



CLINICAL GUIDELINES PROGRAM

NEW YORK STATE DEPARTMENT OF HEALTH AIDS INSTITUTE | HIV • HCV • STIs • SUBSTANCE USE • LGBTQ+ HEALTH

Immunizations for Adults With HIV

Updates, Authorship, and Related Resources

Date of current publication	April 30, 2025
Highlights of changes, additions, and updates in the April 30, 2025 edition	COVID-19 section: Recommendation added: “Clinicians should vaccinate individuals with HIV and CD4 counts <350 cells/mm ³ for COVID-19 according to the CDC schedule for individuals who are moderately or severely compromised. (A2)”
Intended users	Clinicians who provide primary care to adults with HIV
Lead authors	Christine Kerr, MD; Mary Dyer, MD
Contributor	Marguerite A. Urban, MD
Writing group	Rona M. Vail, MD, AAHIVS; Sanjiv S. Shah, MD, MPH, AAHIVS; Steven M. Fine, MD, PhD; Joseph P. McGowan, MD, FACP, FIDSA, AAHIVS; Samuel T. Merrick, MD, FIDSA; Asa E. Radix, MD, MPH, PhD, FACP, AAHIVS; Anne K. Monroe, MD, MSPH; Jessica Rodrigues, MPH, MS; Christopher J. Hoffmann, MD, MPH, MSc, FACP; Brianna L. Norton, DO, MPH; Charles J. Gonzalez, MD
Author and writing group conflict of interest disclosures	There are no author or writing group conflict of interest disclosures.
Date of original publication	December 15, 2022
Committee	Medical Care Criteria Committee
Developer and funder	New York State Department of Health AIDS Institute (NYSDOH AI)
Development process	See Supplement: Guideline Development and Recommendation Ratings
Related NYSDOH AI resources	Guidelines <ul style="list-style-type: none">• Prevention and Management of Hepatitis A Virus Infection in Adults With HIV• Prevention and Management of Hepatitis B Virus Infection in Adults With HIV• Prevention and Management of Human Papillomavirus Infection in Adults With HIV• Screening for Anal Dysplasia and Cancer in Adults With HIV• Screening for Cervical Dysplasia and Cancer in Adults With HIV Podcast <ul style="list-style-type: none">• Viremic—Cases in HIV

Immunizations for Adults With HIV

Date of current publication: April 30, 2025

Lead authors: Christine Kerr, MD; Mary Dyer, MD

Contributor: Marguerite A. Urban, MD

Writing group: Rona M. Vail, MD, AAHIVS; Sanjiv S. Shah, MD, MPH, AAHIVS; Steven M. Fine, MD, PhD; Joseph P. McGowan, MD, FACP, FIDSA, AAHIVS; Samuel T. Merrick, MD, FIDSA; Asa E. Radix, MD, MPH, PhD, FACP, AAHIVS; Anne K. Monroe, MD, MSPH; Jessica Rodrigues, MPH, MS; Christopher J. Hoffmann, MD, MPH, MSc, FACP; Brianna L. Norton, DO, MPH; Charles J. Gonzalez, MD

Committee: [Medical Care Criteria Committee](#)

Date of original publication: December 15, 2022

Contents

Purpose of This Guideline	2
Considerations and Contraindications	3
COVID-19	4
Haemophilus Influenzae Type B (Hib)	5
Hepatitis A Virus (HAV)	5
Hepatitis B Virus (HBV)	6
Human Papillomavirus (HPV)	8
Influenza	9
Measles, Mumps, Rubella (MMR)	10
Meningococcal Serotypes A, C, W, and Y (MenACWY)	11
Meningococcal Serotype B (MenB)	11
Mpox	12
Pneumococcal	13
Tetanus, Diphtheria, and Pertussis (Tdap) and Tetanus-Diphtheria (Td)	14
Varicella	15
Zoster	16
All Recommendations	17
References	17
Supplement: Guideline Development and Recommendation Ratings	25

Purpose of This Guideline

This compendium of immunization recommendations for adults (≥ 18 years) with HIV was compiled by the New York State Department of Health AIDS Institute (NYSDOH AI) to assist clinical practitioners in New York State who provide primary care to adults with HIV. The goal is to present a single compilation of all routine vaccinations for adults with HIV recommended by the Centers for Disease Control and Prevention (CDC), National Institutes of Health (NIH), HIV Medicine Association (HIVMA) [DHHS 2022], and the Infectious Disease Society of America [Thompson, et al. 2021]. The European AIDS Clinical Society guidelines were also consulted [EACS 2021]. Where a recommendation differs from these source documents, the rationale is provided.

This document also discusses published literature related to specific vaccines and the rationale for recommendations for which there is no consensus among the referenced guidelines, no evidence specific to patients with HIV, or new data have been published.

Considerations and Contraindications

RECOMMENDATION

Immunizations

- Clinicians should follow the recommendations for routine vaccination of adults with HIV issued by the [Centers for Disease Control and Prevention](#), the [National Institutes of Health](#), the [HIV Medicine Association](#), and the [Infectious Disease Society of America](#), as presented here. (A3)

The tables and accompanying discussion in this guideline compile recommendations, vaccination schedules, clinical comments, and sources from the Centers for Disease Control and Prevention (CDC), National Institutes of Health, and HIV Medicine Association guidelines [DHHS 2022], the Infectious Diseases Society of America [Thompson, et al. 2021], and the European AIDS Clinical Society [EACS 2021].

Immunizations against infectious diseases are a particularly important component of care for individuals with HIV. Immunodeficiency reduces natural defenses to vaccine-preventable diseases in people with HIV and places them at increased risk for disease and for severe disease [Thompson, et al. 2021; Crum-Cianflone and Wallace 2014]. However, there is concern that individuals with HIV-associated immunodeficiency may not be able to mount and maintain an appropriate immune response to vaccines and may be harmed by live virus vaccines. The strength of the immune response may be lower in adults with advanced HIV, especially those with CD4 counts <200 cells/mm³ and/or HIV RNA levels (viral loads) ≥ 200 copies/mL, and shorter in duration than in adults without HIV [Crum-Cianflone and Wallace 2014]. Immunogenicity, vaccine response monitoring, and requirements for additional booster doses for patients with HIV are discussed on pages for individual vaccines.

Inactivated vaccines are generally considered safe, although data are insufficient to rule out rare adverse effects [ACIP 2022; Thompson, et al. 2021]. Live, attenuated vaccines are contraindicated for patients with CD4 counts <200 cells/mm³, because of the risk of severe reactions in individuals who are immunosuppressed [CDC 1996; Redfield, et al. 1987; CDC 1985; Davis, et al. 1977]. For patients with HIV and CD4 counts ≥ 200 cells/mm³, inactivated forms of vaccines such as those for polio, influenza, typhoid, and zoster are preferred over the live vaccine options. Live, attenuated vaccines should be administered only when an inactivated version does not exist and the risk of the disease clearly outweighs the theoretical risk of vaccination.

→ KEY POINTS: USE OF LIVE, ATTENUATED VACCINES

- **Individuals with CD4 count <200 cells/mm³:** The following live, attenuated vaccines are **contraindicated**: Bacillus Calmette-Guérin; measles, mumps, rubella; oral typhoid; rotavirus; varicella; yellow fever; zoster.
- **Individuals with CD4 count ≥ 200 cells/mm³:** Use live, attenuated vaccines only if an inactivated alternative is not available *and* the risk of disease is greater than the risk of vaccination.
- **Patient education:** Patients with HIV should avoid handling diapers of infants vaccinated against rotavirus in the previous 4 weeks, and all household members should wash their hands after changing diapers of an infant recently vaccinated against rotavirus. Those who lack varicella immunity should avoid direct contact with people who develop rash.

Transient increases in viral load and decreases in CD4 cell count caused by immune system activation have been described after vaccination in patients with HIV in some older studies [Kolber, et al. 2002; Rey, et al. 2000]. The changes are less likely to occur in patients taking antiretroviral therapy and have not been found to have long-term negative effects [Thompson, et al. 2021; Sullivan, et al. 2000]. In people older than 5 years with HIV, effective ART is defined as ART taken for ≥ 6 months, with a CD4 percentage $\geq 15\%$ and a CD4 count ≥ 200 cells/mm³ for ≥ 6 months [McLean, et al. 2013]. Viral suppression is defined as an HIV RNA level (viral load) <200 copies/mL.

Clinicians should advise their patients with HIV that family members, close contacts, and other household members should receive all age-appropriate vaccinations, including an annual influenza vaccine, to reduce the patients' exposure to vaccine-preventable diseases [Thompson, et al. 2021; Grohskopf, et al. 2019; Fiore, et al. 2011]. Live, attenuated virus vaccines may be safely administered to close contacts of individuals with HIV, with specific precautions for varicella and rotavirus vaccines. Transmission of live, attenuated virus after vaccination is rare [Thompson, et al. 2021]. However, patients with HIV who lack

varicella immunity are advised to avoid direct contact with people who develop a rash after varicella or zoster vaccination. [Thompson, et al. 2021; Fiore, et al. 2011; Cortese and Parashar 2009; Marin, et al. 2007].

The tables in this guideline (for each vaccine listed) present the recommended immunizations for adults with HIV, followed by discussion of each. For complete vaccination recommendations, see the [CDC Immunization Schedules](#) and the vaccine manufacturers' package inserts.

◊ RESOURCE: HOW TO FILE A CLAIM WITH THE VACCINE INJURY COMPENSATION PROGRAM

- Tel: 1-800-338-2382
- Website: hrsa.gov/vaccinecompensation
- Address to file a claim: US Court of Federal Claims, 717 Madison Place NW, Washington, DC 20439

COVID-19

Table 1: COVID-19 Vaccines

Trade Names See FDA Vaccines Licensed for Use in the United States	<ul style="list-style-type: none"> • Moderna COVID-19 Vaccine (mRNA vaccine) • Pfizer-BioNTech COVID-19 Vaccine (mRNA vaccine) • Novavax COVID-19 Vaccine, Adjuvanted (protein subunit vaccine)
Indications	<ul style="list-style-type: none"> • At least 1 monovalent 2024–2025 COVID-19 vaccine for all individuals aged 18 years and older with HIV • Clinical Guidelines Program recommendation: Clinicians should vaccinate individuals with HIV and CD4 counts <350 cells/mm³ for COVID-19 according to the CDC schedule for individuals who are moderately or severely compromised. (A2)
Administration	Administer according to Tables 1 and 2 in CDC Interim Clinical Considerations for Use of COVID-19 Vaccines in the United States .
Comments	See also CDC Interim Clinical Considerations for Use of COVID-19 Vaccines in the United States > Description of moderate and severe immunocompromising conditions and treatments .
Abbreviations: CDC, Centers for Disease Control and Prevention; FDA, U.S. Food and Drug Administration.	

Universal vaccination: To reduce community transmission and protect individuals with HIV, this committee agrees with the Centers for Disease Control and Prevention (CDC) recommendation for universal vaccination against COVID-19 for adults (aged 18 years and older) with HIV, regardless of prior history of COVID-19 infection. All patients should be vaccinated with the most up-to-date seasonal vaccine.

The CDC recommends that people with advanced HIV (CD4 count <200 cells/mm³, history of an AIDS-defining illness without immune reconstitution, or clinical manifestations of symptomatic HIV) or untreated HIV be vaccinated as per the schedule for moderately or severely immunocompromised patients. However, given evidence that individuals with CD4 counts <350 cells/mm³ are at high risk for breakthrough infection [Lang, et al. 2022], [this committee](#) recommends that this population also be vaccinated as per the CDC schedule for moderately or severely immunocompromised patients.

Schedules for all patients include at least 1 COVID-19 vaccine dose, regardless of prior vaccination.

