcal disease and/or for patients at increased risk, such as those living in dormitories or barracks, and during meningococcal B outbreaks. The MenB vaccine should be avoided during pregnancy, unless the woman is at increased risk of meningococcal infection.

- **Dosing Recommendations**: If MenB-4C is used, 2 doses should be given at least 1 month apart.[2,3] If MenB-FHbp is used, then give 3 doses at 0, 1-2, and 6 months.[2,3] If the second dose of MenB-FHbp was administered 6 months after the first dose in the series, then a third dose is not required.[3] People with HIV should not receive the two-dose series of MenB-FHbp vaccine.[2] In addition, the MenB-4C and the MenB-FHbp should not be used interchangeably. Persons should receive one booster dose of the MenB vaccine 1 year after completing the initial vaccine series, followed by booster doses every 2 to 3 years if there is a persistent risk of meningococcal infection.[3]

Adults who Need to Receive Both MenACWY and MenB

For adults who need to receive both MenACWY and MenB vaccines, the ACIP Adult Immunization Schedule provides the option of administering a single dose of the pentavalent Men-ABCWY (*Penbraya*) vaccine instead of giving separate Men-ACWY and Men-B vaccines.[1] There are no data or recommendations for using the pentavalent meningococcal in persons with HIV.

Mpox Vaccination

Background

Mpox is caused by monkeypox virus—a double-stranded DNA virus closely related to smallpox virus.[74] In the 2022-2023 mpox outbreak in the United States, persons with HIV were disproportionately impacted, with roughly 40% of cases involving persons with HIV.[75,76] In addition, persons with HIV with mpox were more likely to require hospitalization, especially those with a CD4 count of less than 350 cells/mm^3 or who were not engaged in care.[75,77]

Vaccines

Currently, there are two vaccines available for orthopoxvirus infection prevention in the United States. *JYNNEOS, t*he Modified Vaccinia Ankara (MVA) vaccine, is an attenuated, non-replicating vaccinia virus vaccine approved for the prevention of mpox disease in those 18 years of age and older at high risk for mpox infection.[78] It is the preferred vaccine for mpox protection.[78] The second approved vaccine—ACAM2000—is a replication-competent smallpox vaccine that is contraindicated in persons with HIV and, therefore, will not be discussed further.[78] The CDC has established mpox vaccine Interim Clinical Considerations; these recommendations include extensive and detailed information about mpox vaccination.

Recommendations

For persons with HIV who have an indication for the mpox vaccine, vaccination is recommended regardless of prior smallpox vaccination status. The *JYNNEOS* vaccine, which is the only mpox vaccine recommended for persons with HIV, may be administered at the same time as any other vaccines, though ideally in different limbs. The *JYNNEOS* vaccine is safe to use in persons with HIV. Some experts recommend waiting 4 weeks after vaccination against COVID-19 because of the rare side effects of myocarditis or pericarditis associated with both of those vaccines. The following recommendations are for the *JYNNEOS* MVA vaccine, which is the mpox vaccine recommended for persons with HIV.[74] The following summarizes recommendations from the Adult and Adolescent OI Guidelines for administering mpox vaccines to adolescents and adults with HIV, including immunization before and after mpox exposure.[74]

Vaccination Before Mpox Exposure

- **Indications**: Mpox vaccination should be offered for persons with HIV who have the potential for mpox exposure or anticipate potential exposure to mpox. In addition, the mpox vaccine should be given to any person with HIV who requests vaccination.
- **Dosing**: Administer two doses of the *JYNNEOS* MVA vaccine, 0.1 mL intradermal or 0.5 mL subcutaneously, 28 days apart.

Vaccination Following Mpox Exposure

- **Indications**: For unvaccinated people with HIV who experience a known or presumed exposure, postexposure mpox vaccination is recommended as soon as possible, ideally within 4 days after exposure. Less preferably, the vaccine can be administered 4 to 14 days after exposure, since the vaccine may still provide some protection against mpox if administered during this time frame.
- **Dosing**: Administer two doses of the *JYNNEOS* MVA vaccine, 0.1 mL intradermal or 0.5 mL subcutaneously at least 28 days apart.(Figure 13)

Pneumococcal Vaccination

Background

In the general population, *Streptococcus pneumoniae* causes significant disease, including bacteremia, meningitis, and pneumonia, and is responsible for approximately 4,000 deaths each year in the United States. In the early years of the HIV epidemic, the risk of invasive pneumococcal disease in persons with HIV was approximately 20 times higher than in adults without high-risk conditions.[79] Subsequently, the incidence of invasive pneumococcal disease has decreased in persons with HIV, likely due to (1) the widespread use of potent antiretroviral therapy that resulted in improved immune function and improved humoral responses to pneumococcal antigens during clinical infections and (2) population herd protection against invasive strains of *S. pneumoniae* following the widespread use of conjugate pneumococcal vaccines in children since 2000.[80,81,82] A study that examined the risk of invasive pneumococcal disease in persons with HIV from 1996 through 2011 at a large integrated healthcare system in the United States reported a sevenfold increased risk of invasive pneumococcal disease in adults with HIV compared with adults without HIV.[83]

Efficacy of Pneumococcal Immunization in Persons with HIV

There are limited data that have addressed the efficacy of pneumococcal vaccination in persons with HIV. Retrospective studies indicate the 23-valent pneumococcal polysaccharide vaccine (PPSV23) alone has modest clinical benefit, if any, in reducing rates of pneumococcal infections in persons with HIV.[84,85] There are no published trials using the 13-valent pneumococcal conjugate vaccine (PCV13) in adults with HIV, but a randomized controlled trial in Malawi that used two doses of PCV7 given 1 month apart in 496 adults (88% with HIV) demonstrated a vaccine efficacy of 74% in preventing invasive pneumococcal disease; this study included a large number of patients with a CD4 count less than 200 cells/mm^3.[86] The safety and immunogenicity of PCV15 compared to PCV13 was evaluated in approximately 300 adults with HIV in a phase 3, randomized, controlled clinical trial conducted at multiple sites internationally.[87] This study demonstrated the PCV15 vaccine was well tolerated and induced adequate antibody responses to all 15 pneumococcal serotypes included in the vaccine.[87,88] The PCV20 has also been shown to be safe and immunogenic in clinical trials involving adults with some medical conditions, but HIV and other immunocompromising conditions were excluded from the study.[88]

Vaccines

Four pneumococcal vaccines are currently available for use in the United States: PCV15, PCV20, and PCV21, and PPSV23.[79,88] The PCV15, PCV20, and PCV21 are conjugate vaccines that provide more robust and longer lasting immune responses than the PPSV23 polysaccharide vaccine.[88] The PCV20 and PCV21 require one dose only; there are no additional doses needed.[88,89] The PCV20 vaccine includes the same 15 serotypes as in the PCV15 plus 5 additional serotypes. The PCV21 vaccine contains 8 serotypes not included in PCV15, PCV20, or PPSV23, but PCV21 does not contain pneumococcal serotype 4.[89] Note that pneumococcal serotype 4 is prominent in certain populations and regions in the western United States, especially in Alaska, Colorado, the Navajo Nation, New Mexico, and Oregon.[89] The PCV15 is administered as a single dose followed by one PPSV23 dose given at least 8 weeks later; no additional doses are recommended after that.

Recommendations

The following summarizes recommendations from Adult and Adolescent OI Guidelines and ACIP Adult Immunization Schedule recommendations for pneumococcal immunization in persons with HIV, with the exact schedule based on age and whether the individual has previously received pneumococcal vaccine.[2,3] Note the PCV21 vaccine was recently FDA-approved, but recommendations for use in persons with HIV have not yet been established in the Adult and Adolescent OI Guidelines.[2]

General Approach

- Initial pneumococcal immunization for persons with HIV should now utilize the newer conjugate vaccines— PCV15 or PCV20 (**AII**).[2,3] If PCV15 is given, a dose of PPSV23 should be administered at least 8 weeks later (**AII**).[2,3] These new recommendations for pneumococcal immunization in persons with HIV provide a markedly simplified approach compared with older recommendations.

No Prior Pneumococcal Immunization

Adults with HIV who have never received a pneumococcal vaccine (or their pneumococcal immunization status is unknown) should receive either (1) a single dose of of PCV20, or (2) a single dose of PCV15 followed by a dose of PPSV23 at least 8 weeks later (**AII**) (Figure 14).[2,3] Regardless of which of these two approaches is used, no further doses of pneumococcal vaccine are needed.[2,88]

Prior Pneumococcal Immunization

In persons who have received at least one dose of a prior pneumococcal vaccine, the approach, options, and timing for completing the pneumococcal vaccine schedule depend on what prior vaccine was administered (Figure 15).[2]

- **Prior Receipt of PCV13 Only**: For persons with HIV who have received PCV13 only, there are two options:
    - Give 1 dose of PCV20 at least 1 year after the PCV13 dose (**BIII**), *or*
    - Complete the recommended older pneumococcal vaccine schedule and given the remaining additional doses of PPSV23 (one dose PPSV23 at least 8 weeks after the dose of PCV13, followed by PPSV23 at least 5 years after the first dose of PPSV23, followed by receipt of a final dose of PPSV23 after age 65 years and at least 5 years after the prior dose of PPSV23) (**BIII**)
- **Prior Receipt of PCV13 and One or More Doses of PPSV23**: For people with HIV who have received PCV13 and at least 1 dose of PPSV23, but have not completed the vaccine series, two options exist:
    - Give 1 dose of PCV20 at least 5 years after the last PPSV23 dose (**CIII**), *or*
    - Complete the recommended older pneumococcal vaccine schedule and give the remaining additional doses of PPSV23 (**BIII**).
- **Prior Receipt of PPSV23 Only**: For persons with HIV who have received one or more doses of PPSV23 previously without receiving PCV13, the recommenced approach is to receive one dose of PCV20 or PCV15, with this dose given at least 1 year after the prior dose of PPSV23.

Prior Completion of Vaccine Series

For people with HIV who have received PCV13 and all the recommended doses of PPSV23, including a dose after 65 years of age, two options exist (shared clinical decision-making should be used):

- Consider the vaccine series complete and give no further pneumococcal vaccine doses (**CIII**), *or*
- Give 1 dose of PCV20 at least 5 years after the last PPSV23 dose (**CIII**)

Tetanus, Diphtheria and Pertussis (Tdap) Vaccination

Background

Tetanus, diphtheria, and pertussis are vaccine-preventable bacterial diseases that can lead to serious complications. Tetanus (lockjaw) can potentially cause muscle paralysis and carries a 20% mortality rate. Diphtheria causes a thick coating to form in the posterior pharynx that can lead to breathing difficulty, and, in some instances, death. Pertussis (whooping cough) causes severe coughing spells that can lead to pneumonia, hypoxia, sleeping problems, and rarely death. Widespread childhood vaccination has markedly reduced the number of serious complications related to tetanus, diphtheria, and pertussis in the United States among all age groups. Although the pertussis vaccine has reduced the incidence of pertussis compared with the prevaccine era, the number of reported cases of pertussis has increased since the 1980s, primarily due to the lack of long-term immunity with the pertussis vaccine.[90] Most individuals with HIV mount adequate antibody responses to tetanus and diphtheria toxins, but responses are often lower among those with CD4 count of less than 300 cells/mm^3.[7,91]

Vaccines

Several tetanus and diphtheria toxoid vaccines (Td) are currently licensed by the FDA.[90] In addition, two tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) vaccines are approved by the FDA: *Boostrix* (for persons aged 10 and older) and *Adacel* (for persons aged 11 to 64 years). Both the Tdap and Td vaccines contain inactivated bacteria and thus are unlikely to pose any risk to individuals with HIV. When the Tdap vaccine was initially licensed, concern existed regarding the safety of administering the Tdap vaccine within 5 years of the Td vaccine. Subsequently, studies reported that administering the Tdap to an individual who had recently received Td (21 days to 2 years) was safe, other than a mild local reaction.[90,92]

Recommendations

The following summarizes recommendations from the ACIP Adult Immunization Schedule and Adult and Adolescent OI Guidelines for administering Tdap and Td for adults with HIV.[2,3]

- **General Approach**: Adults and adolescents with HIV should receive immunization with Tdap and Td per the same schedule as nonpregnant adults without HIV.[2,3] The timing and dosing of the Tdap and Td vaccination in persons with HIV is not altered based on CD4 cell count.
- **No Prior Tdap**: For adults and adolescents with HIV who have not received the primary vaccination series for tetanus, diphtheria, or pertussis, give an initial three-dose series consisting of one dose Tdap, followed by one dose Td or Tdap at least 4 weeks after Tdap, and another dose Td or Tdap 6 months to 12 months after the last Td or Tdap.
- **No Tdap After Age 11 Years**: For adults and adolescents with HIV who received the primary vaccine series for tetanus, diphtheria, or pertussis, but have not received a dose of Tdap after age 11 years, give a one-time dose of Tdap, followed by a Td or Tdap booster every 10 years (**AII**).[2] Adults and adolescents who previously received Td but have not had a Tdap dose should receive the Tdap vaccine regardless of the interval since Td was last administered.
- **Tdap During Pregnancy**: Give Tdap during every pregnancy in persons with HIV to prevent pertussis morbidity and mortality in infants. The dose of Tdap should be given preferably during gestational weeks 27 to 36, and it should be administered regardless of the pregnant woman’s prior history of receiving Tdap.[2,3]

Varicella Vaccination

Background

Varicella-zoster virus (VZV), or the chickenpox virus, is a highly contagious virus that causes rash, fever, and potentially severe, disseminated disease in persons with weakened immune systems. Prior to the introduction of the varicella vaccine and the incorporation of this vaccine into the routine childhood immunization schedule, chickenpox was very common in the United States general population, causing infection in more than 4 million persons each year. Primary varicella-zoster virus infection is uncommon in adults with HIV since most have acquired immunity through childhood infection.[93]

Vaccine

The varicella vaccine is a live attenuated vaccine that poses a significant risk to persons with HIV who have advanced immunosuppression. The duration of protection from varicella vaccine is not known. In addition to providing protection against primary varicella infection, the varicella vaccine has also been shown in studies to reduce the risk of herpes zoster (when compared with wild-type infection).[94,95]

Recommendations

The following summarizes recommendations from the ACIP Adult Immunization Schedule and the Adult and Adolescent OI Guidelines for administering varicella vaccine to adults with HIV.[1,93]

- **General Approach**: The Adult and Adolescent OI Guidelines recommend adults with HIV should receive varicella vaccine if (1) they do not have immunity to VZV, and (2) they have a CD4 count of at least 200 cells/mm^3 and a CD4 percentage of at least 15%.[2] If all of these criteria are met, the ACIP Adult Immunization Schedule recommends considering administering varicella vaccine based a shared decision-making process.[3] The varicella vaccine does not need to be given to those born in the United States before 1980 (except health care personnel), or to those with VZV immunity.
- **Varicella Serologic Screening**: To identify persons with HIV who lack immunity to VZV, some experts would obtain varicella antibody titers (quantitative IgG) if the individual does not have any of the following: prior varicella immunization, prior clinical varicella (or zoster) infection, or a documented protective varicella IgG titer. The varicella titer does not have optimal sensitivity, especially in persons who have previously received the varicella vaccine.
- **Dosing Recommendation**: Two doses of varicella vaccine should be given at least 3 months apart.
- **Varicella Vaccine in Pregnancy**: The varicella vaccine is contraindicated during pregnancy, regardless of HIV status. Pregnant women without evidence of varicella immunity and a CD4 count of at least 200 cells/mm^3 and a CD4 percentage of at least 15% should receive (or complete) the varicella vaccine series upon completion of pregnancy and before discharge from the health facility; varicella vaccine for these women should be administered as outlined, regardless of whether they were born in the United States before 1980.
- **Contraindications**: Varicella vaccine is contraindicated in persons with HIV who have a CD4 count of less than 200 cells/mm^3 or a CD4 percentage of less than 15%. In addition, as noted above, the varicella vaccine is contraindicated in pregnant women. Further, the quadrivalent measles-mumps-rubella-varicella vaccine is not recommended for individuals with HIV. The zoster vaccine should not be used interchangeably with the varicella vaccine.

Zoster Vaccination

Background

Although primary varicella-zoster virus infection is unusual in persons with HIV, the incidence of zoster among adults with HIV who are not receiving antiretroviral therapy is at least 15-fold higher than among age-matched immunocompetent adults, and the risk is highest in persons with a CD4 count less than 200 cells/mm^3.[93,96,97] Individuals with HIV have an additional increased risk in the first 4 months after starting effective antiretroviral therapy, likely as a result of immune reconstitution.[98] Following the widespread use of potent antiretroviral therapy, the incidence rate of zoster has markedly decreased compared with the early years of the HIV epidemic.[99] Zoster is typically limited to a painful, dermatomal vesicular rash but can result in severe and complicated disease in adults with HIV, especially those with a low CD4 count.[100] The goal of using the zoster vaccine in persons with HIV is twofold: prevent zoster and reduce the severity of zoster if it does occur.