Discussion: COVID-19 morbidity and mortality are increased among individuals of older age and who have comorbidities that put them at high risk of severe disease [Bhaskaran, et al. 2021; Costenaro, et al. 2021; Mirzaei, et al. 2021; Patel, et al. 2021; Tesoriero, et al. 2021; Cooper, et al. 2020; Nandy, et al. 2020; Ssentongo, et al. 2020]. Although initial studies of HIV and COVID-19-related mortality found conflicting results, a World Health Organization report based on results from 37 countries found a 30% increased risk of severe illness at time of hospital admission and an in-hospital mortality rate of 23.1% for people with HIV [WHO 2021]. Because there is also an increased risk of COVID-19 infection, whether due to overlapping comorbidities or disease-specific factors, people with HIV are a high-priority group for vaccination [Mellor, et al. 2021; Patel, et al. 2021; Ssentongo, et al. 2021; Byrd, et al. 2020].

More than 28 days after COVID-19 infection, individuals with HIV are at increased risk of death and post-acute sequelae of SARS-CoV-2 (PASC), also known as long COVID. Vaccination was associated with significantly lower all-cause mortality and PASC in individuals with HIV previously infected with COVID-19 [Yendewa, et al. 2024].

COVID-19 vaccines have been shown to be safe and highly effective at reducing severe illness, hospitalization, and mortality in the general population [Chenchula, et al. 2024; Grana, et al. 2022]. COVID-19 vaccines have also been shown to be safe and effective in people with HIV [Yin, et al. 2022]. There has been no evidence of decreased vaccine efficacy and no reports of increased vaccine-related adverse effects in people with HIV, although antibody response may peak later and wane earlier [Fowokan, et al. 2023; Chambers, et al. 2022].

Common mild adverse vaccine-related effects include injection site pain, headache, fatigue, myalgias, fever, and nausea. Rarely, more serious allergic reactions can occur. Myocarditis has been reported primarily among young men, mostly after the second dose of an mRNA vaccine, and has been generally mild with spontaneous resolution (see CDC [Clinical Considerations Myocarditis and Pericarditis after Receipt of COVID-19 Vaccines Among Adolescents and Young Adults](#)).

→ KEY POINTS

- Medical mistrust may prevent people in high vaccine priority groups from seeking or agreeing to vaccination [Bogart, et al. 2021]; heightened awareness and open discussion of medical mistrust are essential to encouraging vaccination of people with HIV.
- The effects of systemic racism and associated health inequities made apparent by the U.S. COVID-19 pandemic may create barriers to vaccine access among some people with HIV. Clinicians who provide medical care for people with HIV are strongly encouraged to discuss and advocate for vaccination with all of their patients.

Haemophilus Influenzae Type B (Hib)

Table 2: Haemophilus influenzae Type B Vaccine

Trade Names	<ul style="list-style-type: none"> • Hiberix • ActHIB
Indications	Patients at risk of Hib infection
Administration	Administer according to CDC Adult Immunization Schedule .
Revaccination	None
Comments	Not routinely recommended for people with HIV in the absence of other risk factors
Abbreviations: CDC, Centers for Disease Control and Prevention; Hib, <i>Haemophilus influenzae</i> type B.	

Discussion: Hib vaccination is not routinely recommended for patients with HIV in the absence of other risk factors, such as anatomic or functional asplenia, sickle cell disease, or hematopoietic stem cell transplant, because there is a low risk of Hib infection in adults with HIV [CDC 2023; Thompson, et al. 2021; Briere, et al. 2014]. Data on the safety and efficacy of the Hib vaccine among adults with HIV indicate a strong immune response, similar to that in adults without HIV, except among those with severe immunosuppression [MacLennan, et al. 2016; Dockrell, et al. 1999; Kroon, et al. 1997; Steinhoff, et al. 1991].

Hepatitis A Virus (HAV)

Table 3: Hepatitis A Virus Vaccine

Trade Names	<ul style="list-style-type: none"> • HAV: Havrix; Vaqta • HAV inactivated + HBV: Twinrix
Indications	All adults with HIV [CDC(a) 2022]

Table 3: Hepatitis A Virus Vaccine	
Administration	<ul style="list-style-type: none"> Administer according to CDC Adult Immunization Schedule. Notes: <ul style="list-style-type: none"> Obtain HAV IgG testing ≥ 1 month after final dose of vaccination series to confirm immune response. If immune reconstitution appears likely, consider deferring until patient’s CD4 count ≥ 200 cells/mm³ [DHHS 2022].
Revaccination	Patients who do not respond to the primary HAV vaccination series should be revaccinated [Thompson, et al. 2021] and counseled to avoid exposure.
Comments	<ul style="list-style-type: none"> See NYSDOH AI guideline Prevention and Management of Hepatitis A Virus Infection in Adults With HIV. Covered by HRSA Vaccine Injury Compensation Program
Abbreviations: CDC, Centers for Disease Control and Prevention; HAV, hepatitis A virus; HBV, hepatitis B virus; HRSA, Health Resources and Services Administration; IgG, immunoglobulin G.	

Discussion: The HAV vaccine is recommended for all adults with HIV who do not have immunity to HAV [CDC(a) 2022; Thompson, et al. 2021].

The reported rate of HAV antibody seroconversion after vaccination ranges from 49% to 96% [Mena, et al. 2015; Crum-Cianflone and Wallace 2014; Fiore, et al. 2006]. A long-term follow-up study reported that more than 85% of individuals who seroconverted after vaccination had a sustained antibody response for 5 to 10 years [Cheng, et al. 2017; Crum-Cianflone(b), et al. 2011]. Although immunocompetent individuals with HIV respond to the HAV vaccine nearly as well as individuals without HIV, individuals with lower CD4 cell counts are less likely to acquire protective levels of antibody [Mena, et al. 2015; Crum-Cianflone and Wallace 2014; Fiore, et al. 2006].

If a patient’s CD4 count is < 200 cells/mm³ or the patient has symptomatic HIV, it is preferable to defer vaccination until several months after initiation of antiretroviral therapy to maximize the antibody response to the vaccine [DHHS 2022]. HAV vaccination should not be deferred in patients who are unlikely to achieve an increased CD4 cell count.

Care providers should [perform HAV IgG testing](#) at least 1 month after the final dose of the vaccination series to confirm immune response. HAV vaccination should be repeated in patients with no response to initial vaccination, [Thompson, et al. 2021], and they should be counseled to avoid exposure to HAV because they remain susceptible to infection, although a small study reported that 31% of participants who had not seroconverted at month 12 and before month 18 (n = 16) subsequently seroconverted after completing the 2-dose vaccination series [Cheng, et al. 2017]. If a patient is susceptible to both HAV and HBV, the combined HAV/HBV vaccine (given as 3 doses at 0, 1, and 6 months) can be used regardless of the patient’s immune status [Thompson, et al. 2021].

Hepatitis B Virus (HBV)

Table 4: Hepatitis B Virus Vaccine	
Trade Names	<ul style="list-style-type: none"> HBV 2-dose series: HEPLISAV-B (see comments) HBV 3-dose series: Engerix-B; Recombivax HB; PreHevbrio (see comments) HAV inactivated + HBV 3-dose series: Twinrix
Indications	Patients who are negative for anti-HBs and do not have chronic HBV infection
Administration	<ul style="list-style-type: none"> Administer according to CDC Adult Immunization Schedule. Notes: <ul style="list-style-type: none"> Alternative administration strategies, such as a 3- or 4-injection double-dose vaccination series or an accelerated schedule of 0, 1, and 3 weeks, may be considered [DHHS 2022]. Test for anti-HBs 4 to 16 weeks after administration of the last dose of the vaccination series.

Table 4: Hepatitis B Virus Vaccine

Revaccination	Patients who do not respond to the primary HBV vaccination series (anti-HBs <10 IU/L) should be revaccinated with Heplisav-B or a double dose of the vaccine series previously administered.
Comments	<ul style="list-style-type: none"> • PreHevbrio, a 3-antigen recombinant HBV vaccine, was approved in 2021 by the FDA for use for individuals ≥18 years old, but as of November 2024 is no longer available. See FDA PREHEVBRIO. • In patients at risk for HBV infection, initial vaccination should not be deferred if the CD4 count is <200 cells/mm³ [DHHS 2022]. • If an accelerated schedule is used, a fourth booster dose should be administered ≥6 months after initiation of the series; the accelerated schedule is not recommended for patients with CD4 counts <500 cells/mm³. • The HAV/HBV combined vaccine is not recommended for the double-dose or 4-injection HBV vaccination strategy. • Heplisav-B is not recommended in pregnancy because of lack of safety data [CDC 2023]. • See NYSDOH AI guideline Prevention and Management of Hepatitis B Virus Infection in Adults With HIV. • Covered by HRSA Vaccine Injury Compensation Program

Abbreviations: anti-HBs, hepatitis B surface antibody; CDC, Centers for Disease Control and Prevention; FDA, U.S. Food and Drug Administration; HAV, hepatitis A virus; HBV, hepatitis B virus; HRSA, Health Resources and Services Administration.

Discussion: The HBV vaccine is recommended for all adults with HIV who do not have immunity to HBV and who do not have chronic HBV infection [CDC 2023]. The antibody response to the HBV vaccine is reduced in individuals with HIV compared with those who do not have HIV; the reported immune response to the standard dose (20 µg) ranges from 34% to 89% [Mena, et al. 2015; Mast, et al. 2006], with diminishing response with lower CD4 cell counts [Pollack, et al. 2016; Pettit, et al. 2010; Kim, et al. 2008; Overton, et al. 2005]. Undetectable or very low viral load is associated with increased response to HBV vaccination [Mena, et al. 2015; Kim, et al. 2008; Overton, et al. 2005]. Initial vaccination should not be deferred in patients with low CD4 cell counts; some patients with HIV and CD4 counts ≤200 cells/mm³ may have an immune response [DHHS 2022; Whitaker, et al. 2012].

The 3 single-antigen HBV vaccines currently approved by the FDA for individuals ≥18 years old are Engerix-B, Recombivax HB, and Heplisav-B.

In 3 randomized controlled trials among individuals without HIV, administration of 2 doses of Heplisav-B was associated with a higher seroprotection rate than 3 doses of Engerix-B [FDA(b) 2020]. However, the 3 formulations have not yet been established to be equally effective in patients with HIV. A retrospective cohort study among individuals with HIV found seroprotection rates were increased with the Heplisav-B vaccine compared with other previously used HBV vaccines [Schnittman, et al. 2021]. In addition, a recent modeling study determined that use of Heplisav-B among individuals with HIV results in lower costs and increased benefits compared with Engerix-B [Rosenthal, et al. 2020]. The 2-dose option may facilitate completion rates for the vaccination series.

Improved immune response has been reported using a 4-injection double-dose (40 µg) regimen [Chaiklang, et al. 2013; Launay, et al. 2011]. Studies of a 3-injection double-dose regimen reported increased seroconversion rates compared with standard dose only among adults with HIV with CD4 counts >350 cells/mm³ and low or undetectable HIV viral load [Potsch, et al. 2012; Fonseca, et al. 2005]. Accelerated schedules (0, 1, and 3 weeks) may increase adherence to the full vaccination series but are not recommended for patients with CD4 counts ≤500 cells/mm³ because of the increased likelihood of nonresponse [de Vries-Sluijs, et al. 2011]. Patients with HIV should be tested for anti-HBs 4 to 16 weeks after completing the vaccination series [DHHS 2022; Thompson, et al. 2021]. Other strategies to improve immune response have demonstrated some success, including intradermal administration [Launay, et al. 2011] and addition of adjuvants [Overton, et al. 2010; Cooper, et al. 2005; Sasaki, et al. 2003], but the evidence is not sufficient to make a recommendation.

Patients who do not respond to primary vaccination should be revaccinated with Heplisav-B or a double dose of the vaccine series previously administered. In a recent retrospective, cross-sectional study among individuals with HIV who failed to seroconvert after vaccination (anti-HBs negative and hepatitis B surface antigen negative) with Engerix-B or Recombivax HB, revaccination with Heplisav-B was highly effective in achieving seroprotection [Khaimova, et al. 2021]. If Heplisav-B is not administered as the initial HBV vaccination series, revaccination with the 2-dose series may be considered. Several studies have reported increased response rates from double-dose revaccination [Pseudos, et al. 2010; Cardell, et al. 2008; de Vries-Sluijs, et al. 2008], although the only randomized controlled trial comparing a 3-injection standard dose (20 µg) to a 3-

injection, double-dose (40 µg) regimen for revaccination found no difference in response rates. However, the double-dose regimen resulted in a greater and more durable immune response [Rey, et al. 2015]. In patients who do not have an immune response to HBV vaccination and are initiating antiretroviral therapy, revaccination can be deferred until the CD4 count increases to ≥200 cells/mm³ [DHHS 2022]. Revaccination should not be delayed in patients who are unlikely to achieve an increased CD4 cell count.

For people who are susceptible to both HAV and HBV, the combined HAV/HBV vaccine can be used regardless of immune status, with 3 doses administered at 0, 1, and 6 months. Because no data are available regarding double-dose or 4-injection HBV vaccination with the combined HAV/HBV vaccine in individuals with HIV, the combined vaccine is not recommended for the double-dose or 4-injection HBV vaccination strategy.

Human Papillomavirus (HPV)

Table 5: Human Papillomavirus Vaccine	
Trade Name	Gardasil 9
Indications	All patients 9 to 45 years old who were not previously vaccinated or did not receive a complete 3-dose series
Administration	Administer through age 45 years as a 3-dose series according to CDC Adult Immunization Schedule .
Revaccination	None
Comments	<ul style="list-style-type: none"> • A 2-dose schedule is not recommended [CDC(a) 2021]. • Because of the broader coverage offered by the 9-valent HPV vaccine, it is the only HPV vaccine currently available in the United States. • Although the 9-valent vaccine has not been specifically studied in people with HIV, it is expected that the response will be the same in this population as with the quadrivalent vaccine. • Follow recommendations for cervical and anal cancer screening in NYSDOH AI guidelines Screening for Cervical Dysplasia and Cancer in Adults With HIV and Screening for Anal Dysplasia and Cancer in Adults With HIV. • Covered by HRSA Vaccine Injury Compensation Program
Abbreviations: CDC, Centers for Disease Control and Prevention; HPV, human papillomavirus; HRSA, Health Resources and Services Administration.	

Discussion: In 2006, the U.S. Food and Drug Administration (FDA) approved a 9-valent vaccine that protects against nononcogenic HPV types 6 and 11 and oncogenic HPV types 16, 18, 31, 33, 45, 52, and 58 ([Gardasil 9](#)). Because it offers broader coverage of HPV types than other vaccines, the 9-valent vaccine is the only HPV vaccine available in the United States (see CDC: [Supplemental information and guidance for vaccination providers regarding use of 9-valent HPV](#) for more information). The HPV vaccine is approved by the FDA for preventive but not therapeutic use.

Extrapolating data from the demonstrated effectiveness of the quadrivalent HPV vaccine in older individuals [Wilkin, et al. 2018], the FDA expanded the age range for approved use of the HPV vaccine in the United States from ages 9 to 26 years to ages 9 to 45 years [FDA(a) 2020]. There is no specific mention of HIV infection in the updated FDA approval. Although 1 study demonstrated lower efficacy of the quadrivalent vaccine in individuals with HIV [Wilkin, et al. 2018], other research linked HIV viral suppression to vaccine efficacy [Money, et al. 2016].

When to vaccinate: HPV vaccination may be scheduled at the same time as standard adolescent vaccines offered at ages 9 to 12 years [CDC(a) 2021]. If possible, the HPV vaccine series should begin at 9 years old. The 3-dose vaccine is recommended for all patients with HIV who are 9 to 45 years old. The 9-valent HPV vaccine should be administered according to the CDC standard schedule for immunocompromised adults, children, and adolescents (a 3-dose regimen over a 6-month period at 0, 2, and 6 months) and should be offered regardless of CD4 cell count.

HPV vaccination provides high levels of neutralizing antibodies for at least 5 years and is protective in individuals ≤ 26 years old who do not have HIV, regardless of history of sexual activity; however, the full length of its protection has not been established. In an observational study conducted in England that examined the effectiveness of a national HPV immunization program, the reduction in cervical cancer was greatest in individuals who received the vaccine at ages 12 to 13 years [Falcaro, et al. 2021]. Although data are limited, the immunogenicity of the quadrivalent HPV vaccine has been demonstrated in individuals with HIV [Wilkin, et al. 2018; Kojic, et al. 2014].

Vaccination is not expected to change the course of established HPV infections but may prevent infection from other strains that are part of a polyvalent vaccine.

HPV testing and vaccination: HPV testing is not recommended before vaccine administration. It is unlikely that an individual will have been infected with all the HPV types covered by the 9-valent vaccine; therefore, it is expected that the 9-valent HPV vaccine will be effective against any of the 9 HPV types or any HPV types to which the individual has not been exposed. There also may be beneficial prevention due to cross-reactivity with other HPV types not included in the 9-valent vaccine [Wheeler, et al. 2012].

Revaccination with the 9-valent HPV vaccine is not currently recommended for individuals who previously received the bivalent or quadrivalent HPV vaccine [Petrosky, et al. 2015]. Vaccination with the quadrivalent HPV vaccine has demonstrated cross-protection against other oncogenic HPV types [Kemp, et al. 2011]. There is no maximum interval between vaccine doses as long as 3 doses are given, so there is no need to repeat doses if a scheduled vaccination is missed [CDC(a) 2021].

Influenza

Table 6: Influenza Vaccine	
Trade Names	See Table 1 in CDC Prevention and Control of Seasonal Influenza with Vaccines: Recommendations of the Advisory Committee on Immunization Practices — United States, 2025–26 Influenza Season .
Indications	All adults with HIV
Administration	Administer annually during flu season (October through May) according to CDC Adult Immunization Schedule .
Revaccination	None
Comments	Covered by HRSA Vaccine Injury Compensation Program
Abbreviations: CDC, Centers for Disease Control and Prevention; HRSA, Health Resources and Services Administration.	

Discussion: People with HIV are at greater risk of severe morbidity from an influenza infection [Grohskopf, et al. 2019; Kunisaki and Janoff 2009] than people who do not have HIV and should be vaccinated annually during flu season (October through May) according to [standard CDC guidelines](#) for all adults [Thompson, et al. 2021; Grohskopf, et al. 2019]. Inactivated influenza vaccine offers protective immunity in adults with HIV [Grohskopf, et al. 2019; Renschmidt, et al. 2014; Beck, et al. 2012]. Live, attenuated influenza vaccine should not be used for individuals with HIV. Antibody titers lower than those observed in the general population have been reported among adults with HIV, especially among those with advanced HIV disease who are ≥ 35 years old, have low CD4 cell counts, and have detectable viremia [Garg, et al. 2016; Crum-Cianflone(a), et al. 2011; Evison, et al. 2009; Yamanaka, et al. 2005; Kroon, et al. 2000]. Studies comparing intradermal and intramuscular vaccines report no difference in immunogenicity, but intradermal vaccination is associated with increased likelihood of redness, swelling, and tenderness at the injection site [Garg, et al. 2016; Seo, et al. 2016].

The CDC does not recommend a second vaccination in individuals with HIV [Grohskopf, et al. 2019], although one study reported that a second dose of an adjuvanted vaccine significantly increased the rate of seroprotective responses [Bickel, et al. 2011]. There is some evidence that influenza seroprotection is higher for people ≥ 18 years old who are given a double-dose vaccine than for those given the standard dose vaccine, but the clinical significance of this remains unknown [McKittrick, et al. 2013; Cooper, et al. 2011]. A study among children and young adults (3 to 21 years old) found no increased immunity among participants with HIV who received the double-dose vaccine [Hakim, et al. 2016].

Results of 2 studies suggest a possible benefit to delaying influenza vaccination to after mid-November; patients vaccinated later in the flu season had lower rates of laboratory-confirmed influenza and influenza-like illnesses than those vaccinated earlier in the season [Glinka, et al. 2016; Werker, et al. 2014]. Monitoring regional influenza activity will help ensure appropriate timing of influenza vaccination. There is no recommendation for post-vaccination serologic testing to determine immune response [Grohskopf, et al. 2019].

Measles, Mumps, Rubella (MMR)

Table 7: Measles, Mumps, Rubella Vaccine	
Trade Name	M-M-R II
Indications	For patients with CD4 counts ≥ 200 cells/mm ³ for ≥ 6 months who do not have evidence of MMR immunity
Administration	Administer according to the CDC Adult Immunization Schedule .
Revaccination	Recommended only in the setting of an outbreak
Comments	<ul style="list-style-type: none"> • Contraindicated for patients with CD4 counts < 200 cells/mm³ • The MMR + varicella vaccine (ProQuad) should not be substituted for the MMR vaccine [McLean, et al. 2013]. • Those who previously received 2 doses of a mumps-containing vaccine and are at increased risk for mumps in the setting of an outbreak should receive a third dose to improve protection against mumps disease and related complications [Marin, et al. 2018]. • Covered by HRSA Vaccine Injury Compensation Program
Abbreviations: CDC, Centers for Disease Control and Prevention; HRSA, Health Resources and Services Administration; MMR, measles, mumps, rubella.	

Discussion: Immunocompromised individuals are at increased risk of serious and life-threatening complications if infected with measles [McLean, et al. 2013]. Patients with HIV who have CD4 counts ≥ 200 cells/mm³ for ≥ 6 months and who do not have evidence of immunity to MMR should be vaccinated with 2 doses of MMR vaccine ≥ 4 weeks apart. Documentation of previous age-appropriate vaccination or laboratory confirmation of prior disease is acceptable evidence of immunity. Serologic screening is required if other acceptable evidence of immunity is not available and to determine rubella immunity among individuals of childbearing potential. In the absence of other evidence of immunity, individuals with perinatally acquired HIV who received childhood vaccination with MMR before establishment of effective antiretroviral therapy (ART) should be revaccinated (2 doses) after effective ART is established [McLean, et al. 2013]. There is no recommendation for post-vaccination serologic testing to determine immune response [McLean, et al. 2013].

Two studies that examined the antibody response after MMR vaccination in adults with HIV taking ART reported high levels of protective antibodies post-vaccination, although the levels were lower than in adults without HIV. A study conducted in Mexico among adults with HIV who were seronegative for measles reported no significant difference in initial antibody response to measles vaccination between adults with and without HIV (81% vs. 85%). However, at 1 year, the observed decline in antibody response was faster in adults with HIV than in those without HIV [Belaunzaran-Zamudio, et al. 2009]. A study in Thailand reported protective antibodies to measles (74.1%), mumps (65.7%), and rubella (93.3%) among adults with HIV 8 to 12 weeks after MMR vaccination. Compared with adults without HIV, the seroconversion rates were lower but reached statistical significance only for mumps [Chaiwarith, et al. 2016].

No data are available on revaccination in adults with HIV. Revaccination has improved measles antibody response in children with HIV on ART who had an inadequate initial response to vaccination [Abzug, et al. 2012; Aupibul, et al. 2007]. If individuals previously vaccinated with 2 doses of a mumps-containing vaccine are identified as having increased risk for mumps by public health authorities because of an outbreak, these at-risk individuals should receive a third dose of a mumps-containing vaccine to improve protection against mumps disease and related complications [Marin, et al. 2018].

MMR vaccination contains live virus and is contraindicated for patients with CD4 counts < 200 cells/mm³ because of reports of adverse events, such as measles pneumonitis, in severely immunocompromised patients [Angel, et al. 1998; CDC 1996]. Serious adverse effects have not been reported in adults who were not severely immunocompromised [Chaiwarith, et al.

2016; McLean, et al. 2013; Belaunzaran-Zamudio, et al. 2009]. The MMR + varicella vaccine has not been adequately studied in individuals with HIV and is not recommended as a substitute for the MMR vaccine in this population [McLean, et al. 2013].