Zoster Vaccines

There are two zoster vaccines that have been approved for use in the United States: recombinant zoster vaccine (RZV) and zoster vaccine live (ZVL). The RZV vaccine contains varicella-zoster glycoprotein E combined with a novel adjuvant ($AS01_B$), whereas ZVL contains high titers of attenuated live varicella-zoster virus (Figure 16).[101,102] As of June 30, 2020, the ZVL vaccine was no longer manufactured and sold in the United States. Therefore, the following discussion will address only the RZV vaccine. The RZV is licensed as a 2-dose vaccine series, given 2 to 6 months apart (minimum interval allowed 4 weeks).[1,102] In July 2021, the FDA expanded the indicated use of RZV to include individuals aged 18 years and older who are or will be at increased risk of developing herpes zoster because of immunodeficiency or immunosuppression.[103] The RZV has shown efficacy of greater than 95% in preventing herpes zoster in phase 3 trials that enrolled immunocompetent older adults.[104,105,106] A phase 1/2a trial evaluated RZV in persons with HIV and found it was safe and immunogenic, but this trial did not evaluate the impact of RZV in preventing zoster.[107] Giving RZV to persons who previously received ZVL may provide a significant benefit. The RZV does not contain live varicella-zoster virus and, therefore, poses no risk of causing varicella-zoster infection.

Recommendations

The following summarizes recommendations in the Adult and Adolescent OI Guidelines for the use of RZV in persons with HIV.[2]

- **General Approach**: The RZV is recommended for adults with HIV who are 18 years of age or older, regardless of previous zoster history or previous receipt of ZVL. This vaccine is considered safe regardless of the CD4 cell count.
- **Vaccine Schedule**: The RZV vaccine should be administered as a 2-dose series given 2 months apart (Figure 17) (**AIII**). The two-dose series should ideally be administered 2 to 6 months apart; if more than 6 months have elapsed by the second dose, the RZV series does not need to be restarted. If, however, the second dose is administered sooner than 4 weeks after the first dose, then another (third) RZV dose should be administered (more than 4 weeks after the dose that was given too early).[103]
- **Timing of Vaccine Administration**: In general, the RZV vaccine is recommended regardless of CD4 count. To maximize immunologic response to the vaccine, some experts recommend delaying vaccination until the individual has started antiretroviral therapy and (1) achieved virologic suppression and/or (2) obtained immune reconstitution, with a CD4 count recovery of at least 200 cells/mm^3 (**CIII**).
- **Prior History of Zoster**: The RZV vaccine is recommended regardless of whether the person with HIV has a history of zoster, but the RZV vaccine should not be given during an episode of acute herpes zoster (**AIII**).

- **Prior Receipt of ZVL**: If an individual with HIV has previously received ZVL, they should undergo revaccination and receive the standard two-dose series of RZV.
- **Contraindications**: The RZV vaccine should be deferred in women who are pregnant, women who are breastfeeding, or anyone who has a current episode of herpes zoster.[103]

Travel Vaccines

Background

An estimated 8% of travelers to resource-limited regions of the world require treatment during travel, and major disease risks include vaccine-preventable illnesses.[108] Vaccines related to travel are generally not part of the initial evaluation process of persons with HIV. Many persons with HIV may, at some point, travel to regions of the world that require multiple preventive vaccinations, such as typhoid fever, cholera, yellow fever virus, Japanese encephalitis virus, and rabies virus. Recommendations for appropriate travel-related vaccines can be very complex and depend on numerous factors, including the immune status of the person with HIV, the specific region of travel, and the types of exposure likely to occur in that region.[109]

Recommendations

All persons with HIV who are planning international travel should undergo an evaluation by a medical provider who has expertise in travel-related issues, and this travel evaluation should occur well in advance of the travel date to allow time for all appropriate immunizations to be given. The CDC provides an online resource for general information regarding HIV and travel.[109,110] The Adult and Adolescent OI Guidelines provide information for vaccines to prevent cholera, typhoid, and yellow fever.[2]

Contraindicated Vaccines

The following summarizes vaccines that are available in the United States that are contraindicated in some or all adolescents and adults with HIV.[2] In general, caution should be exerted when considering the use of a live vaccine in any person with HIV.

The following live vaccines are contraindicated in all people with HIV regardless of CD4 cell count.

- Live intranasal influenza vaccine (LAIV) (*FluMist*)
- Live smallpox/mpox vaccine (ACAM2000) vaccine
- Quadrivalent measles-mumps-rubella-varicella vaccine

The following live vaccines are contraindicated in adults with HIV who have a CD4 count less than 200 cells/mm^3, a CD4 percentage less than 15%, or uncontrolled HIV.

- Live attenuated oral Typhoid vaccine (*Vivotif*)
- Live measles, mumps, and rubella (MMR) vaccine
- Live varicella vaccine (*Varivax*)
- Live yellow fever vaccine (*YF-VA*X) due to the theoretical risk of developing encephalitis in severely immunocompromised patients

The following live vaccine has inadequate safety and efficacy data in persons with HIV.

- Live cholera vaccine (lyophilized CVD 103-HgR) (*Vaxchora*)

The following live vaccine is considered safe in adults with HIV.

- Live smallpox/mpox vaccine (*JYNNEOS*): this vaccine contains nonreplicating virus and is considered safe to give to adults with HIV, regardless of CD4 cell count.

Summary Points

- Immune responses to vaccinations among persons with HIV are enhanced in persons with higher levels of CD4 cell counts and with suppressed HIV RNA levels while taking antiretroviral therapy.
- Hepatitis A vaccine is recommended for all persons with HIV who are not immune to HAV. Postvaccination antibody testing should be performed 1 to 2 months after completion of the primary hepatitis A vaccine series.
- When giving the hepatitis B vaccine to adults with HIV, the preferred initial option is to use 2 doses of *Heplisav-B*. Postvaccination antibody titers should be checked 1 to 2 months after completion of the primary hepatitis B vaccine series.
- Three doses of 9vHPV should be administered to all persons with HIV who are 9 through 26 years of age. For persons with HIV who are 27 through 45 years of age, shared decision-making should be used to determine whether to administer this vaccine.
- All adults with HIV should receive two doses of conjugate meningococcal vaccine and booster doses every 5 years thereafter.
- MMR and varicella vaccines are indicated for asymptomatic persons with HIV who have a CD4 count of at least 200 cells/mm^3 and a CD4 percentage of at least 15%, if they lack immunity to these vaccine-preventable viruses.
- Mpox vaccination should be offered for persons with HIV who are at risk for Mpox exposure.
- Pneumococcal vaccine-naïve persons should receive a single dose of either PCV15 or PCV20. If they receive PCV15, a follow-up dose of PPSV23 should be given at least 8 weeks later. Persons who have received PCV13, but have not completed the series of PPSV23 doses, should complete the vaccine with PCV20 or complete those doses as originally planned.
- Two doses of RZV are recommended for persons with HIV who are 18 years of age and older, regardless of CD4 cell count and prior history of zoster.
- Some live virus vaccines are contraindicated in all persons with HIV, and other live vaccines are contraindicated in persons with HIV who have a CD4 count of less than 200 cells/mm^3.
- Persons with HIV who plan to travel outside the United States should undergo an evaluation by a medical provider who has expertise in travel-related issues well in advance of planned travel. Some travel vaccines are contraindicated in persons with HIV.

Citations

1. Advisory Committee on Immunization Practices (ACIP). Recommended Immunization Schedule for Ages 19 Years or Older, United States, 2025.
[ACIP] -

2. Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Immunizations for Preventable Diseases in Adults and Adolescents Living with HIV. Last updated: December 16, 2024.
[HIV.gov] -

3. Advisory Committee on Immunization Practices (ACIP). Recommended Adult Immunization Schedule by Medical Condition and Other Indications, United States, 2025.
[ACIP] -

4. Centers for Disease Control and Prevention. Vaccines in the Adult Immunization Schedule.
[CDC] -

5. Su JR, Ng C, Lewis PW, Cano MV. Adverse events after vaccination among HIV-positive persons, 1990-2016. PLoS One. 2018;13:e0199229.
[PubMed Abstract] -

6. Kemper CA, Haubrich R, Frank I, Dubin G, Buscarino C, McCutchan JA, Deresinski SC; California Collaborative Treatment Group. Safety and immunogenicity of hepatitis A vaccine in human immunodeficiency virus-infected patients: a double-blind, randomized, placebo-controlled trial. J Infect Dis. 2003;187:1327-31.
[PubMed Abstract] -

7. Kroon FP, van Dissel JT, de Jong JC, van Furth R. Antibody response to influenza, tetanus and pneumococcal vaccines in HIV-seropositive individuals in relation to the number of CD4+ lymphocytes. AIDS. 1994;8:469-76.
[PubMed Abstract] -

8. Lange CG, Lederman MM, Medvik K, Asaad R, Wild M, Kalayjian R, Valdez H. Nadir CD4+ T-cell count and numbers of CD28+ CD4+ T-cells predict functional responses to immunizations in chronic HIV-1 infection. AIDS. 2003;17:2015-23.
[PubMed Abstract] -

9. Wong EK, Bodsworth NJ, Slade MA, Mulhall BP, Donovan B. Response to hepatitis B vaccination in a primary care setting: influence of HIV infection, CD4+ lymphocyte count and vaccination schedule. Int J STD AIDS. 1996;7:490-4.
[PubMed Abstract] -

10. Tesoriero JM, Swain CE, Pierce JL, et al. COVID-19 Outcomes Among Persons Living With or Without Diagnosed HIV Infection in New York State. JAMA Netw Open. 2021;4:e2037069.
[PubMed Abstract] -

11. Dandachi D, Geiger G, Montgomery MW, et al. Characteristics, Comorbidities, and Outcomes in a Multicenter Registry of Patients With Human Immunodeficiency Virus and Coronavirus Disease 2019. Clin Infect Dis. 2021;73:e1964-e1972.
[PubMed Abstract] -

12. Bhaskaran K, Rentsch CT, MacKenna B, et al. HIV infection and COVID-19 death: a population-based cohort analysis of UK primary care data and linked national death registrations within the OpenSAFELY platform. Lancet HIV. 2021;8:e24-e32.
[PubMed Abstract] -

13. Ssentongo P, Heilbrunn ES, Ssentongo AE, et al. Epidemiology and outcomes of COVID-19 in HIV-infected individuals: a systematic review and meta-analysis. Sci Rep. 2021;11:6283.
[PubMed Abstract] -

14. Baden LR, El Sahly HM, Essink B, et al. Efficacy and Safety of the mRNA-1273 SARS-CoV-2 Vaccine. N Engl J Med. 2021;384:403-16.
[PubMed Abstract] -

15. Thompson MG, Stenehjem E, Grannis S, et al. Effectiveness of Covid-19 Vaccines in Ambulatory and Inpatient Care Settings. N Engl J Med. 2021;385:1355-71.
[PubMed Abstract] -

16. Dolgin E. The tangled history of mRNA vaccines. Nature. 2021;597:318-24.
[PubMed Abstract] -

17. U.S. Food and Drug Administration. FDA Approves and Authorizes Updated mRNA COVID-19 Vaccines to Better Protect Against Currently Circulating Variants. August 22, 2024.
[U.S. FDA] -

18. Centers for Disease Control and Prevention. Use of COVID-19 Vaccines in the United States. Interim Clinical Considerations. Last updated September 6, 2024.
[CDC] -

19. Farley MM, Stephens DS, Brachman PS Jr, Harvey RC, Smith JD, Wenger JD. Invasive *Haemophilus influenzae* disease in adults. A prospective, population based surveillance. CDC Meningitis Surveillance Group. Ann Intern Med. 1992;116:806-12.
[PubMed Abstract] -

20. Briere EC, Rubin L, Moro PL, Cohn A, Clark T, Messonnier N. Prevention and control of haemophilus influenzae type b disease: recommendations of the advisory committee on immunization practices (ACIP). MMWR Recomm Rep. 2014;63:1-14.
[MMWR] -

21. Kroon FP, van Dissel JT, Rijkers GT, Labadie J, van Furth R. Antibody response to *Haemophilus influenzae* type b vaccine in relation to the number of CD4+ T lymphocytes in adults infected with human immunodeficiency virus. Clin Infect Dis. 1997;25:600-6.
[PubMed Abstract] -

22. Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Community-acquired-pneumonia. Last updated: September 7, 2022.
[HIV.gov] -

23. Matheny SC, Kingery JE. Hepatitis A. Am Fam Physician. 2012;86:1027-34.
[PubMed Abstract] -

24. Foster MA, Hofmeister MG, Kupronis BA, et al. Increase in Hepatitis A Virus Infections - United States, 2013-2018. MMWR Morb Mortal Wkly Rep. 2019;68:413-5.
[PubMed Abstract] -

25. Centers for Disease Control and Prevention (CDC). 2022 Viral Hepatitis Surveillance Report—Hepatitis A Surveillance 2022. Published April 2024.
[CDC] -

26. Wallace MR, Brandt CJ, Earhart KC, Kuter BJ, Grosso AD, Lakkis H, Tasker SA. Safety and immunogenicity of an inactivated hepatitis A vaccine among HIV-infected subjects. Clin Infect Dis. 2004;39:1207-13.
[PubMed Abstract] -

27. Nelson NP, Weng MK, Hofmeister MG, et al. Prevention of Hepatitis A Virus Infection in the United States: Recommendations of the Advisory Committee on Immunization Practices, 2020. MMWR Recomm Rep. 2020;69:1-38.
[PubMed Abstract] -

28. Rubin LG, Levin MJ, Ljungman P, et al. 2013 IDSA clinical practice guideline for vaccination of the immunocompromised host. Clin Infect Dis. 2014;58:309-18.
[PubMed Abstract] -

29. Brennan J, Moore K, Sizemore L, et al. Notes from the Field: Acute Hepatitis A Virus Infection Among Previously Vaccinated Persons with HIV Infection - Tennessee, 2018. MMWR Morb Mortal Wkly Rep. 2019;68:328-9.
[PubMed Abstract] -

30. Huang SH, Huang CH, Wang NC, et al. Early Seroreversion After 2 Doses of Hepatitis A Vaccination in Human Immunodeficiency Virus-Positive Patients: Incidence and Associated Factors. Hepatology. 2019;70:465-75.
[PubMed Abstract] -

31. Thio CL, Seaberg EC, Skolasky R Jr, et al. HIV-1, hepatitis B virus, and risk of liver-related mortality in the Multicenter Cohort Study (MACS). Lancet. 2002;360:1921-6.
[PubMed Abstract] -

32. Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Hepatitis B virus infection. Last Updated: December 16, 2024.
[HIV.gov] -

33. Schillie S, Harris A, Link-Gelles R, Romero J, Ward J, Nelson N. Recommendations of the Advisory Committee on Immunization Practices for Use of a Hepatitis B Vaccine with a Novel Adjuvant. MMWR Morb Mortal Wkly Rep. 2018;67:455-458.
[PubMed Abstract] -

34. Kim HN, Harrington RD, Crane HM, Dhanireddy S, Dellit TH, Spach DH. Hepatitis B vaccination in HIV-infected adults: current evidence, recommendations, and practical considerations. Int J STD AIDS. 2009;20:595-600.
[PubMed Abstract] -

35. Whitaker JA, Rouphael NG, Edupuganti S, Lai L, Mulligan MJ. Strategies to increase responsiveness to

hepatitis B vaccination in adults with HIV-1. Lancet Infect Dis. 2012;12:966-76.
[PubMed Abstract] -

36. Wiedmann M, Liebert UG, Oesen U, et al. Decreased immunogenicity of recombinant hepatitis B vaccine in chronic hepatitis C. Hepatology. 2000;31:230-4.
[PubMed Abstract] -

37. Rey D, Krantz V, Partisani M, et al. Increasing the number of hepatitis B vaccine injections augments anti-HBs response rate in HIV-infected patients. Effects on HIV-1 viral load. Vaccine. 2000;18:1161-5.
[PubMed Abstract] -

38. Launay O, van der Vliet D, Rosenberg AR, et al. Safety and immunogenicity of 4 intramuscular double doses and 4 intradermal low doses vs standard hepatitis B vaccine regimen in adults with HIV-1: a randomized controlled trial. JAMA. 2011;305:1432-40.
[PubMed Abstract] -

39. Marks KM, Kang M, Umbleja T, et al. Immunogenicity and Safety of Hepatitis B Virus (HBV) Vaccine With a Toll-Like Receptor 9 Agonist Adjuvant in HBV Vaccine-Naïve People With Human Immunodeficiency Virus. Clin Infect Dis. 2023;77:414-8.
[PubMed Abstract] -

40. Marks KM, Kang M, Umbleja T, et al. HepB-CpG vs HepB-Alum Vaccine in People With HIV and Prior Vaccine Nonresponse: The BEe-HIVe Randomized Clinical Trial. JAMA. 2024 Dec 1:e2424490. Online ahead of print.
[PubMed Abstract] -

41. Piroth L, Launay O, Michel ML, et al. Vaccination Against Hepatitis B Virus (HBV) in HIV-1-Infected Patients With Isolated Anti-HBV Core Antibody: The ANRS HB EP03 CISOVAC Prospective Study. J Infect Dis. 2016;213:1735-42.
[PubMed Abstract] -