Meningococcal Serotypes A, C, W, and Y (MenACWY)

Table 8: Meningococcal Serotypes A, C, W, and Y Vaccine	
Trade Names	<ul style="list-style-type: none"> • Menactra (MenACWY-D) • Menveo (MenACWY-CRM) • MenQuadfi (MenACWY-TT)
Indications	All patients with HIV
Administration	<ul style="list-style-type: none"> • Administer 2 doses of MenACWY vaccine ≥8 weeks apart in those not previously vaccinated. • For those previously vaccinated with 1 dose of MenACWY vaccine, administer the second dose at the earliest opportunity ≥8 weeks after the previous dose. • See CDC Adult Immunization Schedule.
Revaccination	Administer 1 booster dose of MenACWY vaccine every 5 years.
Comments	<ul style="list-style-type: none"> • MenACWY-D should not be administered until ≥4 weeks after pneumococcal conjugate vaccine. • See Meningococcal Disease: NYSDOH Health Advisory and Vaccine Recommendations • Covered by HRSA Vaccine Injury Compensation Program
Abbreviations: CDC, Centers for Disease Control and Prevention; HRSA, Health Resources and Services Administration; MenACWY, meningococcal serotypes A, C, W, and Y.	

Discussion: Adults with HIV are at increased risk of invasive meningococcal disease due to serogroups C, W, and Y [Mbaeyi, et al. 2020; Folaranmi, et al. 2017]. A study in New York City reported a 10-fold increased risk of invasive meningococcal disease in patients with HIV, with the highest risk among those with CD4 counts ≤200 cells/mm³ [Miller, et al. 2014]. As of 2020, the CDC recommends vaccinating all previously unvaccinated adults with HIV with a 2-dose primary series of MenACWY vaccine (MenACWY-CRM, MenACWY-D, or MenACWY-TT) administered ≥8 weeks apart [Mbaeyi, et al. 2020].

Data on meningococcal vaccine efficacy among adults with HIV are not currently available [Mbaeyi, et al. 2020]. Among adolescents with HIV, available evidence indicates that the vaccine is immunogenic and serious adverse events are rare, but adolescents with HIV (and especially those with lower CD4 cell counts and higher viral loads) had reduced antibody levels compared with adolescents without HIV [Lujan-Zilbermann, et al. 2012; Siberry, et al. 2010]. Adding a second vaccine dose significantly improved antibody levels 28 and 72 weeks after immunization, particularly among adolescents with CD4% ≥15 [Lujan-Zilbermann, et al. 2012].

Booster doses every 5 years are needed to maintain immunity. There is no recommendation for post-vaccination serologic testing to determine immune response [Mbaeyi, et al. 2020].

Meningococcal Serotype B (MenB)

Table 9: MenB Vaccine for Prevention of MenB Infection	
Trade Names	<ul style="list-style-type: none"> • Bexsero (4CMenB) • Trumenba (MenB-FHbp)
Indications	Patients at risk of MenB infection
Administration	Administer according to CDC Adult Immunization Schedule .
Revaccination	None

Table 9: MenB Vaccine for Prevention of MenB Infection	
Comments	<ul style="list-style-type: none"> • Bexsero (4CMenB) and Trumenba (MenB-FHbp) are not interchangeable • Not routinely recommended for people with HIV in the absence of other risk factors • Covered by HRSA Vaccine Injury Compensation Program
Abbreviations: CDC, Centers for Disease Control and Prevention; HRSA, Health Resources and Services Administration; MenB, meningococcal serotype B.	

Discussion: The MenB vaccine offers protection against MenB infection. MenB vaccine is not routinely recommended for adults with HIV unless they have another indication for immunization. No increased risk of serogroup B meningococcal disease among individuals with HIV has been reported [CDC 2023].

Mpox

☑ RECOMMENDATIONS
<p>Mpox Vaccine</p> <ul style="list-style-type: none"> • Clinicians should recommend vaccination against mpox (formerly “monkeypox”) for individuals ≥18 years old with HIV who are at high risk of or who have been exposed to mpox within the past 14 days and for whom vaccination may reduce the risk of infection or decrease symptoms if infection has occurred. (A2) • Clinicians should use only the JYNNEOS (Imvamune or Imvanex) mpox vaccine for individuals with HIV, as it is the only available vaccine that is considered safe for administration in this population. (A*) • Clinicians should recommend vaccination for adults with HIV, regardless of their CD4 cell count and degree of viral suppression. (A3)

Table 10: Mpox Vaccine [a]	
Trade name	JYNNEOS (also called Imvamune or Imvanex)
Type of vaccine	Live virus that does not replicate efficiently in human cells
Administration	Two subcutaneous injections 4 weeks apart
Indication	Individuals with HIV ≥18 years old who are at high risk of or who have been exposed to mpox within the past 14 days
Adverse reactions	Injection site reactions such as pain, swelling, and redness. Vaccination with JYNNEOS will not cause mpox infection.
Contraindications	Severe allergy to any component of the vaccine (gentamicin, ciprofloxacin, or egg protein)
Immune response	Maximal development of the immune response takes 2 weeks after second dose.
Pregnancy/ breastfeeding	No evidence of reproductive harm from animal data. Pregnancy and breastfeeding are not contraindications for vaccination.
Abbreviation: CDC, Centers for Disease Control and Prevention.	
Note:	
a. See package insert and CDC Interim Clinical Considerations for Use of JYNNEOS and ACAM2000 Vaccines During the 2022 U.S. Monkeypox Outbreak .	

Immunization: The CDC considers people with HIV to be at risk for severe mpox disease and recommends prioritization of those at risk for receipt of the JYNNEOS mpox vaccine [CDC(b) 2022]. Vaccination is used to prevent mpox and as post-exposure prophylaxis; it protects against disease when administered before exposure. If administered after exposure, the

vaccine may prevent development or decrease the severity of mpox disease (see CDC [Interim Clinical Considerations for Use of JYNNEOS and ACAM2000 Vaccines During the 2022 U.S. Monkeypox Outbreak](#)).

Two vaccines against mpox are currently approved by the U.S. Food and Drug Administration: JYNNEOS (Imvamune or Imvanex) and ACAM2000. Only JYNNEOS is safe for people with HIV. The ACAM2000 vaccine is contraindicated in adults with HIV and their household contacts.

JYNNEOS contains live vaccinia virus, but the virus does not replicate in humans. JYNNEOS is considered safe to use in adults with HIV regardless of viral load or CD4 cell count. No data are available on the effectiveness of available mpox vaccines in this current outbreak.

The safety and immunogenicity of the JYNNEOS vaccine have been evaluated in adults with HIV; however, the immunogenicity is unknown in individuals who are not virally suppressed or who have with CD4 counts ≤ 200 cells/mm³. Vaccine efficacy may be lower in patients with low CD4 cell counts. However, given the risk of severe illness in immunosuppressed individuals, vaccination is recommended regardless of CD4 cell count and degree of viral suppression.

Vaccine dosing: The CDC recommends the mpox vaccine be given within 4 days of exposure to prevent disease. If given 4 to 14 days after exposure, vaccination may not prevent disease but may reduce symptoms [CDC(b) 2022]. Peak immunogenicity is achieved 2 weeks after the second JYNNEOS dose [Rao, et al. 2022].

→ KEY POINTS

- JYNNEOS (Imvamune or Imvanex) is the only mpox vaccination safe for adults with HIV.
- Care should be taken to avoid language and behavior that marginalizes and stigmatizes communities at risk.

Presentation: A high index of suspicion is required because the clinical presentation of mpox disease can vary from a few scattered papules and mild constitutional symptoms to severe illness. Symptoms of mpox may include fever, headache, muscle aches, backache, swollen lymph nodes, moderate to severe pain, exhaustion, and rash that may include painful oral, anal, or genital lesions.

Mortality: Studies of mpox in remote, medically underserved areas of Central Africa have reported mortality of 11% in unvaccinated individuals [Durski, et al. 2018]. People with advanced HIV or who are not virally suppressed may be at risk of severe disease. To date, no deaths have been reported in the United States during the current outbreak, but a fulminant form of mpox has been reported in people with advanced immunosuppression due to HIV [Mitja, et al. 2023].

Transmission: Although many of those affected in the current global outbreaks are men who have sex with men, the virus can be acquired by anyone who has been in close contact with someone with mpox. The virus that causes mpox is transmitted via the following:

- Direct skin-to-skin contact with an infectious rash, scabs, or body fluids
- Exposure to respiratory secretions during prolonged face-to-face contact or intimate physical contact, such as kissing, cuddling, or sex
- Touching objects or fabrics (e.g., clothing or linens) that have been in contact with the rash or body fluids of someone with mpox
- Being scratched or bitten by an infected animal

Pneumococcal

Table 11: Pneumococcal Vaccine [a]	
Trade Names	<ul style="list-style-type: none"> • Vaxneuvance (PCV15; 15-valent pneumococcal conjugate vaccine) • Prevnar 20 (PCV20; 20-valent pneumococcal conjugate vaccine) • Pneumovax 23 (PPSV23; 23-valent pneumococcal polysaccharide vaccine)
Indications	All patients with HIV

Table 11: Pneumococcal Vaccine [a]	
Administration	For patients who have not received a pneumococcal vaccine or whose vaccination status is unknown: Vaccinate with 1 dose of PCV15 or 1 dose of PCV20. If PCV15 is used, follow with 1 dose of PPSV23, with a minimum interval of 8 weeks between the doses.
Revaccination	Consult CDC PneumoRecs VaxAdvisor
Comments	<ul style="list-style-type: none"> Pneumococcal vaccination should be not be deferred for patients with CD4 count <200 cells/mm³ and/or detectable viral load; however, the follow-up secondary administration of the PPSV23 vaccine may be deferred until the patient’s CD4 count is ≥200 cells/mm³ and/or viral load is undetectable. The Menactra (MenACWY-D) vaccine for meningococcal serotype groups A,C, W, and Y (MenACWY) should not be administered until ≥4 weeks after pneumococcal conjugate vaccine.
Abbreviation: CDC, Centers for Disease Control and Prevention.	
Note:	
a. See also Tables 1 and 2 in CDC Recommended Adult Immunizations Schedule for Ages 19 Years or Older and ACIP Recommendations: Pneumococcal Vaccine .	

Discussion: Individuals with HIV are at increased risk of serious disease due to *Streptococcus pneumoniae*, including bacteremia, meningitis, and pneumonia. Pneumococcal vaccination is recommended for all adults with HIV as soon as possible after HIV diagnosis [CDC 2023; Kobayashi, et al. 2022]. Patients who have not previously been vaccinated or whose vaccination status is unknown should receive 1 dose of PCV15 or 1 dose of PCV20; if PCV15 is used, it should be followed with 1 dose of PPSV23, with a minimum interval of 8 weeks between the doses. There is no recommendation for post-vaccination serologic testing to determine immune response [CDC 2023; Kobayashi, et al. 2022]. See the CDC [PneumoRecs VaxAdvisor](#) for vaccination recommendations by age and pneumococcal immunization history.

Pneumococcal vaccination has been shown to reduce pneumococcal bacteremia and mortality among adults with HIV [Chowers, et al. 2017; Rodriguez-Barradas, et al. 2008; Grau, et al. 2005; Hung, et al. 2004]. Both polysaccharide and conjugate pneumococcal vaccines appear to be safe and immunogenic among adults with HIV who have CD4 counts ≥200 cells/mm³ [Lombardi, et al. 2016; Bhorat, et al. 2015; Rodriguez-Barradas, et al. 2015; Ho, et al. 2013].

Patients with CD4 counts <200 cells/mm³ are at the highest risk of pneumococcal disease. Immunogenicity was demonstrated for individuals with HIV with CD4 counts <200 cells/mm³ who received PCV7 [French, et al. 2010]. Patients with HIV who have not previously received any pneumococcal vaccine should receive a dose of PCV15 or PCV20, regardless of CD4 cell count. Although there is evidence of the effectiveness of PPSV23 among patients with CD4 counts <200 cells/mm³, the benefit appears to be greatest among patients with HIV RNA levels <100,000 copies/mL and among those who are on antiretroviral therapy [French, et al. 2010].

Contraindications to pneumococcal vaccination include a history of anaphylaxis caused by any vaccine component. Patients with a history of an anaphylactic reaction to any conjugate vaccines or diphtheria toxoid should not receive conjugate vaccine [CDC 2023].

Tetanus, Diphtheria, and Pertussis (Tdap) and Tetanus-Diphtheria (Td)

Table 12: Tdap and Td Vaccines	
Trade Names	<ul style="list-style-type: none"> Tdap: Adacel; Boostrix Td: Tenivac; TDVax
Indications	All adult patients
Administration	Administer according to CDC Adult Immunization Schedule .