42. Aberg JA, Gallant JE, Ghanem KG, Emmanuel P, Zingman BS, Horberg MA. Primary care guidelines for the management of persons infected with HIV: 2013 update by the HIV medicine association of the Infectious Diseases Society of America. Clin Infect Dis. 2014;58:e1-34.
[HIVMA] -

43. Gaisa M, Sigel K, Hand J, Goldstone S. High rates of anal dysplasia in HIV-infected men who have sex with men, women, and heterosexual men. AIDS. 2014;28:215-22.
[PubMed Abstract] -

44. Simard EP, Pfeiffer RM, Engels EA. Spectrum of cancer risk late after AIDS onset in the United States. Arch Intern Med. 2010;170:1337-45.
[PubMed Abstract] -

45. Schiller JT, Davies P. Delivering on the promise: HPV vaccines and cervical cancer. Nat Rev Microbiol. 2004;2:343-7.
[PubMed Abstract] -

46. Drolet M, Bénard É, Pérez N, Brisson M. Population-level impact and herd effects following the introduction of human papillomavirus vaccination programmes: updated systematic review and meta-analysis. Lancet. 2019;394:497-509.
[PubMed Abstract] -

47. Chaturvedi AK, Graubard BI, Broutian T, et al. Prevalence of Oral HPV Infection in Unvaccinated Men

and Women in the United States, 2009-2016. JAMA. 2019;322:977-9.
[PubMed Abstract] -

48. Lei J, Ploner A, Elfström KM, et al. HPV Vaccination and the Risk of Invasive Cervical Cancer. N Engl J Med. 2020;383:1340-8.
[PubMed Abstract] -

49. Petrosky E, Bocchini JA Jr, Hariri S, et al. Use of 9-Valent Human Papillomavirus (HPV) Vaccine: Updated HPV Vaccination Recommendations of the Advisory Committee on Immunization Practices. MMWR Morb Mortal Wkly Rep. 2015;64:300-4.
[PubMed Abstract] -

50. U.S. Food and Drug Administration. FDA News Release: FDA approves expanded use of Gardasil 9 to include individuals 27 through 45 years old.
[U.S. FDA] -

51. Kahn JA, Xu J, Kapogiannis BG, et al. Immunogenicity and safety of the human papillomavirus 6, 11, 16, 18 vaccine in HIV-infected young women. Clin Infect Dis. 2013;57:735-44.
[PubMed Abstract] -

52. Wilkin T, Lee JY, Lensing SY, et al. Safety and immunogenicity of the quadrivalent human papillomavirus vaccine in HIV-1-infected men. J Infect Dis. 2010;202:1246-53.
[PubMed Abstract] -

53. Meites E, Kempe A, Markowitz LE. Use of a 2-Dose Schedule for Human Papillomavirus Vaccination - Updated Recommendations of the Advisory Committee on Immunization Practices. MMWR Morb Mortal Wkly Rep. 2016;65:1405-8.
[PubMed Abstract] -

54. Goss MA, Lievano F, Buchanan KM, Seminack MM, Cunningham ML, Dana A. Final report on exposure during pregnancy from a pregnancy registry for quadrivalent human papillomavirus vaccine. Vaccine. 2015;33:3422-8.
[PubMed Abstract] -

55. Grohskopf LA, Olsen SJ, Sokolow LZ, et al. Prevention and control of seasonal influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices (ACIP) -- United States, 2014-15 influenza season. MMWR Morb Mortal Wkly Rep. 2014;63:691-7.
[MMWR] -

56. Lin JC, Nichol KL. Excess mortality due to pneumonia or influenza during influenza seasons among persons with acquired immunodeficiency syndrome. Arch Intern Med. 2001;161:441-6.
[PubMed Abstract] -

57. Grohskopf LA, Alyanak E, Ferdinands JM, et al. Prevention and Control of Seasonal Influenza with Vaccines: Recommendations of the Advisory Committee on Immunization Practices, United States, 2021-22 Influenza Season. MMWR Recomm Rep. 2021;70:1-28.
[PubMed Abstract] -

58. Grohskopf LA, Ferdinands JM, Blanton LH, Broder KR, Loehr J. Prevention and Control of Seasonal Influenza with Vaccines: Recommendations of the Advisory Committee on Immunization Practices — United States, 2024–25 Influenza Season. MMWR Recomm Rep. 2024:73;1–25.
[CDC] -

59. Watson JC, Hadler SC, Dykewicz CA, Reef S, Phillips L. Measles, mumps, and rubella--vaccine use and

strategies for elimination of measles, rubella, and congenital rubella syndrome and control of mumps: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep. 1998;47(RR-8):1-57.
[MMWR] -

60. Centers for Disease Control and Prevention. Measles Cases and Outbreaks.
[CDC] -

61. Stermole BM, Grandits GA, Roediger MP, et al. Long-term safety and serologic response to measles, mumps, and rubella vaccination in HIV-1 infected adults. Vaccine. 2011;29:2874-80.
[PubMed Abstract] -

62. McLean HQ, Fiebelkorn AP, Temte JL, Wallace GS. Prevention of measles, rubella, congenital rubella syndrome, and mumps, 2013: summary recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep. 2013;62:1-34.
[PubMed Abstract] -

63. Angel JB, Walpita P, Lerch RA, et al. Vaccine-associated measles pneumonitis in an adult with AIDS. Ann Intern Med. 1998;129:104-6.
[PubMed Abstract] -

64. Scott P, Moss WJ, Gilani Z, Low N. Measles vaccination in HIV-infected children: systematic review and meta-analysis of safety and immunogenicity. J Infect Dis. 2011;204 Suppl 1:S164-78.
[PubMed Abstract] -

65. Sprauer MA, Markowitz LE, Nicholson JK, et al. Response of human immunodeficiency virus-infected adults to measles-rubella vaccination. J Acquir Immune Defic Syndr (1988). 1993;6:1013-6.
[PubMed Abstract] -

66. MacNeil JR, Rubin LG, Patton M, Ortega-Sanchez IR, Martin SW. Recommendations for Use of Meningococcal Conjugate Vaccines in HIV-Infected Persons - Advisory Committee on Immunization Practices, 2016. MMWR Morb Mortal Wkly Rep. 2016;65:1189-94.
[PubMed Abstract] -

67. Mbaeyi SA, Bozio CH, Duffy J, et al. Meningococcal Vaccination: Recommendations of the Advisory Committee on Immunization Practices, United States, 2020. MMWR Recomm Rep. 2020;69:1-41.
[PubMed Abstract] -

68. Harris CM, Wu HM, Li J, et al. Meningococcal Disease in Patients With Human Immunodeficiency Virus Infection: A Review of Cases Reported Through Active Surveillance in the United States, 2000-2008. Open Forum Infect Dis. 2016;3:ofw226.
[PubMed Abstract] -

69. Kamiya H, MacNeil J, Blain A, et al. Meningococcal disease among men who have sex with men - United States, January 2012-June 2015. MMWR Morb Mortal Wkly Rep. 2015;64:1256-7.
[PubMed Abstract] -

70. Centers for Disease Control and Prevention (CDC). Notes from the field: serogroup C invasive meningococcal disease among men who have sex with men - New York City, 2010-2012. MMWR Morb Mortal Wkly Rep. 2013;61:1048.
[MMWR] -

71. Rubis AB, Howie RL, Marasini D, Sharma S, Marjuki H, McNamara LA. Notes from the Field: Increase in Meningococcal Disease Among Persons with HIV - United States, 2022. MMWR Morb Mortal Wkly Rep.

2023;72:663-4.
[PubMed Abstract] -

72. Centers for Disease Control and Prevention (CDC). Updated recommendations for use of meningococcal conjugate vaccines--Advisory Committee on Immunization Practices (ACIP), 2010. MMWR Morb Mortal Wkly Rep. 2011;60;72-6.
[MMWR] -

73. Lujan-Zilbermann J, Warshaw MG, Williams PL, et al. Immunogenicity and safety of 1 vs 2 doses of quadrivalent meningococcal conjugate vaccine in youth infected with human immunodeficiency virus. J Pediatr. 2012;161:676-81.e2.
[PubMed Abstract] -

74. Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Mpox. Last updated: July 24, 2023.
[HIV.gov] -

75. Curran KG, Eberly K, Russell OO, et al. HIV and Sexually Transmitted Infections Among Persons with Monkeypox - Eight U.S. Jurisdictions, May 17-July 22, 2022. MMWR Morb Mortal Wkly Rep. 2022;71:1141-7.
[CDC] -

76. Philpott D, Hughes CM, Alroy KA, et al. Epidemiologic and Clinical Characteristics of Monkeypox Cases - United States, May 17-July 22, 2022. MMWR Morb Mortal Wkly Rep. 2022;71:1018-22.
[PubMed Abstract] -

77. Philpott DC, Bonacci RA, Weidle PJ, et al. Low CD4 Count or Being Out of Care Increases the Risk for Mpox Hospitalization Among People with HIV and Mpox. Clin Infect Dis. 2023 Aug 17.Online ahead of print.
[PubMed Abstract] -

78. Rao AK, Petersen BW, Whitehill F, et al. Use of JYNNEOS (Smallpox and Monkeypox Vaccine, Live, Nonreplicating) for Preexposure Vaccination of Persons at Risk for Occupational Exposure to Orthopoxviruses: Recommendations of the Advisory Committee on Immunization Practices - United States, 2022. MMWR Morb Mortal Wkly Rep. 2022;71:734-42.
[PubMed Abstract] -

79. Centers for Disease Control and Prevention (CDC). Use of 13-valent pneumococcal conjugate vaccine and 23-valent pneumococcal polysaccharide vaccine for adults with immunocompromising conditions: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Morb Mortal Wkly Rep. 2012;61:816-9.
[PubMed Abstract] -

80. Isaacman DJ, Fletcher MA, Fritzell B, Ciuryla V, Schranz J. Indirect effects associated with widespread vaccination of infants with heptavalent pneumococcal conjugate vaccine (PCV7; Prevnar). Vaccine. 2006;25:2420-7.
[PubMed Abstract] -

81. Flannery B, Heffernan RT, Harrison LH, et al. Changes in invasive pneumococcal disease among HIV-infected adults living in the era of childhood pneumococcal immunization. Ann Intern Med. 2006;144:1-9.
[PubMed Abstract] -

82. Vadlamudi NK, Chen A, Marra F. Impact of the 13-Valent Pneumococcal Conjugate Vaccine Among Adults: A Systematic Review and Meta-analysis. Clin Infect Dis. 2019;69:34-49.
[PubMed Abstract] -

83. Marcus JL, Baxter R, Leyden WA, et al. Invasive Pneumococcal Disease Among HIV-Infected and HIV-Uninfected Adults in a Large Integrated Healthcare System. AIDS Patient Care STDS. 2016;30:463-470.
[PubMed Abstract] -

84. Rodriguez-Barradas MC, Alexandraki I, Nazir T, Foltzer M, Musher DM, Brown S, Thornby J. Response of human immunodeficiency virus-infected patients receiving highly active antiretroviral therapy to vaccination with 23-valent pneumococcal polysaccharide vaccine. Clin Infect Dis. 2003;37:438-47.
[PubMed Abstract] -

85. Dworkin MS, Ward JW, Hanson DL, Jones JL, Kaplan JE. Pneumococcal disease among human immunodeficiency virus-infected persons: incidence, risk factors, and impact of vaccination. Clin Infect Dis. 2001;32:794-800.
[PubMed Abstract] -

86. French N, Gordon SB, Mwalukomo T, et al. A trial of a 7-valent pneumococcal conjugate vaccine in HIV-infected adults. N Engl J Med. 2010;362:812-22.
[PubMed Abstract] -

87. Mohapi L, Pinedo Y, Osiyemi O, et al. Safety and immunogenicity of V114, a 15-valent pneumococcal conjugate vaccine, in adults living with HIV. AIDS. 2022;36:373-82.
[PubMed Abstract] -

88. Kobayashi M, Farrar JL, Gierke R, et al. Use of 15-Valent Pneumococcal Conjugate Vaccine and 20-Valent Pneumococcal Conjugate Vaccine Among U.S. Adults: Updated Recommendations of the Advisory Committee on Immunization Practices - United States, 2022. MMWR Morb Mortal Wkly Rep. 2022;71:109-17.
[PubMed Abstract] -

89. Kobayashi M, Leidner AJ, Gierke R, et al. Use of 21-Valent Pneumococcal Conjugate Vaccine Among U.S. Adults: Recommendations of the Advisory Committee on Immunization Practices - United States, 2024. MMWR Morb Mortal Wkly Rep. 2024;73:793-8.
[PubMed Abstract] -

90. Liang JL, Tiwari T, Moro P, et al. Prevention of Pertussis, Tetanus, and Diphtheria with Vaccines in the United States: Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep. 2018;67:1-44.
[PubMed Abstract] -

91. Kroon, FP, van Dissel JT, Labadie J, van Loon AM, van Furth R. Antibody response to diphtheria, tetanus, and poliomyelitis vaccines in relation to the number of CD4+ T lymphocytes in adults infected with human immunodeficiency virus. Clin Infect Dis. 1995;21:1197-2003.
[PubMed Abstract] -

92. Centers for Disease Control and Prevention (CDC). Updated recommendations for use of tetanus toxoid, reduced diphtheria toxoid and acellular pertussis (Tdap) vaccine from the Advisory Committee on Immunization Practices, 2010. MMWR Morb Mortal Wkly Rep. 2011;60:13-5.
[MMWR] -

93. Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention

and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Varicella-zoster virus disease. Last updated: September 7, 2022.
[HIV.gov] -

94. Marin M, Güris D, Chaves SS, Schmid S, Seward JF; Advisory Committee on Immunization Practices, Centers for Disease Control and Prevention (CDC). Prevention of varicella: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep. 2007;56(RR-4):1-4.
[MMWR] -

95. Weinmann S, Naleway AL, Koppolu P, et al. Incidence of Herpes Zoster Among Children: 2003-2014. Pediatrics. 2019;144:e20182917.
[PubMed Abstract] -

96. Buchbinder SP, Katz MH, Hessol NA, Liu JY, O'Malley PM, Underwood R, Holmberg SD. Herpes zoster and human immunodeficiency virus infection. J Infect Dis. 1992;166:1153-6.
[PubMed Abstract] -

97. Donahue JG, Choo PW, Manson JE, Platt R. The incidence of herpes zoster. Arch Intern Med. 1995;155:1605-9.
[PubMed Abstract] -

98. Domingo P, Torres OH, Ris J, Vazquez G. Herpes zoster as an immune reconstitution disease after initiation of combination antiretroviral therapy in patients with human immunodeficiency virus type-1 infection. Am J Med. 2001;110:605-9.
[PubMed Abstract] -

99. Moanna A, Rimland D. Decreasing incidence of herpes zoster in the highly active antiretroviral therapy era. Clin Infect Dis. 2013;57:122-5.
[PubMed Abstract] -

100. Vafai A, Berger M. Zoster in patients infected with HIV: a review. Am J Med Sci. 2001;321:372-80.
[PubMed Abstract] -

101. Chlibek R, Bayas JM, Collins H, et al. Safety and immunogenicity of an AS01-adjuvanted varicella-zoster virus subunit candidate vaccine against herpes zoster in adults >=50 years of age. J Infect Dis. 2013;208:1953-61.
[PubMed Abstract] -

102. Dooling KL, Guo A, Patel M, et al. Recommendations of the Advisory Committee on Immunization Practices for Use of Herpes Zoster Vaccines. MMWR Morb Mortal Wkly Rep. 2018;67:103-108.
[PubMed Abstract] -

103. Anderson TC, Masters NB, Guo A, et al. Use of Recombinant Zoster Vaccine in Immunocompromised Adults Aged ≥19 Years: Recommendations of the Advisory Committee on Immunization Practices - United States, 2022. MMWR Morb Mortal Wkly Rep. 2022;71:80-4.
[PubMed Abstract] -

104. Lal H, Cunningham AL, Godeaux O, et al. Efficacy of an adjuvanted herpes zoster subunit vaccine in older adults. N Engl J Med. 2015;372:2087-96.
[PubMed Abstract] -

105. Godeaux O, Kovac M, Shu D, et al. Immunogenicity and safety of an adjuvanted herpes zoster subunit

candidate vaccine in adults ≥ 50 years of age with a prior history of herpes zoster: A phase III, non-randomized, open-label clinical trial. Hum Vaccin Immunother. 2017;:1-8.
[PubMed Abstract] -

106. Cunningham AL, Lal H, Kovac M, et al. Efficacy of the Herpes Zoster Subunit Vaccine in Adults 70 Years of Age or Older. N Engl J Med. 2016;375:1019-32.
[PubMed Abstract] -

107. Berkowitz EM, Moyle G, Stellbrink HJ, et al. Safety and immunogenicity of an adjuvanted herpes zoster subunit candidate vaccine in HIV-infected adults: a phase 1/2a randomized, placebo-controlled study. J Infect Dis. 2015;211:1279-87.
[PubMed Abstract] -

108. Smith DS. Travel medicine and vaccines for HIV-infected travelers. Top Antivir Med. 2012;20:111-5.
[PubMed Abstract] -

109. Kotton CN. Vaccination and immunization against travel-related diseases in immunocompromised hosts. Expert Rev Vaccines. 2008;7:663-72.
[PubMed Abstract] -

110. Kotton CN, Freedman DO. Immunocompromised travelers. In: CDC Health Information for International Travel (The Yellow Book). 2014
[CDC] -

References

- Armbruster C, Junker W, Vetter N, Jaksch G. Disseminated bacille Calmette-Guérin infection in an AIDS patient 30 years after BCG vaccination. J Infect Dis. 1990;162:1216.
[PubMed Abstract] -

- Centers for Disease Control and Prevention (CDC). Updated recommendations for use of tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine (Tdap) in pregnant women--Advisory Committee on Immunization Practices (ACIP), 2012. MMWR Morb Mortal Wkly Rep. 2013;62:131-5.
[MMWR] -

- Centers for Disease Control and Prevention. Mpox Vaccination
[CDC] -

- Crum-Cianflone NF, Wilkins K, Lee AW, et al. Long-term durability of immune responses after hepatitis A vaccination among HIV-infected adults. J Infect Dis. 2011;203:1815-23.
[PubMed Abstract] -

- Deputy NP, Deckert J, Chard AN, et al. Vaccine Effectiveness of JYNNEOS against Mpox Disease in the United States. N Engl J Med. 2023;388:2434-2443.
[PubMed Abstract] -

- Faherty EAG, Holly T, Ogale YP, et al. Notes from the Field: Emergence of an Mpox Cluster Primarily Affecting Persons Previously Vaccinated Against Mpox - Chicago, Illinois, March 18-June 12, 2023. MMWR Morb Mortal Wkly Rep. 2023 Jun 23;72:696-8.
[PubMed Abstract] -

- Farrar JL, Lewis NM, Houck K, et al. Demographic and Clinical Characteristics of Mpox in Persons Who Had Previously Received 1 Dose of JYNNEOS Vaccine and in Unvaccinated Persons - 29 U.S.