Table 12: Tdap and Td Vaccines	
Revaccination	Td is usually given as a booster dose every 10 years, but it can also be given earlier after a severe and dirty wound or burn.
Comments	Covered by HRSA Vaccine Injury Compensation Program
Abbreviations: CDC, Centers for Disease Control and Prevention; HRSA, Health Resources and Services Administration; Tdap, tetanus, diphtheria, and pertussis; Td, tetanus-diphtheria.	

Discussion: The recommendations for Tdap and Td vaccination of adults with HIV are the same as for those in the general population [CDC 2023; Thompson, et al. 2021]. The safety and efficacy of vaccination with Tdap has not been studied in this population [Crum-Cianflone and Wallace 2014].

Varicella

Table 13: Varicella Vaccine	
Trade Name	Varivax
Indications	For patients with CD4 counts ≥ 200 cells/mm ³ who do not have evidence of immunity to varicella
Administration	Administer according to CDC Adult Immunization Schedule .
Revaccination	None
Comments	<ul style="list-style-type: none"> • Contraindicated for patients with CD4 counts < 200 cells/mm³ (see CDC Adult Immunization Schedule) • Anti-varicella IgG screening should be performed in patients with no known history of chickenpox or shingles [Marin, et al. 2007]. • MMR + varicella (ProQuad) vaccine should not be used [McLean, et al. 2013]. • Antiherpetic agents should be avoided ≥ 24 hours before and for 14 days after administration [ACIP 2022; CDC(b) 2021]. • An interval of ≥ 5 months is recommended between administration of post-exposure VariZIG and varicella vaccination [ACIP 2022; DHHS 2022; CDC 2006]. • Clinical disease due to varicella after vaccination, a very rare event, should be treated with acyclovir [DHHS 2022]. • Covered by HRSA Vaccine Injury Compensation Program
Abbreviations: CDC, Centers for Disease Control and Prevention; HRSA, Health Resources and Services Administration; IgG, immunoglobulin G; MMR, measles, mumps, rubella; VariZIG, varicella zoster immune globulin.	

Discussion: Patients with HIV who have CD4 counts ≥ 200 cells/mm³ and do not have immunity to varicella should be vaccinated according to [CDC guidelines](#) for all adults, with 2 doses of single-antigen varicella vaccine administered 4 to 8 weeks apart or a second dose if they have received only 1 dose. Varicella vaccination contains live virus and is contraindicated for patients with CD4 counts < 200 cells/mm³ because of the risk of disseminated disease [CDC 2023; Marin, et al. 2007; Kramer, et al. 2001]. Data on the effectiveness of varicella vaccination among adults with HIV are lacking, but vaccination has been shown to be effective among children with HIV [Crum-Cianflone and Wallace 2014; CDC 2012; Marin, et al. 2007].

Because of the possibility of severe disease in individuals with HIV, clinicians should verify varicella immunity. Birth before 1980 is not accepted as evidence of immunity in immunocompromised individuals; anti-varicella immunoglobulin G screening should be performed in patients with HIV who have no known history of chickenpox or shingles [Marin, et al. 2007]. Post-vaccination serologic testing to determine immune response is not recommended because commercially available assays lack sensitivity and may give false-negative results [Marin, et al. 2007]. Clinical disease due to varicella after vaccination, a very rare event, should be treated with acyclovir [DHHS 2022; Marin, et al. 2007]. If household members or close contacts develop a rash after vaccination, people with HIV should avoid contact with the affected individual until after the rash resolves [ACIP 2022; Marin, et al. 2007]. Because they can interfere with vaccine virus replication and decrease vaccine effectiveness, all

antiherpetic agents should be avoided for at least 24 hours before varicella vaccination through 14 days after [ACIP 2022; CDC(b) 2021]. If post-exposure varicella zoster immune globulin is given, clinicians should wait ≥5 months before varicella vaccination [ACIP 2022; DHHS 2022; CDC 2006].

Zoster

Table 14: Zoster Vaccine	
Trade Names	Shingrix: RZV, adjuvanted
Indications	MCCC recommendation: Patients with HIV ≥18 years old (A2)
Administration	<ul style="list-style-type: none"> • Two intramuscular doses, given 2 to 6 months apart, regardless of past receipt of ZVL (brand name Zostavax) • Perform anti-varicella IgG screening in patients with no known history of chickenpox or shingles [Marin, et al. 2007]. • CDC Adult Immunization Schedule.
Comments	<ul style="list-style-type: none"> • RZV provides strong protection against shingles and post-herpetic neuralgia. Currently, there are no data on immunogenicity specific to people with HIV; however, superior efficacy and longer duration of protection have been demonstrated among the elderly, and a recombinant vaccine is preferred for people with HIV [Anderson, et al. 2022; Dooling, et al. 2018]. • As of November 2020, ZVL is no longer available for use in the United States.
Abbreviations: CDC, Centers for Disease Control and Prevention; IgG, immunoglobulin G; MCCC, Medical Care Criteria Committee; RZV, recombinant zoster vaccine; ZVL, zoster vaccine live.	

Discussion: People with HIV are at increased risk of zoster (initial episodes and recurrences) at all stages of HIV disease; the risk is greater among those with severe immunodeficiency and lower CD4 cell counts [Blank, et al. 2012; Harpaz, et al. 2008]. Zoster vaccination may reduce disease burden in individuals with HIV; however, data on the use of zoster vaccine among adults with HIV are limited.

The Advisory Committee on Immunization Practices recommends 2 doses of recombinant zoster vaccine (RZV; brand name Shingrix) to prevent herpes zoster in adults ≥19 years old who are immunosuppressed [Anderson, et al. 2022]; the previous recommendation was for vaccination of adults ≥50 years old [Dooling, et al. 2018]. On December 1, 2021, the MCCC updated its recommendation as well: Adults with HIV ≥18 years old should receive 2 doses of RZV, administered 2 to 6 months apart. RZV provides strong protection against shingles and post-herpetic neuralgia. There is no specific data on immunogenicity in people with HIV; however, superior efficacy and longer duration of seroprotection have been demonstrated in the elderly [Anderson, et al. 2022; Dooling, et al. 2018]. As of November 2020, the live, attenuated zoster vaccine (ZVL; brand name Zostavax) is no longer available for use in the United States.

Anti-varicella IgG screening should be performed in patients with no known history of chickenpox or shingles [Marin, et al. 2007], and patients with a negative titer should be vaccinated for varicella if their CD4 count is >200 cells/mm³ as an initial step, and the series should be completed before zoster vaccination. There is no recommendation for post-vaccination serologic testing to determine immune response [Harpaz, et al. 2008].

All Recommendations

ALL RECOMMENDATIONS: IMMUNIZATIONS FOR ADULTS WITH HIV

Immunizations

- Clinicians should follow the recommendations for routine vaccination of adults with HIV issued by the [CDC, the National Institutes of Health, the HIV Medicine Association](#), and the [Infectious Disease Society of America](#), as presented here. (A3)

COVID-19 Vaccine

- Clinicians should vaccinate individuals with HIV and CD4 counts <350 cells/mm³ for COVID-19 according to the CDC schedule for individuals who are moderately or severely compromised. (A2)

Mpox Vaccine

- Clinicians should recommend vaccination against mpox (formerly “monkeypox”) for individuals ≥18 years old with HIV who are at high risk of or who have been exposed to mpox within the past 14 days and for whom vaccination may reduce the risk of infection or decrease symptoms if infection has occurred. (A2)
- Clinicians should use only the JYNNEOS (Imvamune or Imvanex) mpox vaccine for individuals with HIV, as it is the only available vaccine that is considered safe for administration in this population. (A*)
- Clinicians should recommend vaccination for adults with HIV, regardless of their CD4 cell count and degree of viral suppression. (A3)

Abbreviation: CDC, Centers for Disease Control and Prevention.

References

- Abzug MJ, Qin M, Levin MJ, et al. Immunogenicity, immunologic memory, and safety following measles revaccination in HIV-infected children receiving highly active antiretroviral therapy. *J Infect Dis* 2012;206(4):512-22. [PMID: 22693229] <https://pubmed.ncbi.nlm.nih.gov/22693229>
- ACIP. General best practice guidelines for immunization: best practices guidance. 2022 Mar 15. <https://www.cdc.gov/vaccines/hcp/acip-recs/general-recs/downloads/general-recs.pdf> [accessed 2022 Oct 20]
- 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(3):80-84. [PMID: 35051134] <https://pubmed.ncbi.nlm.nih.gov/35051134>
- Angel JB, Walpita P, Lerch RA, et al. Vaccine-associated measles pneumonitis in an adult with AIDS. *Ann Intern Med* 1998;129(2):104-6. [PMID: 9669968] <https://pubmed.ncbi.nlm.nih.gov/9669968>
- Aurpibul L, Puthanakit T, Sirisanthana T, et al. Response to measles, mumps, and rubella revaccination in HIV-infected children with immune recovery after highly active antiretroviral therapy. *Clin Infect Dis* 2007;45(5):637-42. [PMID: 17683001] <https://pubmed.ncbi.nlm.nih.gov/17683001>
- Beck CR, McKenzie BC, Hashim AB, et al. Influenza vaccination for immunocompromised patients: systematic review and meta-analysis by etiology. *J Infect Dis* 2012;206(8):1250-59. [PMID: 22904335] <https://pubmed.ncbi.nlm.nih.gov/22904335>
- Belaunzaran-Zamudio PF, Garcia-Leon ML, Wong-Chew RM, et al. Early loss of measles antibodies after MMR vaccine among HIV-infected adults receiving HAART. *Vaccine* 2009;27(50):7059-64. [PMID: 19799846] <https://pubmed.ncbi.nlm.nih.gov/19799846>
- Bhaskaran K, Bacon S, Evans SJ, et al. Factors associated with deaths due to COVID-19 versus other causes: population-based cohort analysis of UK primary care data and linked national death registrations within the OpenSAFELY platform. *Lancet Reg Health Eur* 2021;6:100109. [PMID: 33997835] <https://pubmed.ncbi.nlm.nih.gov/33997835>
- Bhorat AE, Madhi SA, Laudat F, et al. Immunogenicity and safety of the 13-valent pneumococcal conjugate vaccine in HIV-infected individuals naive to pneumococcal vaccination. *AIDS* 2015;29(11):1345-54. [PMID: 25888646] <https://pubmed.ncbi.nlm.nih.gov/25888646>

- Bickel M, von Hentig N, Wieters I, et al. Immune response after two doses of the novel split virion, adjuvanted pandemic H1N1 influenza A vaccine in HIV-1-infected patients. *Clin Infect Dis* 2011;52(1):122-27. [PMID: 21148530] <https://pubmed.ncbi.nlm.nih.gov/21148530>
- Blank LJ, Polydefkis MJ, Moore RD, et al. Herpes zoster among persons living with HIV in the current antiretroviral therapy era. *J Acquir Immune Defic Syndr* 2012;61(2):203-7. [PMID: 22766968] <https://pubmed.ncbi.nlm.nih.gov/22766968>
- Bogart LM, Ojikutu BO, Tyagi K, et al. COVID-19 related medical mistrust, health impacts, and potential vaccine hesitancy among Black Americans living with HIV. *J Acquir Immune Defic Syndr* 2021;86(2):200-207. [PMID: 33196555] <https://pubmed.ncbi.nlm.nih.gov/33196555>
- Briere EC, Rubin L, Moro PL, et al. Prevention and control of haemophilus influenzae type b disease: recommendations of the advisory committee on immunization practices (ACIP). *MMWR Recomm Rep* 2014;63(Rr-01):1-14. [PMID: 24572654] <https://pubmed.ncbi.nlm.nih.gov/24572654>
- Byrd KM, Beckwith CG, Garland JM, et al. SARS-CoV-2 and HIV coinfection: clinical experience from Rhode Island, United States. *J Int AIDS Soc* 2020;23(7):e25573. [PMID: 32657527] <https://pubmed.ncbi.nlm.nih.gov/32657527>
- Cardell K, Akerlind B, Sallberg M, et al. Excellent response rate to a double dose of the combined hepatitis A and B vaccine in previous nonresponders to hepatitis B vaccine. *J Infect Dis* 2008;198(3):299-304. [PMID: 18544037] <https://pubmed.ncbi.nlm.nih.gov/18544037>
- CDC. Disseminated mycobacterium bovis infection from BCG vaccination of a patient with acquired immunodeficiency syndrome. *MMWR Morb Mortal Wkly Rep* 1985;34(16):227-28. [PMID: 3920493] <https://pubmed.ncbi.nlm.nih.gov/3920493>
- CDC. Measles pneumonitis following measles-mumps-rubella vaccination of a patient with HIV infection, 1993. *MMWR Morb Mortal Wkly Rep* 1996;45(28):603-6. [PMID: 8676852] <https://pubmed.ncbi.nlm.nih.gov/8676852>
- CDC. A new product (VariZIG) for postexposure prophylaxis of varicella available under an investigational new drug application expanded access protocol. *MMWR Morb Mortal Wkly Rep* 2006;55(8):209-10. [PMID: 16511443] <https://pubmed.ncbi.nlm.nih.gov/16511443>
- CDC. FDA approval of an extended period for administering VariZIG for postexposure prophylaxis of varicella. *MMWR Morb Mortal Wkly Rep* 2012;61(12):212. [PMID: 22456121] <https://pubmed.ncbi.nlm.nih.gov/22456121>
- CDC. Adult immunization schedule. 2023 Feb 17. <https://www.cdc.gov/vaccines/schedules/hcp/adult.html> [accessed 2023 Feb 22]
- CDC(a). HPV vaccine schedule and dosing. 2021 Nov 1. <https://www.cdc.gov/hpv/hcp/schedules-recommendations.html> [accessed 2022 Oct 20]
- CDC(a). ACIP recommendations. 2022 Nov 16. <https://www.cdc.gov/vaccines/acip/recommendations.html> [accessed 2022 Oct 3]
- CDC(b). Varicella. 2021 Sep 20. <https://www.cdc.gov/vaccines/pubs/pinkbook/varicella.html> [accessed 2022 Oct 21]
- CDC(b). Interim clinical considerations for use of JYNNEOS and ACAM2000 vaccines during the 2022 U.S. monkeypox outbreak. 2022 Oct 19. <https://www.cdc.gov/poxvirus/monkeypox/considerations-for-monkeypox-vaccination.html> [accessed 2022 Oct 25]
- Chaiklang K, Wipasa J, Chaiwarith R, et al. Comparison of immunogenicity and safety of four doses and four double doses vs. standard doses of hepatitis B vaccination in HIV-infected adults: a randomized, controlled trial. *PLoS One* 2013;8(11):e80409. [PMID: 24265819] <https://pubmed.ncbi.nlm.nih.gov/24265819>
- Chaiwarith R, Preparattanapan J, Nuket K, et al. Seroprevalence of antibodies to measles, mumps, and rubella, and serologic responses after vaccination among human immunodeficiency virus (HIV)-1 infected adults in Northern Thailand. *BMC Infect Dis* 2016;16:190. [PMID: 27138005] <https://pubmed.ncbi.nlm.nih.gov/27138005>
- Chambers C, Samji H, Cooper CL, et al. Coronavirus disease 2019 vaccine effectiveness among a population-based cohort of people living with HIV. *AIDS* 2022;36(15):F17-26. [PMID: 36254892] <https://pubmed.ncbi.nlm.nih.gov/36254892>
- Chenchula S, Chandra MB, Adusumilli MB, et al. Immunogenicity, clinical efficacy and safety of additional second COVID-19 booster vaccines against Omicron and its subvariants: A systematic review. *Rev Med Virol* 2024;34(1):e2515. [PMID: 38282403] <https://pubmed.ncbi.nlm.nih.gov/38282403>
- Cheng A, Chang SY, Sun HY, et al. Long-term durability of responses to 2 or 3 doses of hepatitis A vaccination in human immunodeficiency virus-positive adults on antiretroviral therapy. *J Infect Dis* 2017;215(4):606-13. [PMID: 28011921] <https://pubmed.ncbi.nlm.nih.gov/28011921>
- Chowers M, Regev-Yochay G, Mor O, et al. Invasive pneumococcal disease (IPD) in HIV infected patients in Israel since the introduction of pneumococcal conjugated vaccines (PCV): analysis of a nationwide surveillance study, 2009-2014. *Hum Vaccin Immunother* 2017;13(1):216-19. [PMID: 27648488] <https://pubmed.ncbi.nlm.nih.gov/27648488>

- Cooper C, Thorne A, Klein M, et al. Immunogenicity is not improved by increased antigen dose or booster dosing of seasonal influenza vaccine in a randomized trial of HIV infected adults. *PLoS One* 2011;6(3):e17758. [PMID: 21512577]
<https://pubmed.ncbi.nlm.nih.gov/21512577>
- Cooper CL, Davis HL, Angel JB, et al. CPG 7909 adjuvant improves hepatitis B virus vaccine seroprotection in antiretroviral-treated HIV-infected adults. *AIDS* 2005;19(14):1473-79. [PMID: 16135900] <https://pubmed.ncbi.nlm.nih.gov/16135900>
- Cooper TJ, Woodward BL, Alom S, et al. Coronavirus disease 2019 (COVID-19) outcomes in HIV/AIDS patients: a systematic review. *HIV Med* 2020;21(9):567-77. [PMID: 32671970] <https://pubmed.ncbi.nlm.nih.gov/32671970>
- Cortese MM, Parashar UD. Prevention of rotavirus gastroenteritis among infants and children: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep* 2009;58(Rr-2):1-25. [PMID: 19194371]
<https://pubmed.ncbi.nlm.nih.gov/19194371>
- Costenaro P, Minotti C, Barbieri E, et al. SARS-CoV-2 infection in people living with HIV: a systematic review. *Rev Med Virol* 2021;31(1):1-12. [PMID: 32875716] <https://pubmed.ncbi.nlm.nih.gov/32875716>
- Crum-Cianflone NF, Wallace MR. Vaccination in HIV-infected adults. *AIDS Patient Care STDS* 2014;28(8):397-410. [PMID: 25029589] <https://pubmed.ncbi.nlm.nih.gov/25029589>
- Crum-Cianflone(a) NF, Eberly LE, Duplessis C, et al. Immunogenicity of a monovalent 2009 influenza A (H1N1) vaccine in an immunocompromised population: a prospective study comparing HIV-infected adults with HIV-uninfected adults. *Clin Infect Dis* 2011;52(1):138-46. [PMID: 21148532] <https://pubmed.ncbi.nlm.nih.gov/21148532>
- Crum-Cianflone(b) 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(12):1815-23. [PMID: 21606540]
<https://pubmed.ncbi.nlm.nih.gov/21606540>
- Davis LE, Bodian D, Price D, et al. Chronic progressive poliomyelitis secondary to vaccination of an immunodeficient child. *N Engl J Med* 1977;297(5):241-45. [PMID: 195206] <https://pubmed.ncbi.nlm.nih.gov/195206>
- de Vries-Sluijs TE, Hansen BE, van Doornum GJ, et al. A randomized controlled study of accelerated versus standard hepatitis B vaccination in HIV-positive patients. *J Infect Dis* 2011;203(7):984-91. [PMID: 21266513]
<https://pubmed.ncbi.nlm.nih.gov/21266513>
- de Vries-Sluijs TE, Hansen BE, van Doornum GJ, et al. A prospective open study of the efficacy of high-dose recombinant hepatitis B rechallenge vaccination in HIV-infected patients. *J Infect Dis* 2008;197(2):292-94. [PMID: 18177248]
<https://pubmed.ncbi.nlm.nih.gov/18177248>
- DHHS. Guidelines for the prevention and treatment of opportunistic infections in adults and adolescents with HIV. 2022 Sep 28. <https://clinicalinfo.hiv.gov/en/guidelines/adult-and-adolescent-opportunistic-infection/whats-new-guidelines> [accessed 2022 Sep 30]
- Dockrell DH, Poland GA, Steckelberg JM, et al. Immunogenicity of three haemophilus influenzae type b protein conjugate vaccines in HIV seropositive adults and analysis of predictors of vaccine response. *Vaccine* 1999;17(22):2779-85. [PMID: 10438047] <https://pubmed.ncbi.nlm.nih.gov/10438047>
- 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(3):103-8. [PMID: 29370152]
<https://pubmed.ncbi.nlm.nih.gov/29370152>
- Durski KN, McCollum AM, Nakazawa Y, et al. Emergence of monkeypox - west and central Africa, 1970-2017. *MMWR Morb Mortal Wkly Rep* 2018;67(10):306-10. [PMID: 29543790] <https://pubmed.ncbi.nlm.nih.gov/29543790>
- EACS. European AIDS Clinical Society guidelines version 11.0. 2021 Oct.
https://www.eacsociety.org/media/final2021eacsguidelinesv11.0_oct2021.pdf [accessed 2022 Sep 30]
- Evison J, Farese S, Seitz M, et al. Randomized, double-blind comparative trial of subunit and virosomal influenza vaccines for immunocompromised patients. *Clin Infect Dis* 2009;48(10):1402-12. [PMID: 19361304]
<https://pubmed.ncbi.nlm.nih.gov/19361304>
- Falcaro M, Castanon A, Ndlela B, et al. The effects of the national HPV vaccination programme in England, UK, on cervical cancer and grade 3 cervical intraepithelial neoplasia incidence: a register-based observational study. *Lancet* 2021;398(10316):2084-92. [PMID: 34741816] <https://pubmed.ncbi.nlm.nih.gov/34741816>
- FDA(a). Gardasil 9. 2020 Aug 21. <https://www.fda.gov/biologicsbloodvaccines/vaccines/approvedproducts/ucm426445.htm> [accessed 2022 Oct 20]
- FDA(b). Heplisav-B. 2020 May 6. <https://www.fda.gov/vaccines-blood-biologics/vaccines/heplisav-b> [accessed 2022 Oct 19]
- Fiore AE, Fry A, Shay D, et al. Antiviral agents for the treatment and chemoprophylaxis of influenza --- recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep* 2011;60(1):1-24. [PMID: 21248682]
<https://pubmed.ncbi.nlm.nih.gov/21248682>