Jurisdictions, May 22-September 3, 2022. MMWR Morb Mortal Wkly Rep. 2022;71:1610-15.
[PubMed Abstract] -

- Halperin SA, Ward B, Cooper C, et al. Comparison of safety and immunogenicity of two doses of investigational hepatitis B virus surface antigen co-administered with an immunostimulatory phosphorothioate oligodeoxyribonucleotide and three doses of a licensed hepatitis B vaccine in healthy adults 18-55 years of age. Vaccine. 2012;30:2556-63.
[PubMed Abstract] -

- Heyward WL, Kyle M, Blumenau J, et al. Immunogenicity and safety of an investigational hepatitis B vaccine with a Toll-like receptor 9 agonist adjuvant (HBsAg-1018) compared to a licensed hepatitis B vaccine in healthy adults 40-70 years of age. Vaccine. 2013;31:5300-5.
[PubMed Abstract] -

- Jackson S, Lentino J, Kopp J, et al. Immunogenicity of a two-dose investigational hepatitis B vaccine, HBsAg-1018, using a toll-like receptor 9 agonist adjuvant compared with a licensed hepatitis B vaccine in adults. Vaccine. 2018;36:668-674.
[PubMed Abstract] -

- Kim DK, Riley LE, Harriman KH, Hunter P, Bridges CB. Advisory Committee on Immunization Practices Recommended Immunization Schedule for Adults Aged 19 Years or Older - United States, 2017. MMWR Morb Mortal Wkly Rep. 2017;66:136-138.
[PubMed Abstract] -

- Kroon FP, van Dissel JT, Ravensbergen E, Nibbering PH, van Furth R. Enhanced antibody response to pneumococcal polysaccharide vaccine after prior immunization with conjugate pneumococcal vaccine in HIV-infected adults. Vaccine. 2000;19:886-94.
[PubMed Abstract] -

- Lin KY, Hsieh SM, Sheng WH, et al. Comparable Serologic Responses to 2 Different Combinations of Inactivated Hepatitis A Virus Vaccines in HIV-Positive Patients During an Acute Hepatitis A Outbreak in Taiwan. J Infect Dis. 2018;218:734-8.
[PubMed Abstract] -

- Miller L, Arakaki L, Ramautar A, et al. Elevated risk for invasive meningococcal disease among persons with HIV. Ann Intern Med. 2014;160:30-7.
[PubMed Abstract] -

- Overton ET, Nurutdinova D, Sungkanuparph S, Seyfried W, Groger RK, Powderly WG. Predictors of immunity after hepatitis A vaccination in HIV-infected persons. J Viral Hepat. 2007;14:189-93.
[PubMed Abstract] -

- Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Human papillomavirus disease. July 9, 2024.
[HIV.gov] -

- Payne AB, Ray LC, Cole MM, et al. Reduced Risk for Mpox After Receipt of 1 or 2 Doses of JYNNEOS Vaccine Compared with Risk Among Unvaccinated Persons - 43 U.S. Jurisdictions, July 31-October 1, 2022. MMWR Morb Mortal Wkly Rep. 2022;71:1560-64.
[PubMed Abstract] -

- Rotz LD, Dotson DA, Damon IK, Becher JA; Advisory Committee on Immunization Practices. Vaccinia

(smallpox) vaccine: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep. 2001;50(RR-10);1-25.
[MMWR] -

- Schnittman SR, Zepf R, Cocohoba J, Sears D. Brief Report: Heplisav-B Seroprotection in People With HIV: A Single-Center Experience. J Acquir Immune Defic Syndr. 2021;86:445-9.
[PubMed Abstract] -

- Siberry GK, Williams PL, Lujan-Zilbermann J, et al. Phase I/II, open-label trial of safety and immunogenicity of meningococcal (groups A, C, Y, and W-135) polysaccharide diphtheria toxoid conjugate vaccine in human immunodeficiency virus-infected adolescents. Pediatr Infect Dis J. 2010;29:391-6.
[PubMed Abstract] -

- Staples JE, Bocchini JA Jr, Rubin L, Fischer M. Yellow Fever Vaccine Booster Doses: Recommendations of the Advisory Committee on Immunization Practices, 2015. MMWR Morb Mortal Wkly Rep. 2015;64:647-50.
[PubMed Abstract] -

- Tack DM, Karem KL, Montgomery JR, et al. Unintentional transfer of vaccinia virus associated with smallpox vaccines: ACAM2000(®) compared with Dryvax(®). Hum Vaccin Immunother. 2013;9:1489-96.
[PubMed Abstract] -

- Toft L, Storgaard M, Müller M, et al. Comparison of the immunogenicity and reactogenicity of Cervarix and Gardasil human papillomavirus vaccines in HIV-infected adults: a randomized, double-blind clinical trial. J Infect Dis. 2013;209:1165-73.
[PubMed Abstract] -

- Veit O, Domingo C, Niedrig M, et al. Long-term Immune Response to Yellow Fever Vaccination in Human Immunodeficiency Virus (HIV)-Infected Individuals Depends on HIV RNA Suppression Status: Implications for Vaccination Schedule. Clin Infect Dis. 2018;66:1099-1108.
[PubMed Abstract] -

- Veit O, Niedrig M, Chapuis-Taillard C, et al. Immunogenicity and safety of yellow fever vaccination for 102 HIV-infected patients. Clin Infect Dis. 2009;48:659-66.
[PubMed Abstract] -

- Weissman S, Feucht C, Moore BA. Response to hepatitis A vaccine in HIV-positive patients. J Viral Hepat. 2006;13:81-6.
[PubMed Abstract] -

Figures

Figure 1 (Image Series) - COVID-19 mRNA Vaccines (Image Series) - Figure 1 (Image Series) - COVID-19 mRNA Vaccines
Image 1A: COVID-19 mRNA Vaccine

COVID-19 mRNA vaccines consist of mRNA surrounded by a lipid nanoparticle (LNP). The LNP protects the mRNA from being degraded and it facilitates cellular uptake of the mRNA. The coding region (orange) is a genetically engineered sequence of nucleoside-modified mRNA that encodes for the prefusion-stabilized SARS-CoV-2 spike protein. The Cap 5′ and 3′ UTR elements enhance the stability and translation of the mRNA

Illustration: Cognition Studio, Inc.

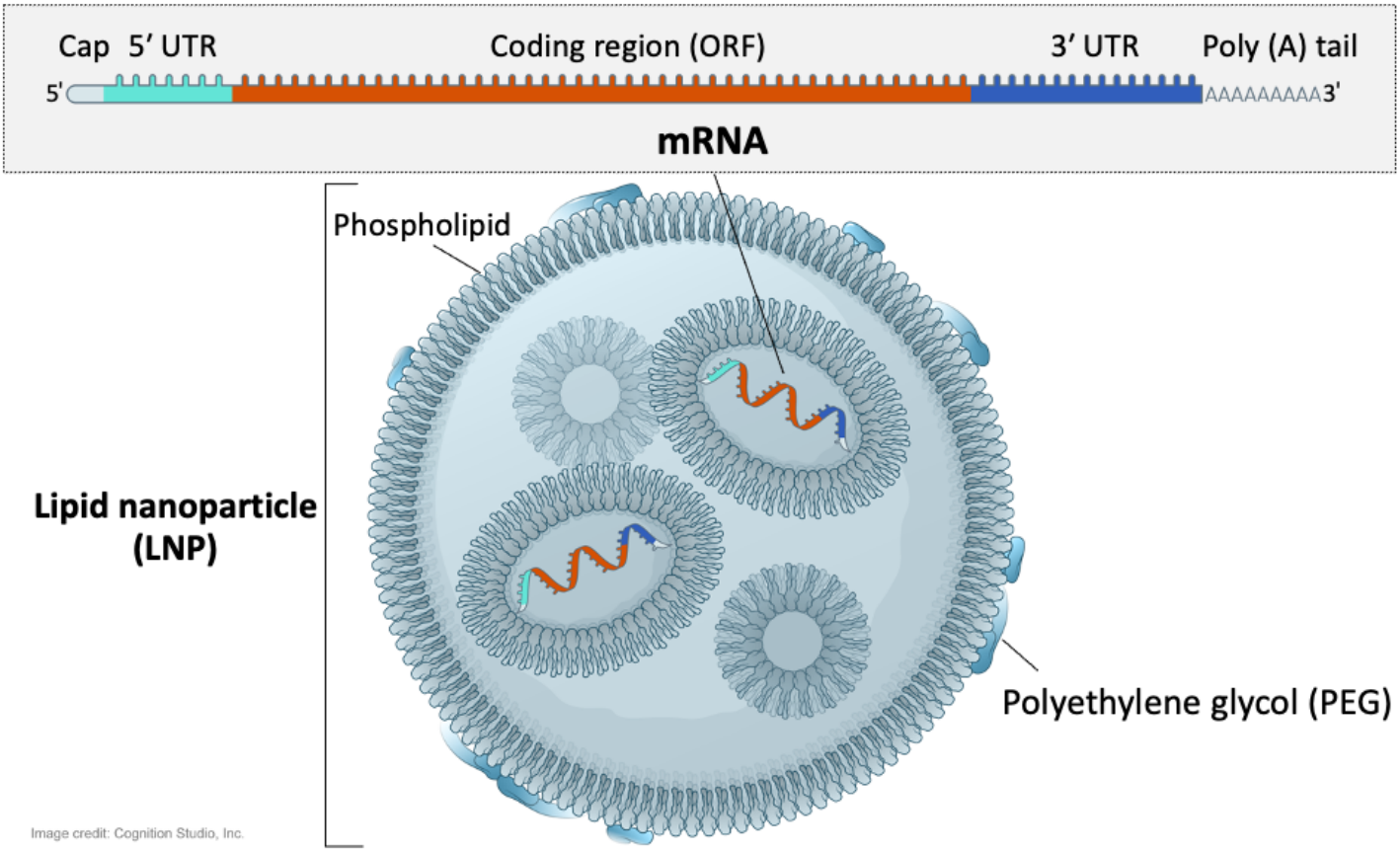

Figure 1 (Image Series) - COVID-19 mRNA Vaccines
Image 1B: COVID-19 mRNA Vaccines and Intracellular Mechanism of Action

The mRNA-1273 enters the cell cytoplasm and does not enter the nucleus. The mRNA is translated by the ribosomes to form prefusion-stabilized SARS-CoV-2 spike proteins. The spike proteins are shuttled to the surface of the cell and are presented to the immune system. The spike proteins are also processed into small peptides that also are presented to the immune system. With this process, the mRNA is non-replicating and is present transiently within the cell.

Illustration: Cognition Studio, Inc.

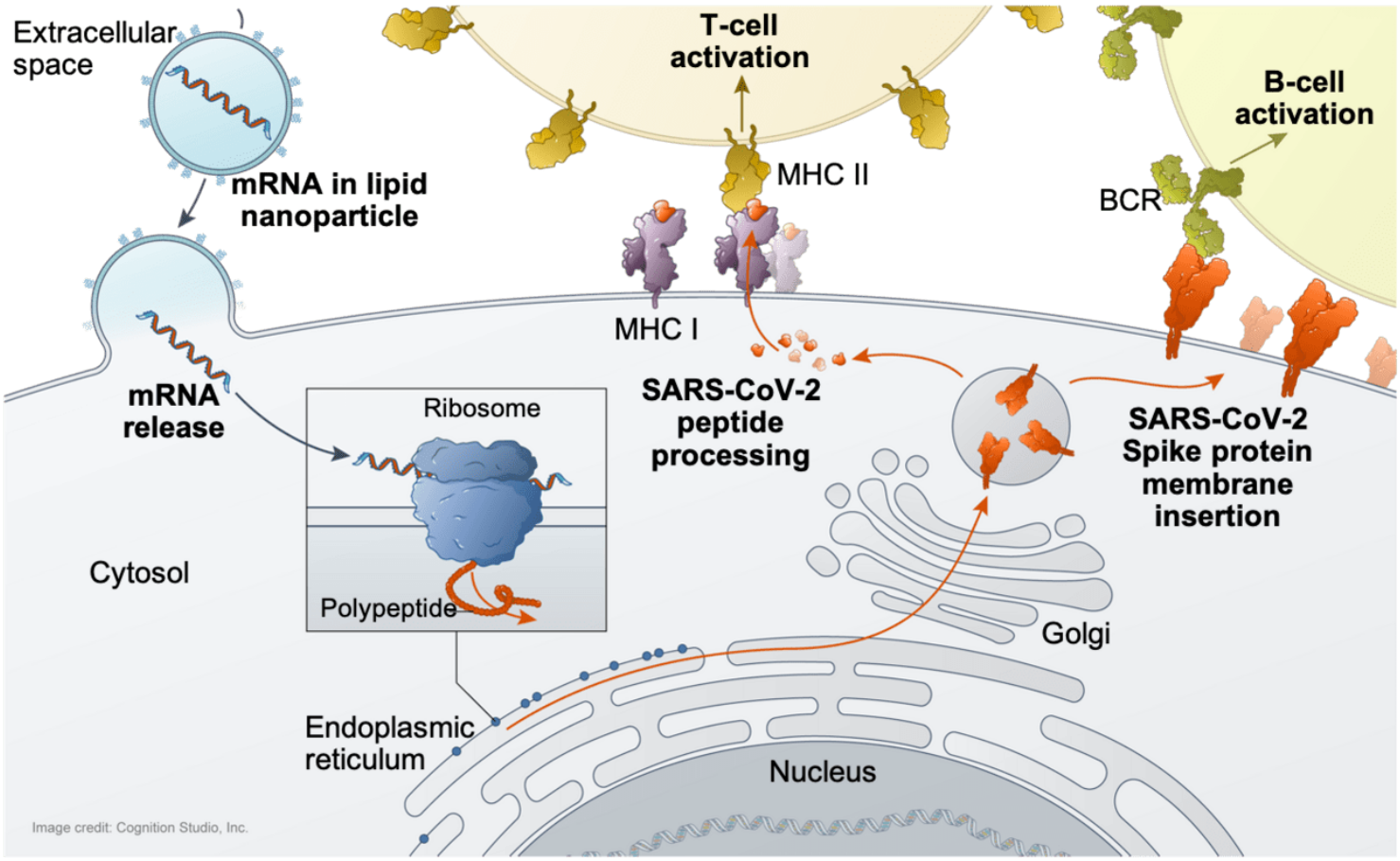

Figure 1 (Image Series) - COVID-19 mRNA Vaccines
Image 1C: COVID-19 mRNA Vaccines and Immune Responses

The immune system responds to the antigens on the surface of the cell produced by the COVID-19 mRNA vaccines. These vaccines generate cellular immune responses (T-cell) and humoral responses (B-cell). The immune response includes: activation of B cells to produce antibodies against SARS-CoV-2; activation of cytotoxic CD8 T-cells that can destroy cells infected with SARS-CoV-2; activation of CD4 T-cells that augment both CD8 T-cell and B-cell responses; generation of memory T and B cells that can quickly respond to future SARS-CoV-2 infection.

Illustration: Cognition Studio, Inc.

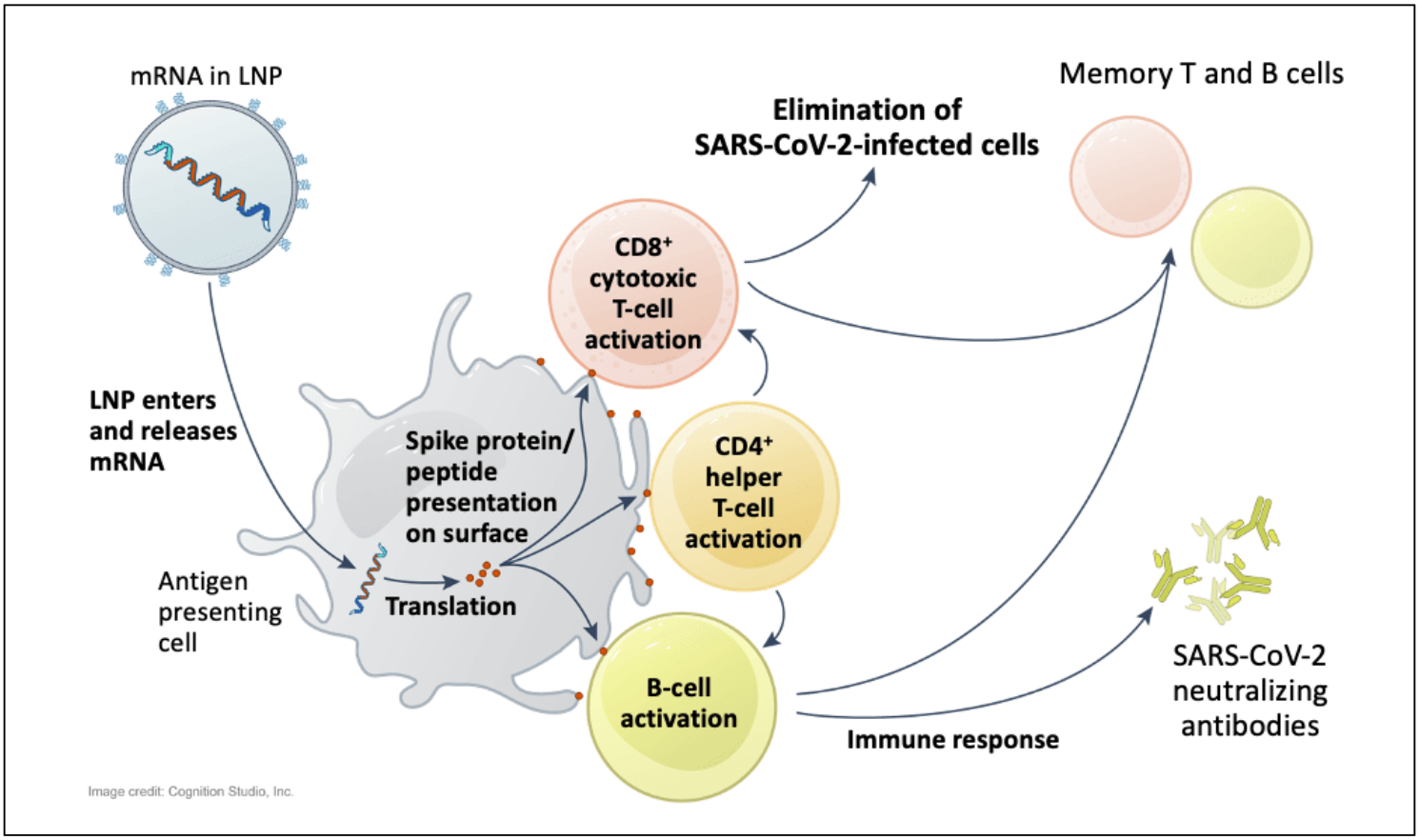

Figure 2 Number of Reported Cases of Hepatitis A Virus Infections, United States, 2015-2022

Source: Centers for Disease Control and Prevention (CDC). 2022 Viral Hepatitis Surveillance Report—Hepatitis A. Published April 2024.

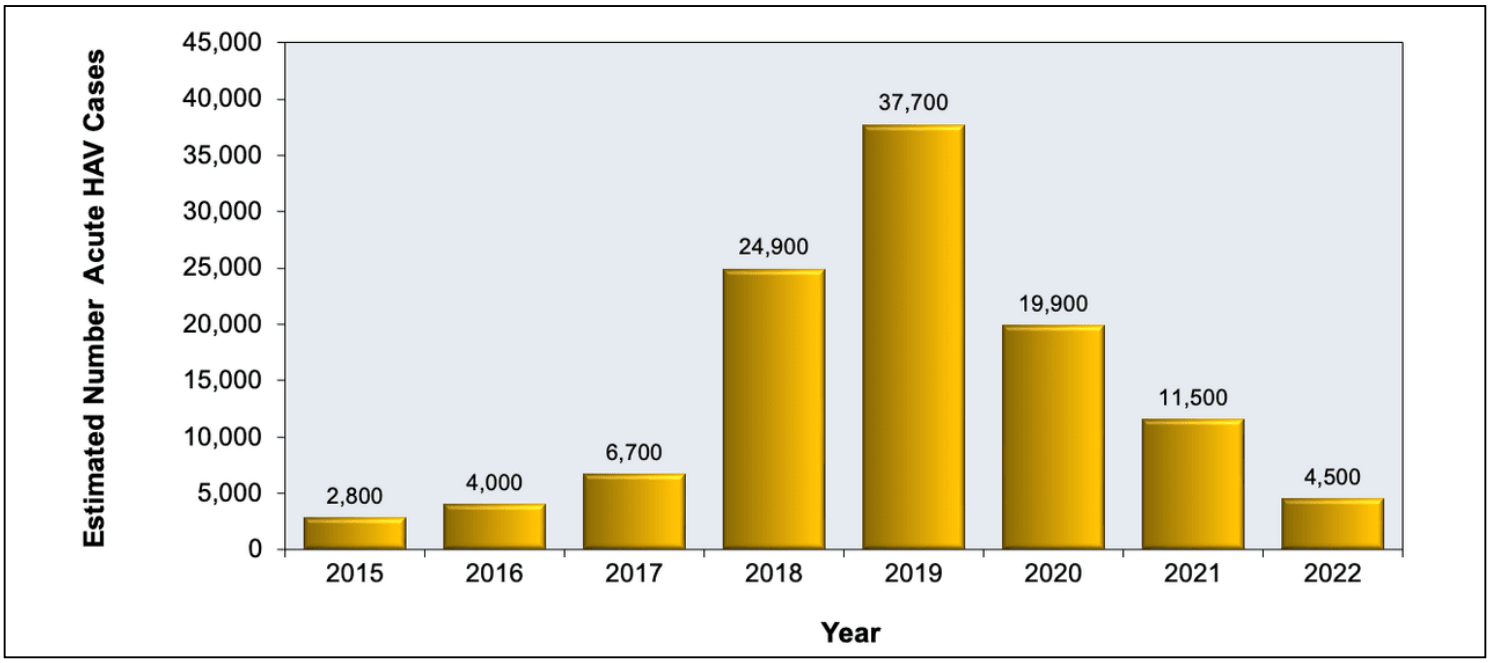

Figure 3 Hepatitis A Vaccine Doses and Schedule for Adults

Vaccine	Dose and Route	Schedule
Hepatitis A Vaccines		
Havrix	1440 ELISA Units (IM)	2 doses given at 0, 6-12 months
Vaqta	50 U (IM)	2 doses given at 0, 6-18 months
Combined Hepatitis A and B Vaccine		
Twinrix	*Havrix* 1440 ELISA Units *plus* *Engerix* 20 µg (IM)	Standard: 3 doses given at 0, 1, 6 months
		*Accelerated: Days 0, 7, 21-30 and 12 months
*For travelers, consider accelerated dosing		

Figure 4 Recommendations for Hepatitis A Vaccine in People with HIV Based on CD4 Cell Count and Risk of Acquiring Hepatitis A Virus

Source: Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Immunizations for Preventable Diseases in Adults and Adolescents Living with HIV. Last updated: April 13, 2023.

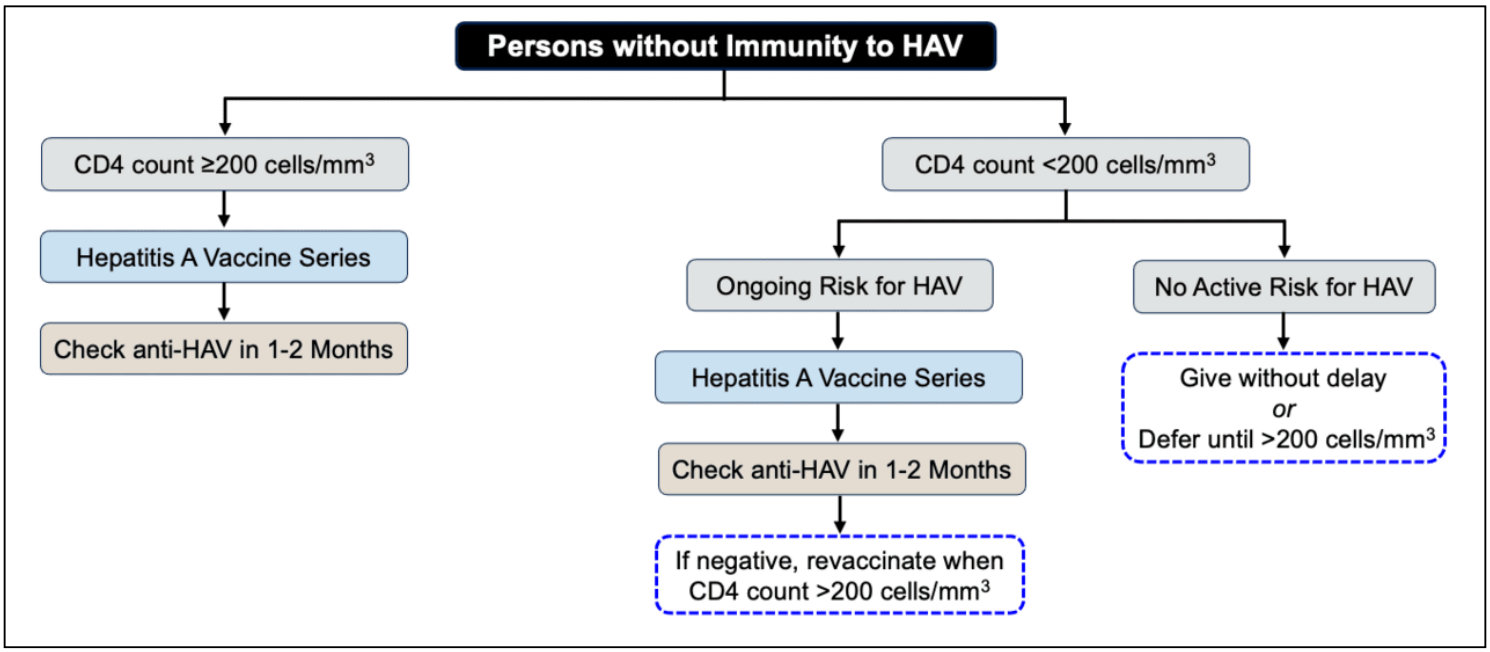

Figure 5 Heplisav-B Vaccine in HBV Vaccine-Naïve People With HIV

This bar graph shows the seroprotective response rates to three doses of Heplisav-B vaccine given at 0, 4, and 24 weeks.

Source: Marks KM, Kang M, Umbleja T, et al. Immunogenicity and Safety of Hepatitis B vaccine with a Toll-like Receptor 9 Agonist Adjuvant (HEPLISAV-B) in HBV Vaccine-naive People with HIV. Clin Infect Dis. 2023;77:414-8.

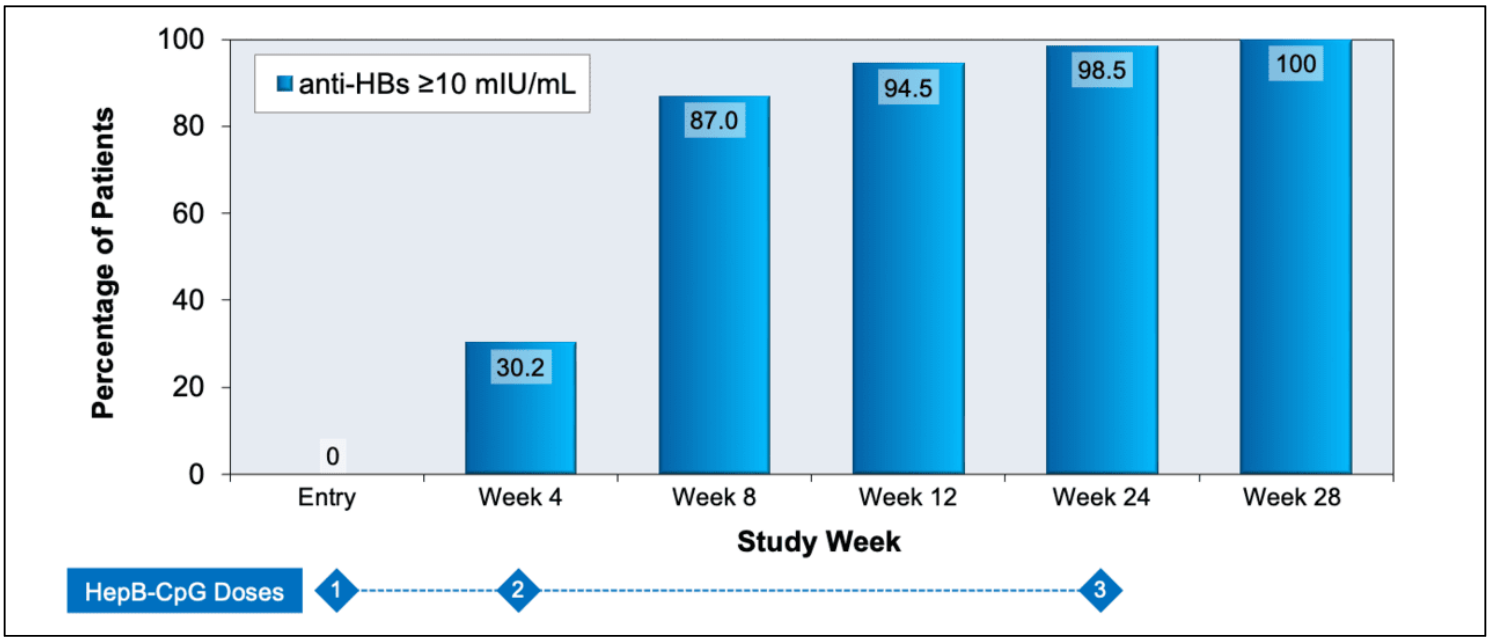

Figure 6 HBV Vaccine Schedule Options in Persons with HIV

Note: A 1.0 mL dose of *Twinrix* contains 720 ELISA units of inactivated hepatitis A virus (antigen component from Havrix) and 20 µg HBsAg (antigen component from Engerix-B). *Twinrix* can be given on an accelerated schedule, but the accelerated schedule requires a total of 4 doses (days 0, 7, and 21 to 30) followed by a booster dose at 12 months).

Source: Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Immunizations for Preventable Diseases in Adults and Adolescents Living with HIV. Last updated: December 16, 2024.

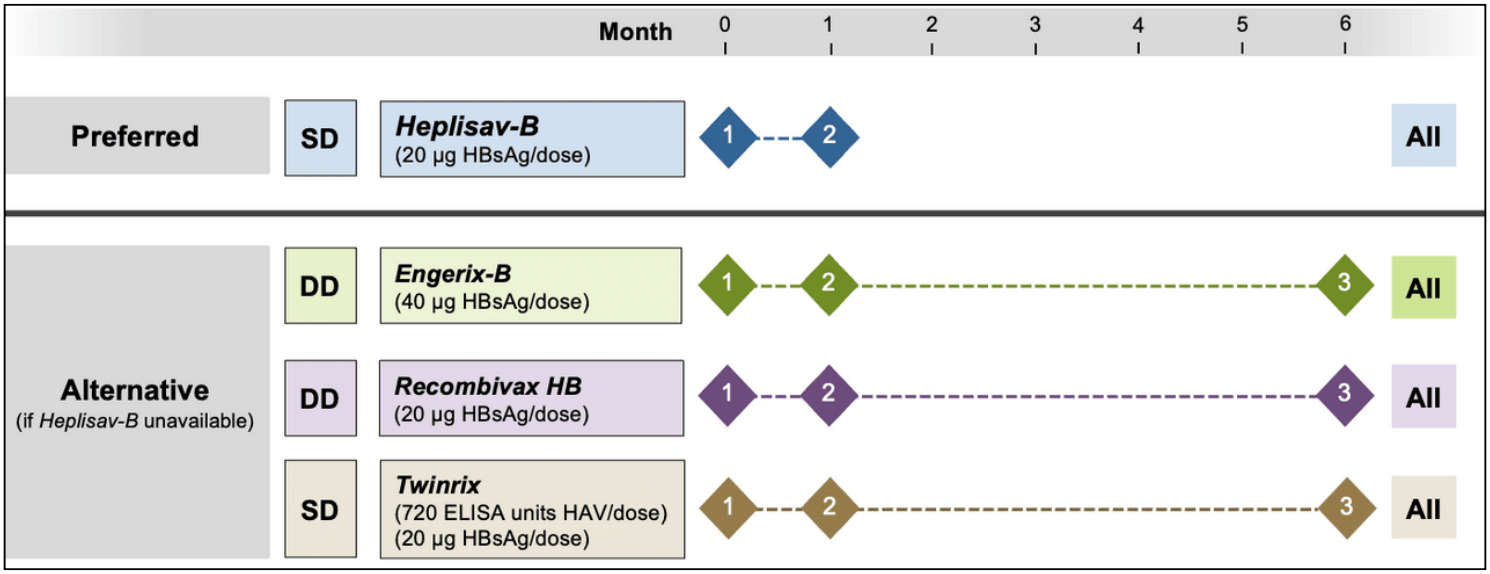

Figure 7 Approach to Isolated Anti-HBc in Persons with HIV

*The full vaccine series options include the 2-dose series using standard-dose *Heplisav-B* or the 3-dose series with double-dose vaccine using *Engerix-B* or *Recombivax HB*.