- Fiore AE, Wasley A, Bell BP. Prevention of hepatitis A through active or passive immunization: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep* 2006;55(Rr-7):1-23. [PMID: 16708058] <https://pubmed.ncbi.nlm.nih.gov/16708058>
- Folaranmi TA, Kretz CB, Kamiya H, et al. Increased risk for meningococcal disease among men who have sex with men in the United States, 2012-2015. *Clin Infect Dis* 2017;65(5):756-63. [PMID: 28505234] <https://pubmed.ncbi.nlm.nih.gov/28505234>
- Fonseca MO, Pang LW, de Paula Cavalheiro N, et al. Randomized trial of recombinant hepatitis B vaccine in HIV-infected adult patients comparing a standard dose to a double dose. *Vaccine* 2005;23(22):2902-8. [PMID: 15780739] <https://pubmed.ncbi.nlm.nih.gov/15780739>
- Fowokan A, Samji H, Puyat JH, et al. Effectiveness of COVID-19 vaccines in people living with HIV in British Columbia and comparisons with a matched HIV-negative cohort: a test-negative design. *Int J Infect Dis* 2023;127:162-70. [PMID: 36462571] <https://pubmed.ncbi.nlm.nih.gov/36462571>
- 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(9):812-22. [PMID: 20200385] <https://pubmed.ncbi.nlm.nih.gov/20200385>
- Garg S, Thongcharoen P, Praphasiri P, et al. Randomized controlled trial to compare immunogenicity of standard-dose intramuscular versus intradermal trivalent inactivated influenza vaccine in HIV-infected men who have sex with men in Bangkok, Thailand. *Clin Infect Dis* 2016;62(3):383-91. [PMID: 26486702] <https://pubmed.ncbi.nlm.nih.gov/26486702>
- Glinka ER, Smith DM, Johns ST. Timing matters - influenza vaccination to HIV-infected patients. *HIV Med* 2016;17(8):601-4. [PMID: 26810556] <https://pubmed.ncbi.nlm.nih.gov/26810556>
- Grana C, Ghosn L, Evrenoglou T, et al. Efficacy and safety of COVID-19 vaccines. *Cochrane Database Syst Rev* 2022;12(12):CD015477. [PMID: 36473651] <https://pubmed.ncbi.nlm.nih.gov/36473651>
- Grau I, Pallares R, Tubau F, et al. Epidemiologic changes in bacteremic pneumococcal disease in patients with human immunodeficiency virus in the era of highly active antiretroviral therapy. *Arch Intern Med* 2005;165(13):1533-40. [PMID: 16009870] <https://pubmed.ncbi.nlm.nih.gov/16009870>
- Grohskopf LA, Alyanak E, Broder KR, et al. Prevention and control of seasonal influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices - United States, 2019-20 influenza season. *MMWR Recomm Rep* 2019;68(3):1-21. [PMID: 31441906] <https://pubmed.ncbi.nlm.nih.gov/31441906>
- Hakim H, Allison KJ, Van de Velde LA, et al. Immunogenicity and safety of high-dose trivalent inactivated influenza vaccine compared to standard-dose vaccine in children and young adults with cancer or HIV infection. *Vaccine* 2016;34(27):3141-48. [PMID: 27129426] <https://pubmed.ncbi.nlm.nih.gov/27129426>
- Harpaz R, Ortega-Sanchez IR, Seward JF. Prevention of herpes zoster: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep* 2008;57(Rr-5):1-30; quiz CE2-4. [PMID: 18528318] <https://pubmed.ncbi.nlm.nih.gov/18528318>
- Ho YL, Brandao AP, de Cunto Brandileone MC, et al. Immunogenicity and safety of pneumococcal conjugate polysaccharide and free polysaccharide vaccines alone or combined in HIV-infected adults in Brazil. *Vaccine* 2013;31(37):4047-53. [PMID: 23684823] <https://pubmed.ncbi.nlm.nih.gov/23684823>
- Hung CC, Chen MY, Hsieh SM, et al. Clinical experience of the 23-valent capsular polysaccharide pneumococcal vaccination in HIV-1-infected patients receiving highly active antiretroviral therapy: a prospective observational study. *Vaccine* 2004;22(15-16):2006-12. [PMID: 15121313] <https://pubmed.ncbi.nlm.nih.gov/15121313>
- Kemp TJ, Hildesheim A, Safaeian M, et al. HPV16/18 L1 VLP vaccine induces cross-neutralizing antibodies that may mediate cross-protection. *Vaccine* 2011;29(11):2011-14. [PMID: 21241731] <https://pubmed.ncbi.nlm.nih.gov/21241731>
- Khaimova R, Fischetti B, Cope R, et al. Serological response with HepBisav-B(R) in prior hepatitis B vaccine non-responders living with HIV. *Vaccine* 2021;39(44):6529-34. [PMID: 34600748] <https://pubmed.ncbi.nlm.nih.gov/34600748>
- Kim HN, Harrington RD, Van Rompaey SE, et al. Independent clinical predictors of impaired response to hepatitis B vaccination in HIV-infected persons. *Int J STD AIDS* 2008;19(9):600-604. [PMID: 18725550] <https://pubmed.ncbi.nlm.nih.gov/18725550>
- 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(4):109-17. [PMID: 35085226] <https://pubmed.ncbi.nlm.nih.gov/35085226>
- Kojic EM, Kang M, Cespedes MS, et al. Immunogenicity and safety of the quadrivalent human papillomavirus vaccine in HIV-1-infected women. *Clin Infect Dis* 2014;59(1):127-35. [PMID: 24723284] <https://pubmed.ncbi.nlm.nih.gov/24723284>

- Kolber MA, Gabr AH, De La Rosa A, et al. Genotypic analysis of plasma HIV-1 RNA after influenza vaccination of patients with previously undetectable viral loads. *AIDS* 2002;16(4):537-42. [PMID: 11872996] <https://pubmed.ncbi.nlm.nih.gov/11872996>
- Kramer JM, LaRussa P, Tsai WC, et al. Disseminated vaccine strain varicella as the acquired immunodeficiency syndrome-defining illness in a previously undiagnosed child. *Pediatrics* 2001;108(2):E39. [PMID: 11483849] <https://pubmed.ncbi.nlm.nih.gov/11483849>
- Kroon FP, van Dissel JT, de Jong JC, et al. Antibody response after influenza vaccination in HIV-infected individuals: a consecutive 3-year study. *Vaccine* 2000;18(26):3040-49. [PMID: 10825608] <https://pubmed.ncbi.nlm.nih.gov/10825608>
- Kroon FP, van Dissel JT, Rijkers GT, et al. 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(3):600-606. [PMID: 9314445] <https://pubmed.ncbi.nlm.nih.gov/9314445>
- Kunisaki KM, Janoff EN. Influenza in immunosuppressed populations: a review of infection frequency, morbidity, mortality, and vaccine responses. *Lancet Infect Dis* 2009;9(8):493-504. [PMID: 19628174] <https://pubmed.ncbi.nlm.nih.gov/19628174>
- Lang R, Humes E, Coburn SB, et al. Analysis of severe illness after postvaccination COVID-19 breakthrough among adults with and without HIV in the US. *JAMA Netw Open* 2022;5(10):e2236397. [PMID: 36227594] <https://pubmed.ncbi.nlm.nih.gov/36227594>
- 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(14):1432-40. [PMID: 21486976] <https://pubmed.ncbi.nlm.nih.gov/21486976>
- Lombardi F, Belmonti S, Fabbiani M, et al. Immunogenicity and safety of the 13-valent pneumococcal conjugate vaccine versus the 23-valent polysaccharide vaccine in unvaccinated HIV-infected adults: a pilot, prospective controlled study. *PLoS One* 2016;11(6):e0156523. [PMID: 27258647] <https://pubmed.ncbi.nlm.nih.gov/27258647>
- 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(4):676-81.e2. [PMID: 22622049] <https://pubmed.ncbi.nlm.nih.gov/22622049>
- MacLennan CA, Richter A, Hodson J, et al. Brief report: immunization of HIV-infected adults in the UK with haemophilus influenzae B/meningococcal C glycoconjugate and pneumococcal polysaccharide vaccines. *J Acquir Immune Defic Syndr* 2016;73(3):287-93. [PMID: 27163175] <https://pubmed.ncbi.nlm.nih.gov/27163175>
- Marin M, Guris D, Chaves SS, et al. Prevention of varicella: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep* 2007;56(Rr-4):1-40. [PMID: 17585291] <https://pubmed.ncbi.nlm.nih.gov/17585291>
- Marin M, Marlow M, Moore KL, et al. Recommendation of the Advisory Committee on Immunization Practices for use of a third dose of mumps virus-containing vaccine in persons at increased risk for mumps during an outbreak. *MMWR Morb Mortal Wkly Rep* 2018;67(1):33-38. [PMID: 29324728] <https://pubmed.ncbi.nlm.nih.gov/29324728>
- Mast EE, Weinbaum CM, Fiore AE, et al. A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States: recommendations of the Advisory Committee on Immunization Practices (ACIP) part II: immunization of adults. *MMWR Recomm Rep* 2006;55(Rr-16):1-33; quiz CE1-4. [PMID: 17159833] <https://pubmed.ncbi.nlm.nih.gov/17159833>
- 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(9):1-41. [PMID: 33417592] <https://pubmed.ncbi.nlm.nih.gov/33417592>
- McKittrick N, Frank I, Jacobson JM, et al. Improved immunogenicity with high-dose seasonal influenza vaccine in HIV-infected persons: a single-center, parallel, randomized trial. *Ann Intern Med* 2013;158(1):19-26. [PMID: 23277897] <https://pubmed.ncbi.nlm.nih.gov/23277897>
- McLean HQ, Fiebelkorn AP, Temte JL, et al. 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(Rr-04):1-34. [PMID: 23760231] <https://pubmed.ncbi.nlm.nih.gov/23760231>
- Mellor MM, Bast AC, Jones NR, et al. Risk of adverse coronavirus disease 2019 outcomes for people living with HIV. *AIDS* 2021;35(4):F1-10. [PMID: 33587448] <https://pubmed.ncbi.nlm.nih.gov/33587448>
- Mena G, Garcia-Basteiro AL, Bayas JM. Hepatitis B and A vaccination in HIV-infected adults: a review. *Hum Vaccin Immunother* 2015;11(11):2582-98. [PMID: 26208678] <https://pubmed.ncbi.nlm.nih.gov/26208678>
- Miller L, Arakaki L, Ramautar A, et al. Elevated risk for invasive meningococcal disease among persons with HIV. *Ann Intern Med* 2014;160(1):30-37. [PMID: 24166695] <https://pubmed.ncbi.nlm.nih.gov/24166695>

- Mirzaei H, McFarland W, Karamouzian M, et al. COVID-19 among people living with HIV: a systematic review. *AIDS Behav* 2021;25(1):85-92. [PMID: 32734438] <https://pubmed.ncbi.nlm.nih.gov/32734438>
- Mitja O, Alemany A, Marks M, et al. Mpox in people with advanced HIV infection: a global case series. *Lancet* 2023;401(10380):939-49. [PMID: 36828001] <https://pubmed.ncbi.nlm.nih.gov/36828001>
- Money DM, Moses E, Blitz S, et al. HIV viral suppression results in higher antibody responses in HIV-positive women vaccinated with the quadrivalent human papillomavirus vaccine. *Vaccine* 2016;34(40):4799-4806. [PMID: 27544584] <https://pubmed.ncbi.nlm.nih.gov/27544584>
- Nandy K, Salunke A, Pathak SK, et al. Coronavirus disease (COVID-19): a systematic review and meta-analysis to evaluate the impact of various comorbidities on serious events. *Diabetes Metab Syndr* 2020;14(5):1017-25. [PMID: 32634716] <https://pubmed.ncbi.nlm.nih.gov/32634716>
- Overton ET, Kang M, Peters MG, et al. Immune response to hepatitis B vaccine in HIV-infected subjects using granulocyte-macrophage colony-stimulating factor (GM-CSF) as a vaccine adjuvant: ACTG study 5220. *Vaccine* 2010;28(34):5597-5604. [PMID: 20600512] <https://pubmed.ncbi.nlm.nih.gov/20600512>
- Overton ET, Sungkanuparph S, Powderly WG, et al. Undetectable plasma HIV RNA load predicts success after hepatitis B vaccination in HIV-infected persons. *Clin Infect Dis* 2005;41(7):1045-48. [PMID: 16142673] <https://pubmed.ncbi.nlm.nih.gov/16142673>
- Patel VV, Felsen UR, Fisher M, et al. Clinical outcomes and inflammatory markers by HIV serostatus and viral suppression in a large cohort of patients hospitalized with COVID-19. *J Acquir Immune Defic Syndr* 2021;86(2):224-30. [PMID: 33433966] <https://pubmed.ncbi.nlm.nih.gov/33433966>
- 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(11):300-304. [PMID: 25811679] <https://pubmed.ncbi.nlm.nih.gov/25811679>
- Pettit NN, DePestel DD, Malani PN, et al. Factors associated with seroconversion after standard dose hepatitis B vaccination and high-dose revaccination among HIV-infected patients. *HIV Clin Trials* 2010;11(6):332-39. [PMID: 21239361] <https://pubmed.ncbi.nlm.nih.gov/21239361>
- Pollack TM, Trang le TT, Ngo L, et al. Response to hepatitis B vaccination among HIV-infected adults in Vietnam. *J Virus Erad* 2016;2(2):102-6. [PMID: 27482443] <https://pubmed.ncbi.nlm.nih.gov/27482443>
- Potsch DV, Camacho LA, Tuboi S, et al. Vaccination against hepatitis B with 4-double doses increases response rates and antibodies titers in HIV-infected adults. *Vaccine* 2012;30(41):5973-77. [PMID: 22828589] <https://pubmed.ncbi.nlm.nih.gov/22828589>
- Pseudos G, Kim JH, Groce V, et al. Efficacy of double-dose hepatitis B rescue vaccination in HIV-infected patients. *AIDS Patient Care STDS* 2010;24(7):403-7. [PMID: 20586648] <https://pubmed.ncbi.nlm.nih.gov/20586648>
- 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(22):734-42. [PMID: 35653347] <https://pubmed.ncbi.nlm.nih.gov/35653347>
- Redfield RR, Wright DC, James WD, et al. Disseminated vaccinia in a military recruit with human immunodeficiency virus (HIV) disease. *N Engl J Med* 1987;316(11):673-76. [PMID: 3821799] <https://pubmed.ncbi.nlm.nih.gov/3821799>
- Remschmidt C, Wichmann O, Harder T. Influenza vaccination in HIV-infected individuals: systematic review and assessment of quality of evidence related to vaccine efficacy, effectiveness and safety. *Vaccine* 2014;32(43):5585-92. [PMID: 25131742] <https://pubmed.ncbi.nlm.nih.gov/25131742>
- 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(13):1161-65. [PMID: 10649616] <https://pubmed.ncbi.nlm.nih.gov/10649616>
- Rey D, Piroth L, Wendling MJ, et al. Safety and immunogenicity of double-dose versus standard-dose hepatitis B revaccination in non-responding adults with HIV-1 (ANRS HB04 B-BOOST): a multicentre, open-label, randomised controlled trial. *Lancet Infect Dis* 2015;15(11):1283-91. [PMID: 26257021] <https://pubmed.ncbi.nlm.nih.gov/26257021>
- Rodriguez-Barradas MC, Goulet J, Brown S, et al. Impact of pneumococcal vaccination on the incidence of pneumonia by HIV infection status among patients enrolled in the Veterans Aging Cohort 5-Site Study. *Clin Infect Dis* 2008;46(7):1093-1100. [PMID: 18444830] <https://pubmed.ncbi.nlm.nih.gov/18444830>
- Rodriguez-Barradas MC, Serpa JA, Munjal I, et al. Quantitative and qualitative antibody responses to immunization with the pneumococcal polysaccharide vaccine in HIV-infected patients after initiation of antiretroviral treatment: results from a randomized clinical trial. *J Infect Dis* 2015;211(11):1703-11. [PMID: 25538270] <https://pubmed.ncbi.nlm.nih.gov/25538270>