Source: Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Hepatitis B virus infection. Last Updated: December 16, 2024.

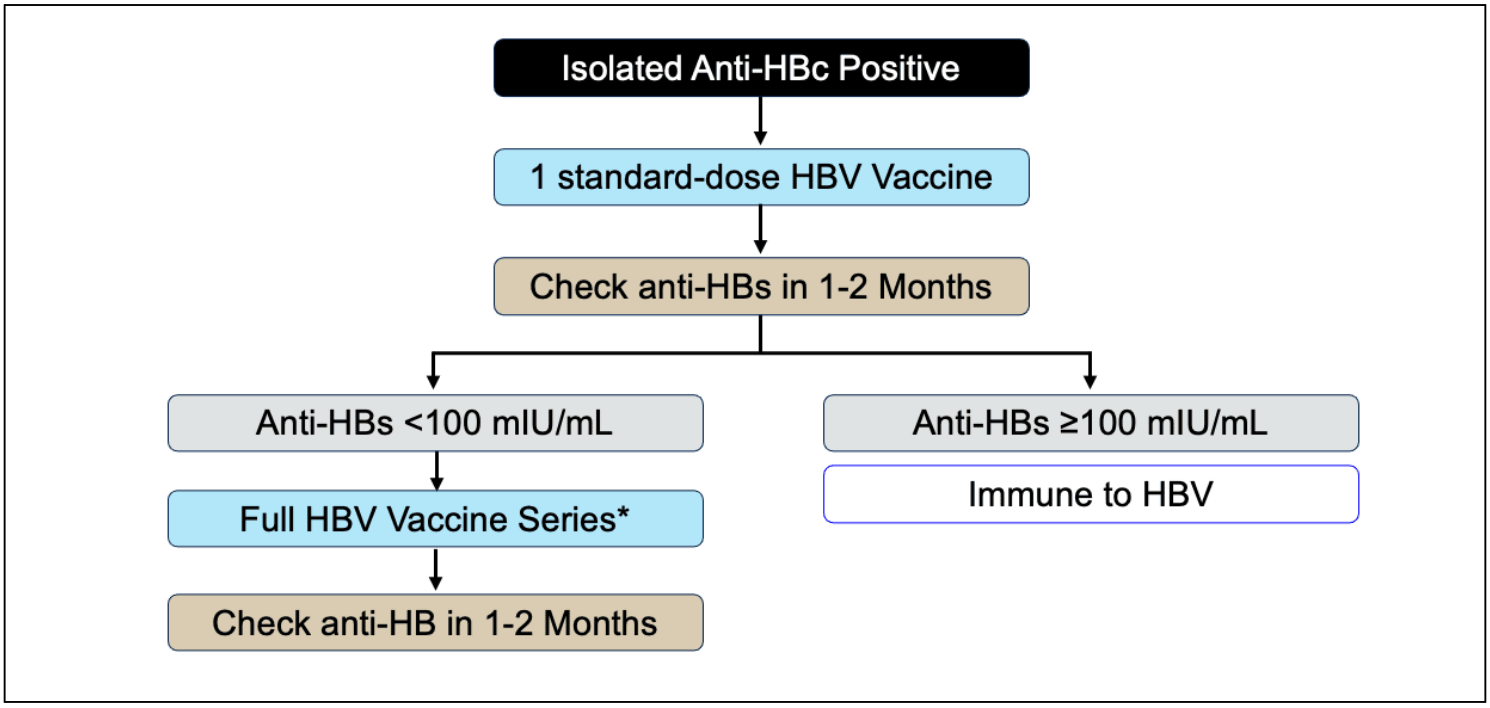

Figure 8 Production of Human Papillomavirus Subunit Vaccine

Conceptual rendition of production of human papillomavirus vaccine. The vaccine process involves recombinant synthesis of major capsid L1 proteins that self-assemble as a shell of 72 pentameric capsomeres to form viral-like particles (VLPs). The assembled pseudovirus is very similar to the native human papillomavirus and is highly immunogenic.

Illustration: David H. Spach, MD

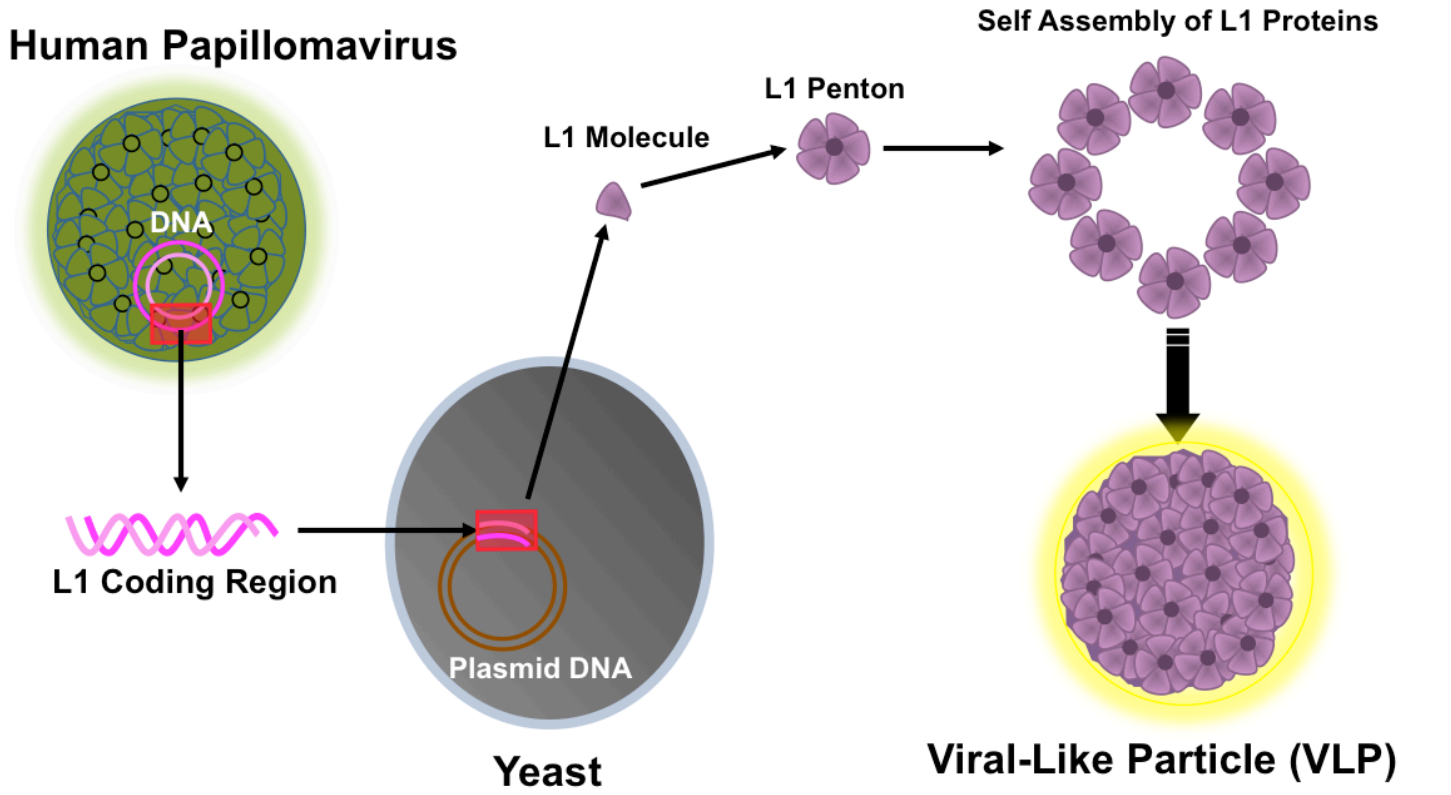

Figure 9 9-valent Human Papillomavirus Vaccine

Illustration: David H. Spach, MD

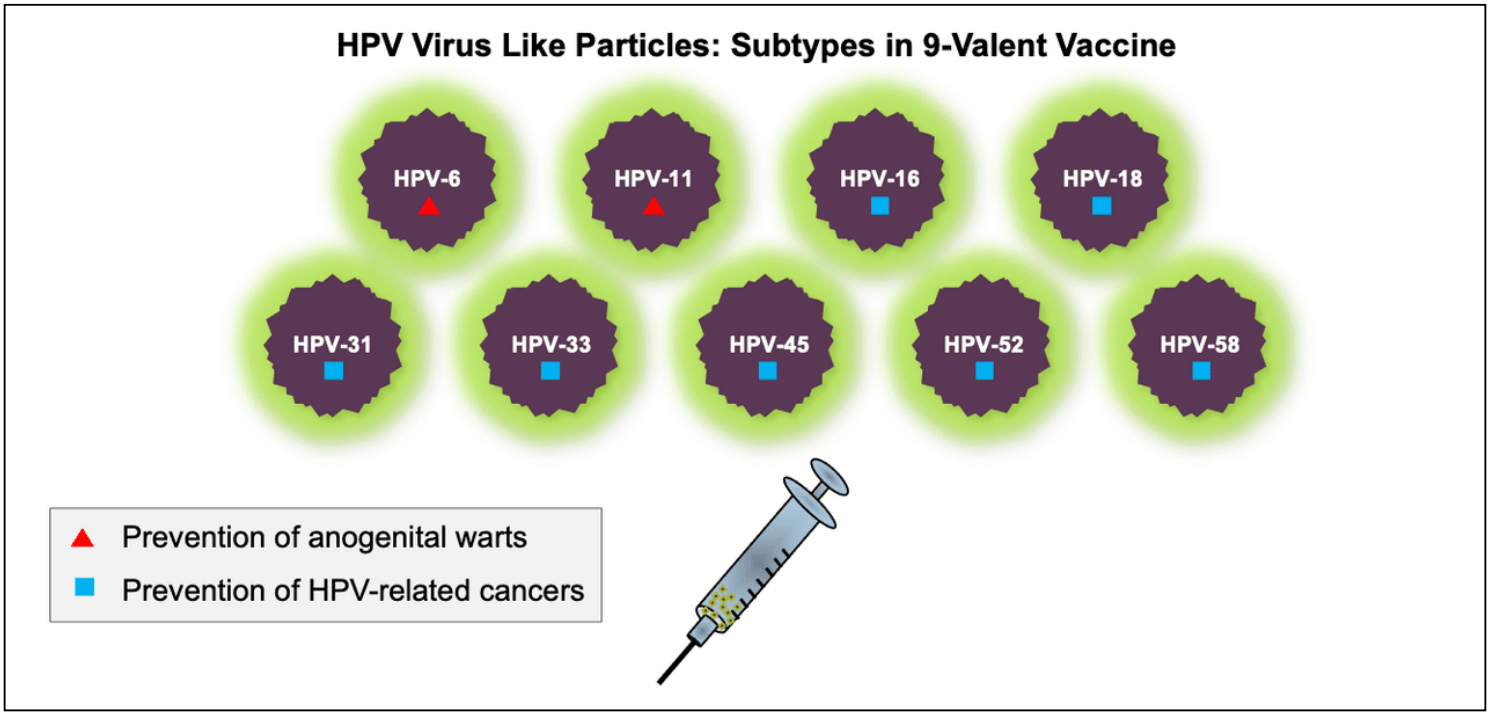

Figure 10 Number of Measles Cases in United States, Reported by Year, 2010-2024*

*Cases in 2024 are for those cases reported through March 14.

Source: Centers for Disease Control and Prevention

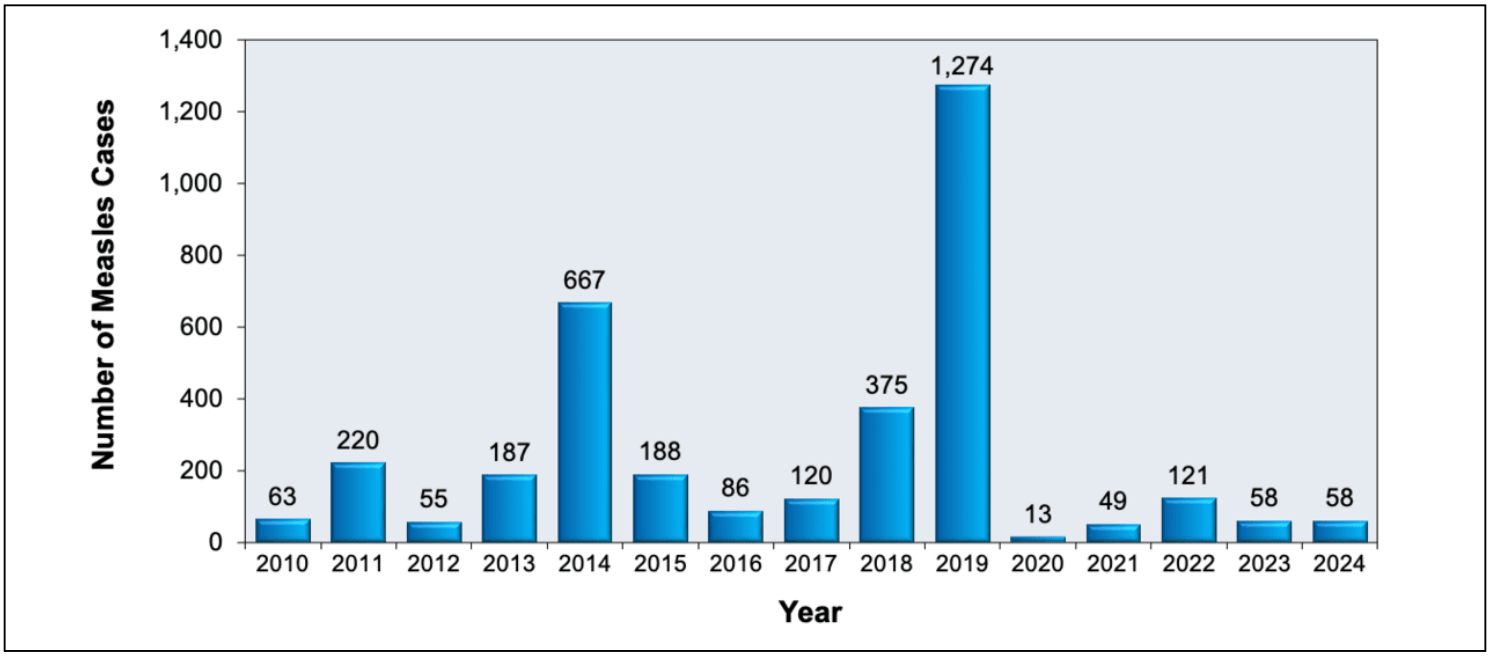

Figure 11 Meningococcal Disease Among Persons with HIV, United States, 2017-2022

Source: Rubis AB, Howie RL, Marasini D, Sharma S, Marjuki H, McNamara LA. Notes from the Field: Increase in Meningococcal Disease Among Persons with HIV - United States, 2022. MMWR Morb Mortal Wkly Rep. 2023;72:663-4.

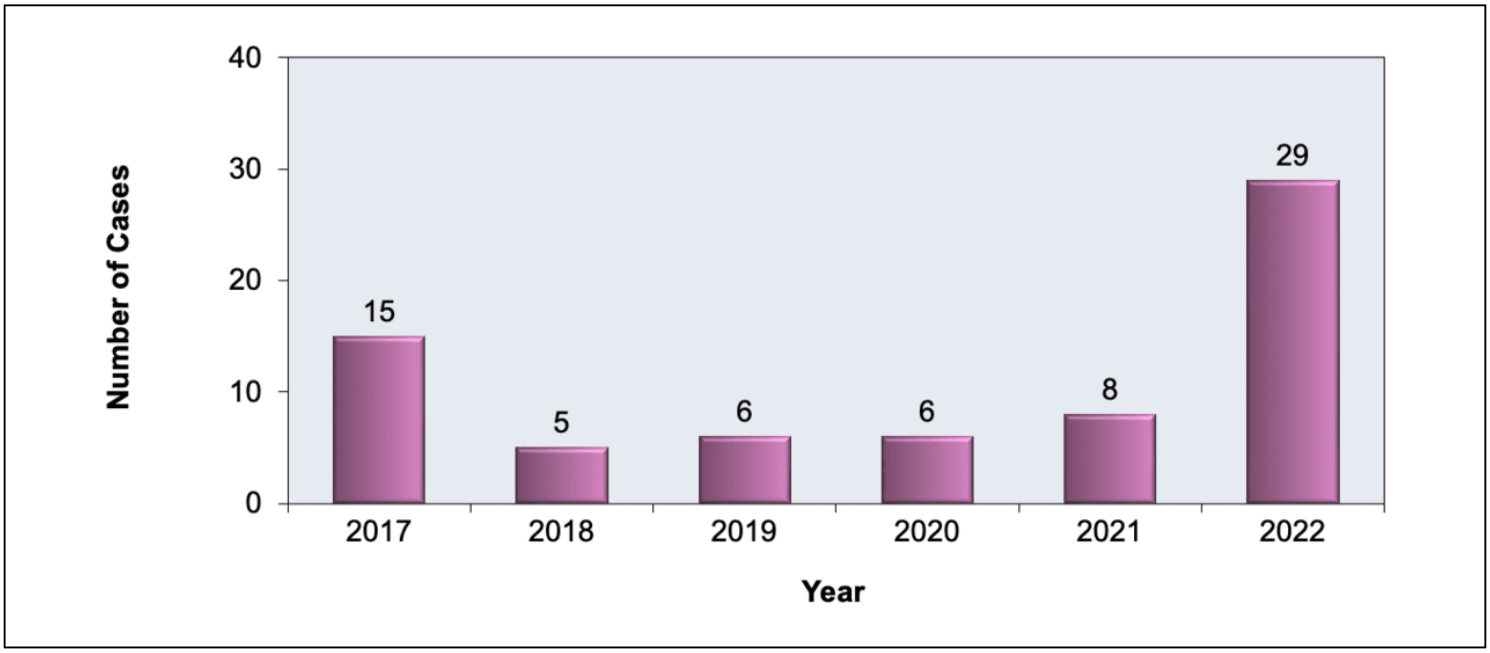

Figure 12 Recommendation for Conjugate Quadrivalent Meningococcal Vaccine in Persons with HIV

Source: Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Immunizations for Preventable Diseases in Adults and Adolescents Living with HIV. Last Updated: December 16, 2024.

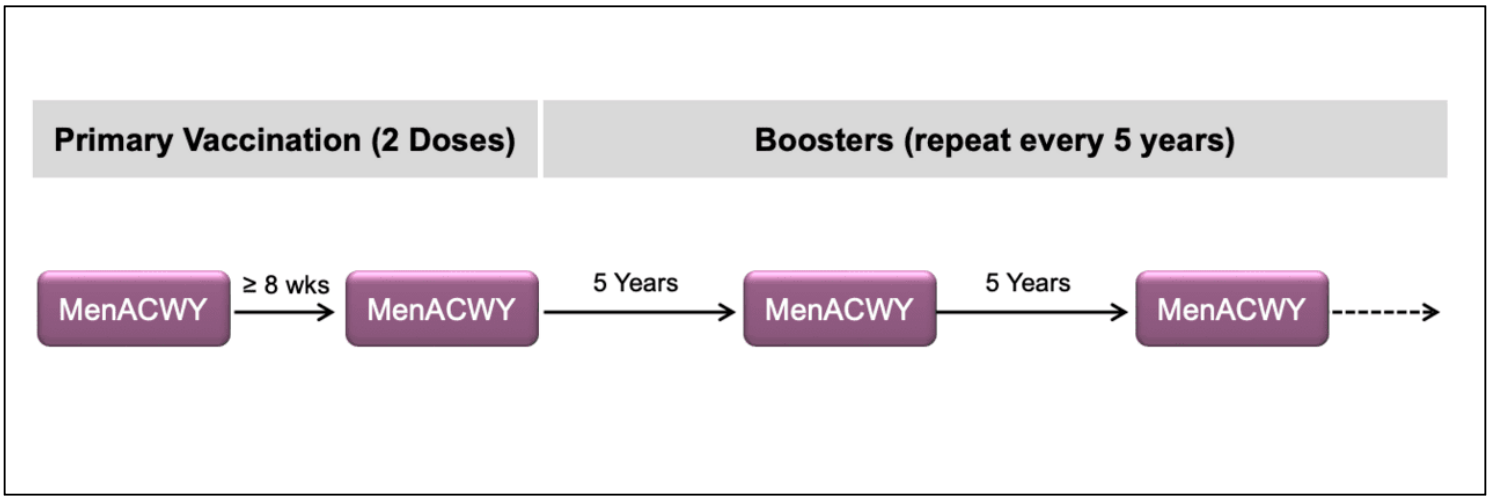

Figure 13 Administration of Mpox Vaccine: Subcutaneous and Intradermal Routes

Illustration: Cognition Studio, Inc. and David H. Spach, MD

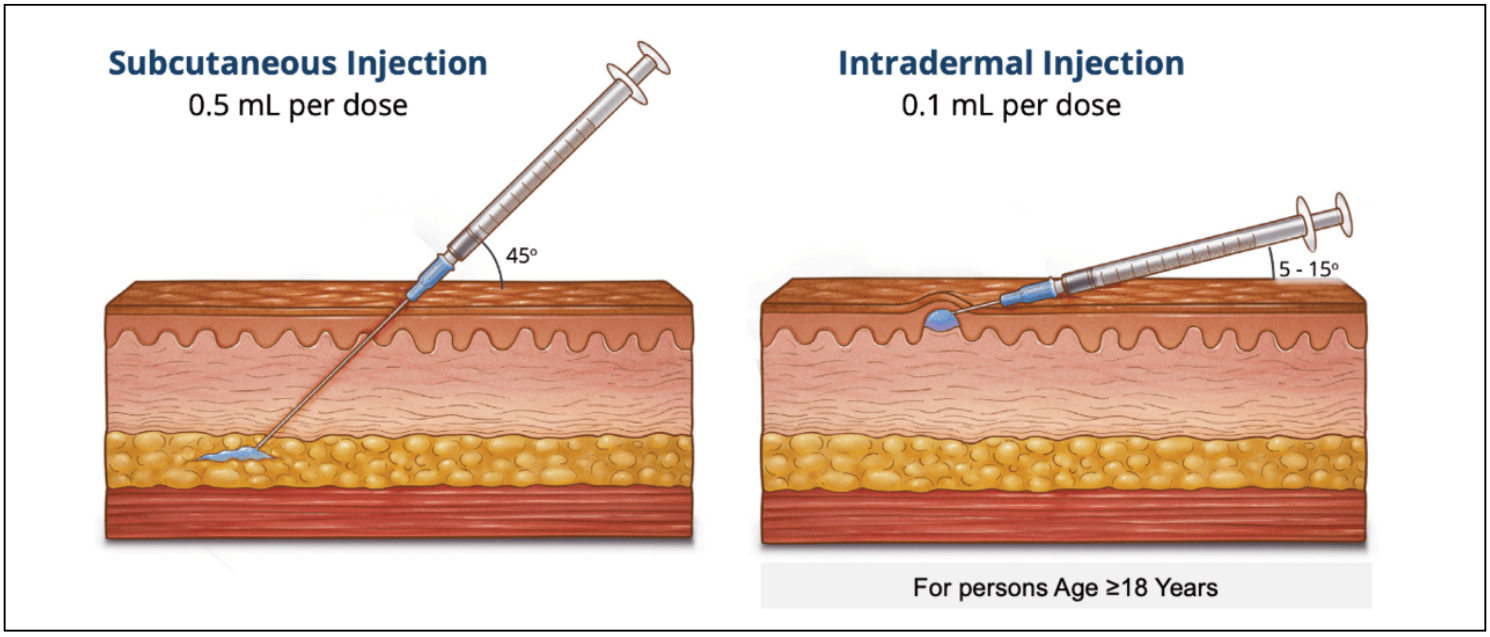

Figure 14 Recommendations for Pneumococcal Immunization in Adults with HIV and No Prior Pneumococcal Immunization

Source: Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Immunizations for Preventable Diseases in Adults and Adolescents Living with HIV. Last Updated: December 16, 2024.

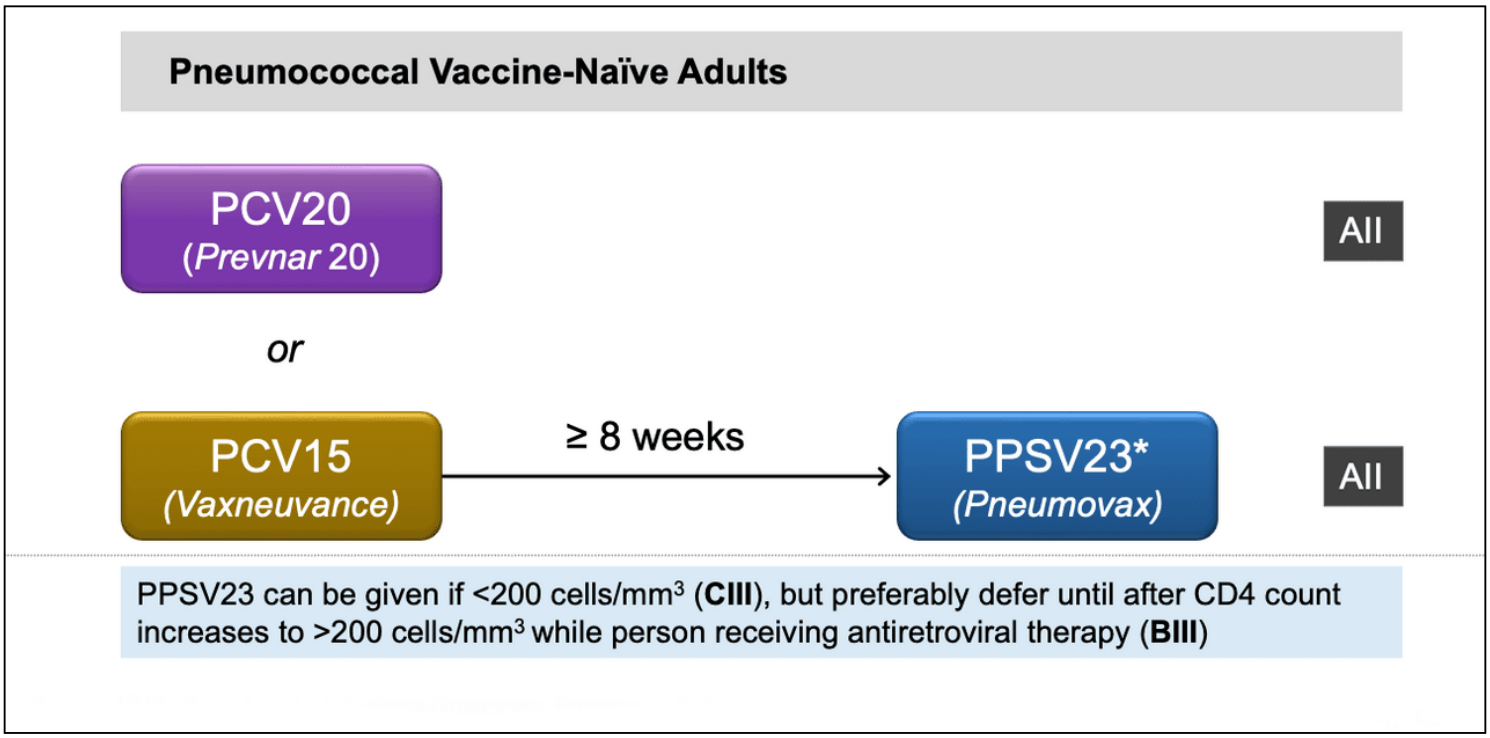

Figure 15 (Image Series) - Approach to Persons with HIV and Prior Receipt of Pneumococcal Vaccine (Image Series) - Figure 15 (Image Series) - Approach to Persons with HIV and Prior Receipt of Pneumococcal Vaccine
Image 15A: Prior Receipt PCV13 Only

Note: the red box represents receipt of prior pneumococcal vaccine.

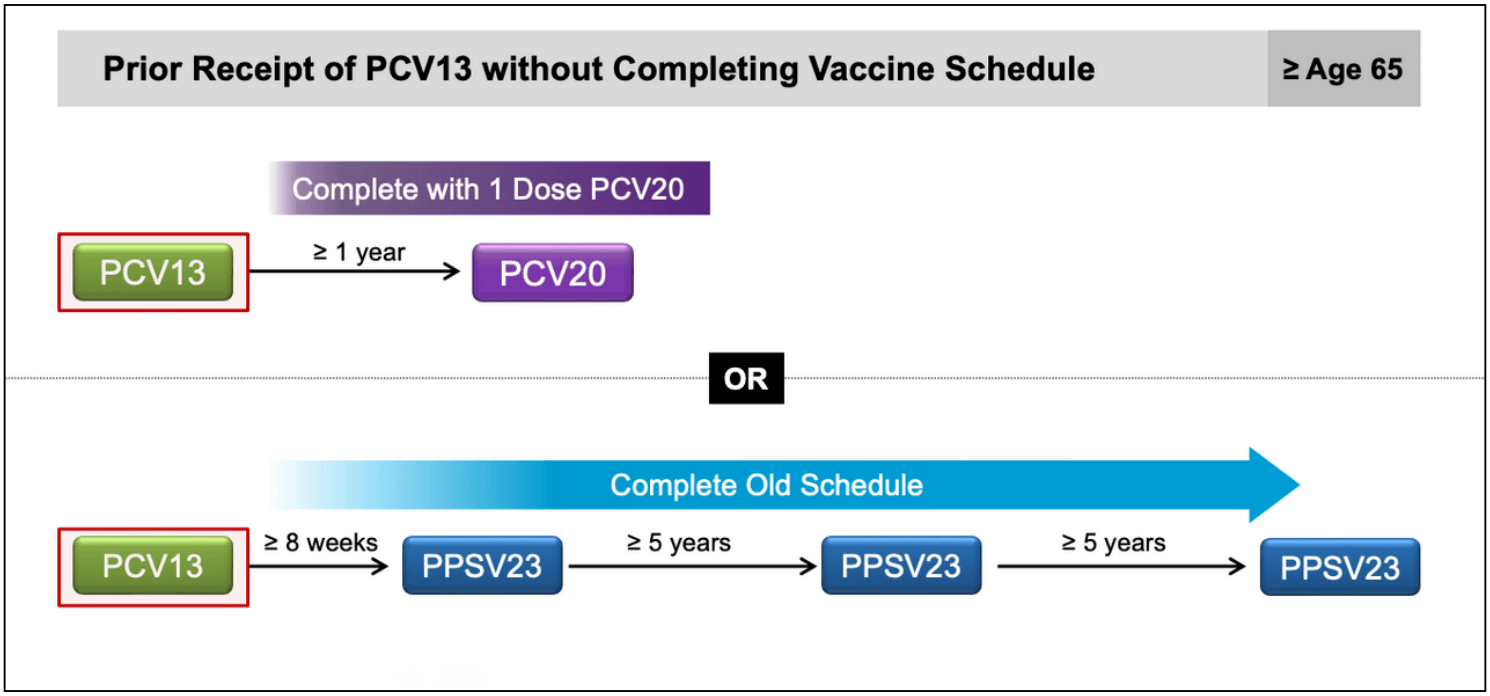

Figure 15 (Image Series) - Approach to Persons with HIV and Prior Receipt of Pneumococcal Vaccine
Image 15B: Prior Receipt PCV13 and ≥1 Dose PPSV23

Note: the red box represents receipt of prior pneumococcal vaccine.

Source: Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Immunizations for Preventable Diseases in Adults and Adolescents Living with HIV. Last Updated: December 16, 2024.

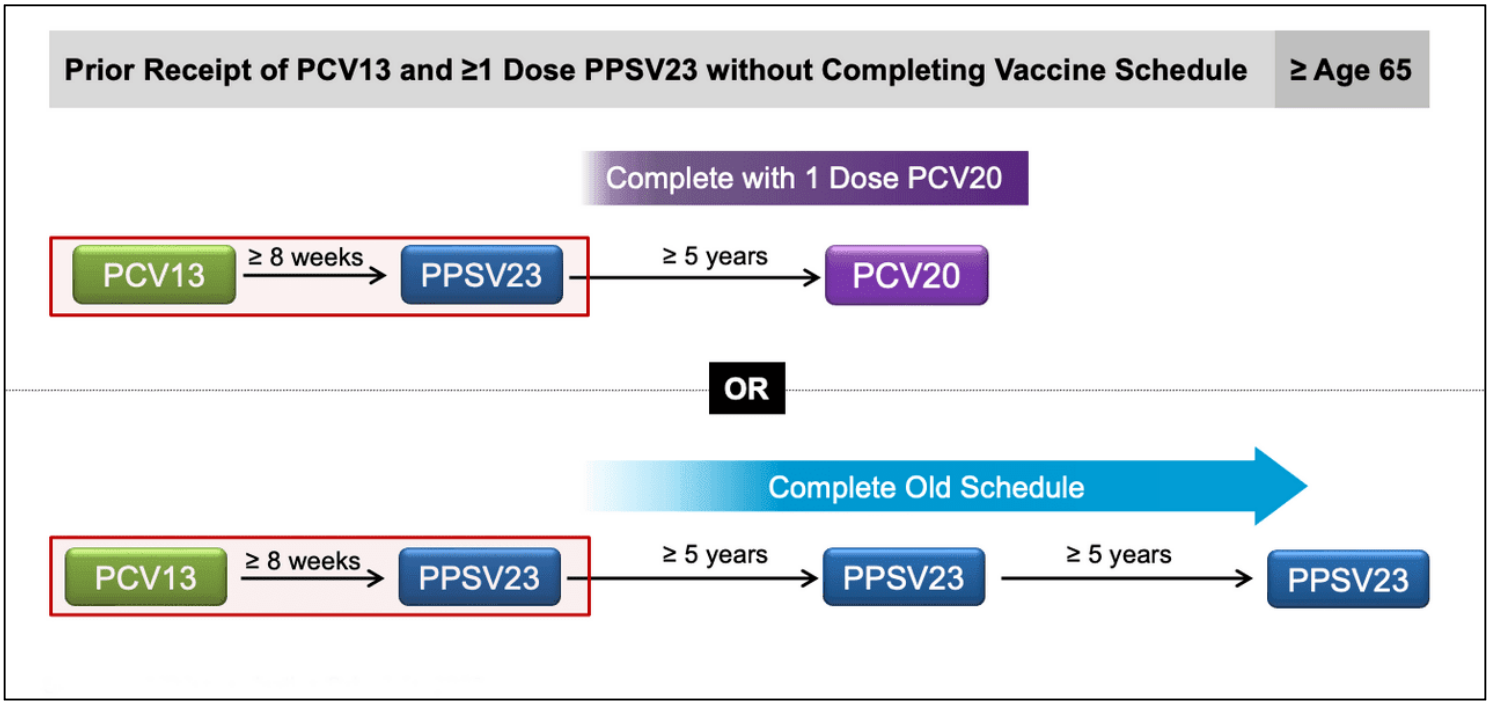

Figure 15 (Image Series) - Approach to Persons with HIV and Prior Receipt of Pneumococcal Vaccine
Image 15C: Prior Receipt of ≥1 Dose of PPSV23 (without PCV13)

Note: the red box represents receipt of prior pneumococcal vaccine.

Source: Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Immunizations for Preventable Diseases in Adults and Adolescents Living with HIV. Last Updated: December 16, 2024.

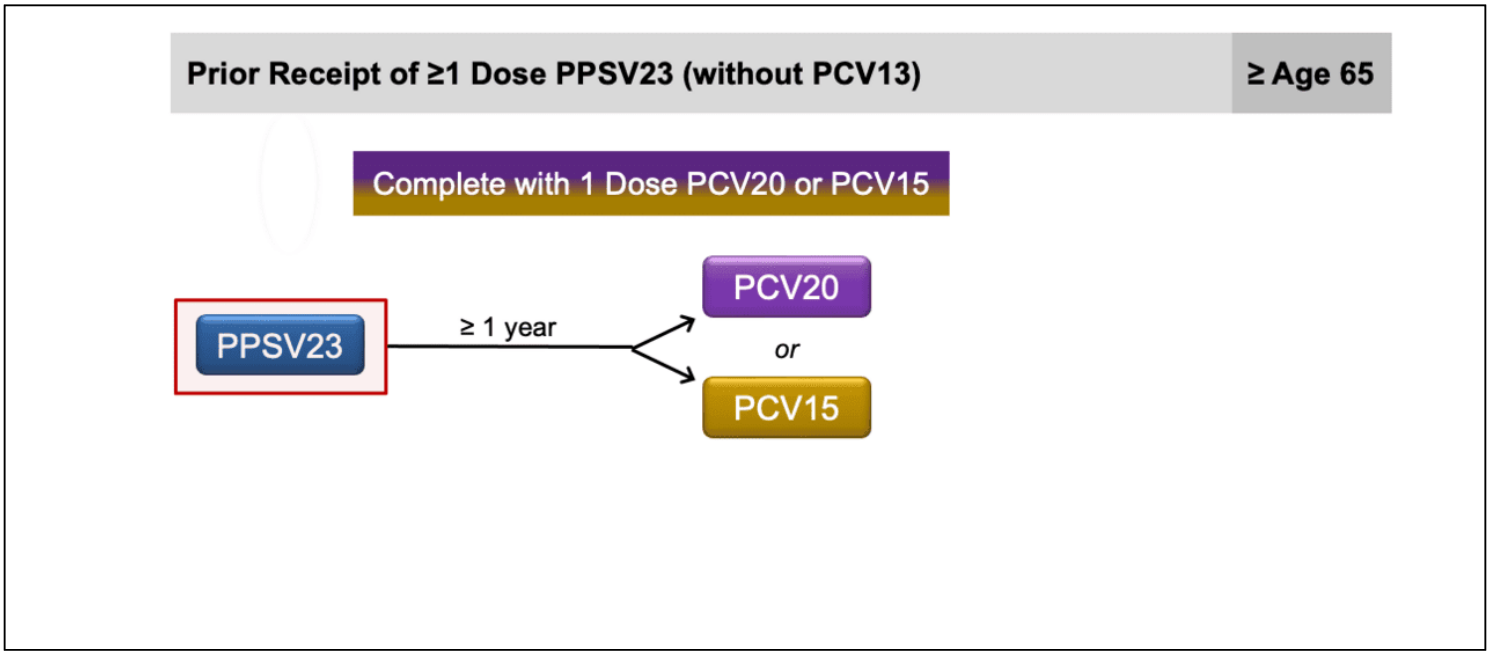

Figure 16 Herpes Zoster Vaccines

Illustration: David H. Spach, MD

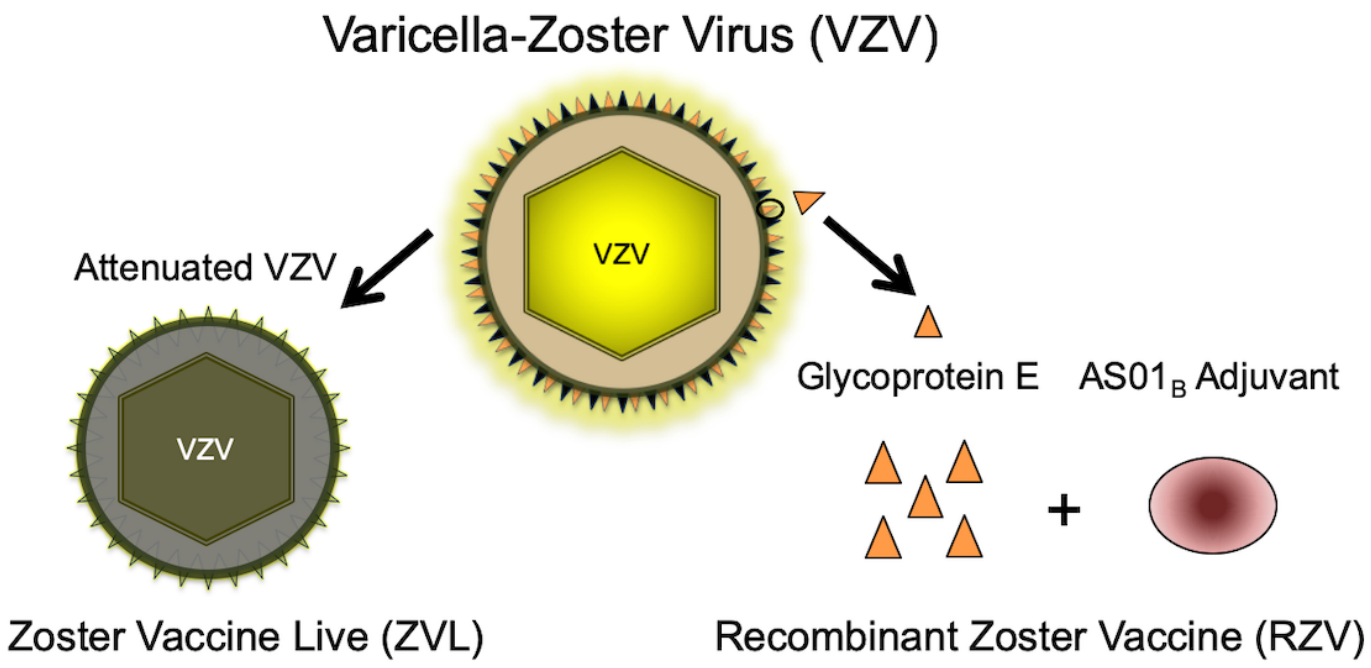

Figure 17 Recommendation for Zoster Vaccine in Persons with HIV

Source: Panel on Opportunistic Infections in Adults and Adolescents with HIV. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. Immunizations for Preventable Diseases in Adults and Adolescents Living with HIV. Last Updated: December 16, 2024.

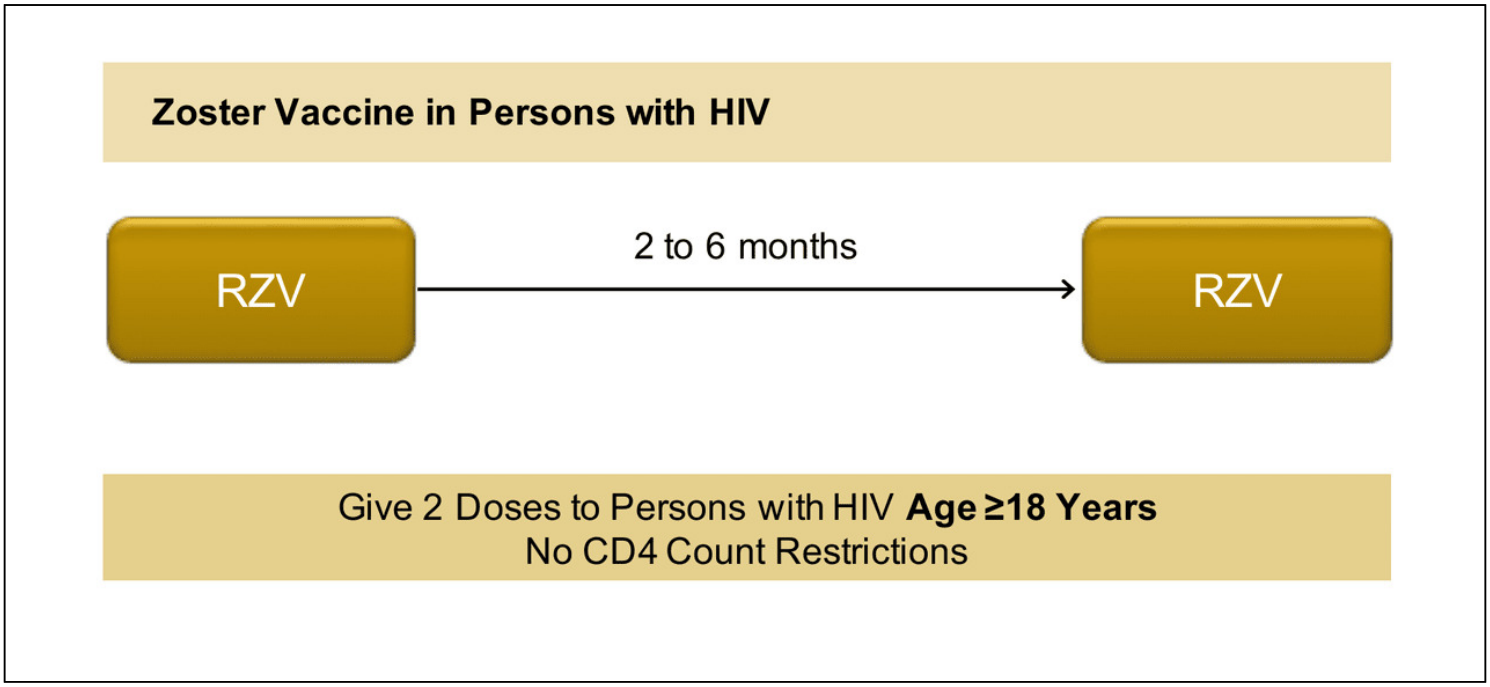

Table 1.

2025 ACIP Recommended Immunizations for Adults with HIV, United States

Vaccines	Abbreviations	CD4 count <15% or <200 cells/mm^3	CD4 cou ≥15% and ≥20
COVID-19	1vCOV-mRNA 1vCOV-aps	**Recommended** Number of doses depends on vaccine and prior COVID immunization history	**Recommended** Number of doses depend on vaccine and prior COVID immunization history
Haemophilus influenza type b	Hib	No Guidance/Not Applicable	
Hepatitis A	HepA	**Recommended** 2 or 3 doses depending on vaccine	
Hepatitis B	HepB	**Recommended** 2 or 3 doses depending on vaccine	
Human papillomavirus	9vHPV	**Recommended** 3 doses through age 26 years (0, 1-2, and 6 month	
Influenza inactivated 3, or Influenza recombinant 3	IIV3 RIV3	**Recommended** 1 dose annually	
Influenza live, attenuated	LAIV3	**Contraindicated**	
Measles-mumps-rubella	MMR	**Contraindicated**	*With no evidence* [&]**Recomme** 2 doses (at least 4
Meningococcal serogroups A, C, W, Y	MenACWY-CRM MenACWY-TT	**Recommended** 2 doses (at least 8 weeks apart), then revaccinate every	
Meningococcal serogroup B	MenB-4C MenB-FHbp	No Guidance/Not Applicable	
Mpox		**Recommended for Persons at Risk** 2 doses (28 days apart)	
Pneumococcal	PCV15 PCV20 PCV21 PPSV23	**Recommended** 1 dose PCV20 or PCV21 or 1 dose PCV15 followed ≥8 weeks by 1 dose PPSV2	
Respiratory Syncytial Virus	RSV	**Recommended for the Following Persons** 1 dose in adults aged ≥75 years 1 dose in adults aged 60-74 years if at increased r	
Tetanus-diphtheria-acellular pertussis Tetanus-diphtheria	Tdap Td	**Recommended** 1 dose Tdap then Td or Tdap booster every 10 yea	
Varicella	VAR	**Contraindicated**	*With no evidence* **Consid** 2 doses (3 mon
Zoster, recombinant	RZV	**Recommended** 2 doses (2-6 months apart) at age ≥19 years	

[†] This table is based on the 2025 ACIP Recommended Adult Immunization Schedule by Medical Condition and Other States.
[&] Recommended if CD4 count greater than 200 cells/mm^3 for at least 6 months with no evidence of immunity to me or rubella

Source:

- Advisory Committee on Immunization Practices (ACIP). Recommended Immunization Schedule for Ages 19 Years or Older, United States, 2025. [ACIP]

Table 2.

Vaccines in the Adult Immunization Schedule

Vaccines	Abbreviations	Trade Names
COVID-19	1vCoVmRNA	Pfizer-BioNTech (*Comirnaty*) Moderna (*Spikevax*)
	1vCoVaPS	Novavax
Haemophilus influenzae type b	Hib	*ActHIB* *Hiberix* *PedvaxHIB*
Hepatitis A vaccine	HepA	*Havrix* *Vaqta*
Hepatitis A and hepatitis B vaccine	HepA-HepB	*Twinrix*
Hepatitis B vaccine	HepB	*Engerix-B* *Heplisav-B* *Recombivax HB*
Human papillomavirus vaccine	HPV	*Gardasil* 9
Influenza vaccine (inactivated, egg-based)	IIV3	Multiple
	aIIV3	*Fluad*
	HD-IIV3	*Fluzone* High-Dose
Influenza vaccine (inactivated, cell culture)	ccIIV3	*Flucelvax*
Influenza vaccine (recombinant)	RIV3	*Flublok*
Influenza vaccine (live, attenuated)	LAIV3	*FluMist*
Measles, mumps, and rubella vaccine	MMR	M-M-R II *Priorix*
Meningococcal serogroups A, C, W, Y vaccine	MenACWY-CRM	*Menveo*
	MenACWY-TT	*MenQuadfi*
Meningococcal serogroup B vaccine	MenB-4C	*Bexsero*
	MenB-FHbp	*Trumemba*
Meningococcal serogroups A, B, C, W, Y vaccine	MenACWY-TT/Men B-FHbp	*Penbraya*
Mpox vaccine	Mpox	*Jynneos*
Pneumococcal conjugate vaccine	PCV15	*Vaxneuvance*
	PCV20	*Prevnar* 20
	PCV21	*Capvaxive*
Pneumococcal 23-valent polysaccharide vaccine	PPSV23	*Pneumovax* 23
Respiratory syncytial virus vaccine	RSV	*Abrysvo* *Arexvy* *mResvia*
Tetanus and diphtheria toxoid vaccine	Td	*Tenivac*
Tetanus and diphtheria toxoids and acellular pertussis vaccine	Tdap	*Adacel* *Boostrix*
Varicella vaccine	VAR	*Varivax*
Zoster vaccine, recombinant vaccine	RZV	*Shingrix*

Source:

- Centers for Disease Control and Prevention. Vaccines in the Adult Immunization Schedule. [CDC]