- Rosenthal EM, Hall EW, Rosenberg ES, et al. Assessing the cost-utility of preferentially administering Heplisav-B vaccine to certain populations. *Vaccine* 2020;38(51):8206-15. [PMID: 33160756] <https://pubmed.ncbi.nlm.nih.gov/33160756>
- Sasaki M, Foccacia R, de Messias-Reason IJ. Efficacy of granulocyte-macrophage colony-stimulating factor (GM-CSF) as a vaccine adjuvant for hepatitis B virus in patients with HIV infection. *Vaccine* 2003;21(31):4545-49. [PMID: 14575766] <https://pubmed.ncbi.nlm.nih.gov/14575766>
- Schnittman SR, Zepf R, Cocohoba J, et al. Brief report: Heplisav-B seroprotection in people with HIV: a single-center experience. *J Acquir Immune Defic Syndr* 2021;86(4):445-49. [PMID: 33196553] <https://pubmed.ncbi.nlm.nih.gov/33196553>
- Seo YB, Lee J, Song JY, et al. Safety and immunogenicity of influenza vaccine among HIV-infected adults: conventional vaccine vs. intradermal vaccine. *Hum Vaccin Immunother* 2016;12(2):478-84. [PMID: 26431466] <https://pubmed.ncbi.nlm.nih.gov/26431466>
- 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(5):391-96. [PMID: 20431379] <https://pubmed.ncbi.nlm.nih.gov/20431379>
- 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(1):6283. [PMID: 33737527] <https://pubmed.ncbi.nlm.nih.gov/33737527>
- Ssentongo P, Ssentongo AE, Heilbrunn ES, et al. Association of cardiovascular disease and 10 other pre-existing comorbidities with COVID-19 mortality: a systematic review and meta-analysis. *PLoS One* 2020;15(8):e0238215. [PMID: 32845926] <https://pubmed.ncbi.nlm.nih.gov/32845926>
- Steinbock MC, Auerbach BS, Nelson KE, et al. Antibody responses to haemophilus influenzae type B vaccines in men with human immunodeficiency virus infection. *N Engl J Med* 1991;325(26):1837-42. [PMID: 1683682] <https://pubmed.ncbi.nlm.nih.gov/1683682>
- Sullivan PS, Hanson DL, Dworkin MS, et al. Effect of influenza vaccination on disease progression among HIV-infected persons. *AIDS* 2000;14(17):2781-85. [PMID: 11125897] <https://pubmed.ncbi.nlm.nih.gov/11125897>
- 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(2):e2037069. [PMID: 33533933] <https://pubmed.ncbi.nlm.nih.gov/33533933>
- Thompson MA, Horberg MA, Agwu AL, et al. Primary care guidance for persons with human immunodeficiency virus: 2020 update by the HIV Medicine Association of the Infectious Diseases Society of America. *Clin Infect Dis* 2021;73(11):e3572-3605. [PMID: 33225349] <https://pubmed.ncbi.nlm.nih.gov/33225349>
- Werker GR, Sharif B, Sun H, et al. Optimal timing of influenza vaccination in patients with human immunodeficiency virus: a Markov cohort model based on serial study participant hemoagglutination inhibition titers. *Vaccine* 2014;32(6):677-84. [PMID: 24355089] <https://pubmed.ncbi.nlm.nih.gov/24355089>
- Wheeler CM, Castellsague X, Garland SM, et al. Cross-protective efficacy of HPV-16/18 AS04-adjuvanted vaccine against cervical infection and precancer caused by non-vaccine oncogenic HPV types: 4-year end-of-study analysis of the randomised, double-blind PATRICIA trial. *Lancet Oncol* 2012;13(1):100-110. [PMID: 22075170] <https://pubmed.ncbi.nlm.nih.gov/22075170>
- Whitaker JA, Roupael NG, Edupuganti S, et al. Strategies to increase responsiveness to hepatitis B vaccination in adults with HIV-1. *Lancet Infect Dis* 2012;12(12):966-76. [PMID: 23174382] <https://pubmed.ncbi.nlm.nih.gov/23174382>
- WHO. Clinical features and prognostic factors of COVID-19 in people living with HIV hospitalized with suspected or confirmed SARS-CoV-2 infection. 2021 Jul 15. <https://apps.who.int/iris/bitstream/handle/10665/342697/WHO-2019-nCoV-Clinical-HIV-2021.1-eng.pdf> [accessed 2021 Dec 10]
- Wilkin TJ, Chen H, Cespedes MS, et al. A randomized, placebo-controlled trial of the quadrivalent human papillomavirus vaccine in human immunodeficiency virus-infected adults aged 27 years or older: AIDS Clinical Trials Group Protocol A5298. *Clin Infect Dis* 2018;67(9):1339-46. [PMID: 29659751] <https://pubmed.ncbi.nlm.nih.gov/29659751>
- Yamanaka H, Teruya K, Tanaka M, et al. Efficacy and immunologic responses to influenza vaccine in HIV-1-infected patients. *J Acquir Immune Defic Syndr* 2005;39(2):167-73. [PMID: 15905732] <https://pubmed.ncbi.nlm.nih.gov/15905732>
- Yendewa GA, Perez JA, Patil N, et al. Associations between post-acute sequelae of SARS-CoV-2, COVID-19 vaccination and HIV infection: a United States cohort study. *Front Immunol* 2024;15:1297195. [PMID: 38318191] <https://pubmed.ncbi.nlm.nih.gov/38318191>
- Yin J, Chen Y, Li Y, et al. Immunogenicity and efficacy of COVID-19 vaccines in people living with HIV: a systematic review and meta-analysis. *Int J Infect Dis* 2022;124:212-23. [PMID: 36241168] <https://pubmed.ncbi.nlm.nih.gov/36241168>

Supplement: Guideline Development and Recommendation Ratings

Table S1: Guideline Development: New York State Department of Health AIDS Institute Clinical Guidelines Program

Developer	New York State Department of Health AIDS Institute (NYSDOH AI) Clinical Guidelines Program
Funding source	NYSDOH AI
Program manager	Clinical Guidelines Program, Johns Hopkins University School of Medicine, Division of Infectious Diseases. See Program Leadership and Staff .
Mission	To produce and disseminate evidence-based, state-of-the-art clinical practice guidelines that establish uniform standards of care for practitioners who provide prevention or treatment of HIV, viral hepatitis, other sexually transmitted infections, and substance use disorders for adults throughout New York State in the wide array of settings in which those services are delivered.
Expert committees	The NYSDOH AI Medical Director invites and appoints committees of clinical and public health experts from throughout New York State to ensure that the guidelines are practical, immediately applicable, and meet the needs of care providers and stakeholders in all major regions of New York State, all relevant clinical practice settings, key New York State agencies, and community service organizations.
Committee structure	<ul style="list-style-type: none"> • Leadership: AI-appointed chair, vice chair(s), chair emeritus, clinical specialist(s), JHU Guidelines Program Director, AI Medical Director, AI Clinical Consultant, AVAC community advisor • Contributing members • Guideline writing groups: Lead author, coauthors if applicable, and all committee leaders
Disclosure and management of conflicts of interest	<ul style="list-style-type: none"> • Annual disclosure of financial relationships with commercial entities for the 12 months prior and upcoming is required of all individuals who work with the guidelines program, and includes disclosure for partners or spouses and primary professional affiliation. • The NYSDOH AI assesses all reported financial relationships to determine the potential for undue influence on guideline recommendations and, when indicated, denies participation in the program or formulates a plan to manage potential conflicts. Disclosures are listed for each committee member.
Evidence collection and review	<ul style="list-style-type: none"> • Literature search and review strategy is defined by the guideline lead author based on the defined scope of a new guideline or update. • A comprehensive literature search and review is conducted for a new guideline or an extensive update using PubMed, other pertinent databases of peer-reviewed literature, and relevant conference abstracts to establish the evidence base for guideline recommendations. • A targeted search and review to identify recently published evidence is conducted for guidelines published within the previous 3 years. • Title, abstract, and article reviews are performed by the lead author. The JHU editorial team collates evidence and creates and maintains an evidence table for each guideline.
Recommendation development	<ul style="list-style-type: none"> • The lead author drafts recommendations to address the defined scope of the guideline based on available published data. • Writing group members review the draft recommendations and evidence and deliberate to revise, refine, and reach consensus on all recommendations. • When published data are not available, support for a recommendation may be based on the committee’s expert opinion. • The writing group assigns a 2-part rating to each recommendation to indicate the strength of the recommendation and quality of the supporting evidence. The group reviews the evidence, deliberates, and may revise recommendations when required to reach consensus.

Table S1: Guideline Development: New York State Department of Health AIDS Institute Clinical Guidelines Program

Review and approval process	<ul style="list-style-type: none"> • Following writing group approval, draft guidelines are reviewed by all contributors, program liaisons, and a volunteer reviewer from the AI Community Advisory Committee. • Recommendations must be approved by two-thirds of the full committee. If necessary to achieve consensus, the full committee is invited to deliberate, review the evidence, and revise recommendations. • Final approval by the committee chair and the NYSDOH AI Medical Director is required for publication.
External reviews	<ul style="list-style-type: none"> • External review of each guideline is invited at the developer’s discretion. • External reviewers recognized for their experience and expertise review guidelines for accuracy, balance, clarity, and practicality and provide feedback.
Update process	<ul style="list-style-type: none"> • JHU editorial staff ensure that each guideline is reviewed and determined to be current upon the 3-year anniversary of publication; guidelines that provide clinical recommendations in rapidly changing areas of practice may be reviewed annually. Published literature is surveilled to identify new evidence that may prompt changes to existing recommendations or development of new recommendations. • If changes in the standard of care, newly published studies, new drug approval, new drug-related warning, or a public health emergency indicate the need for immediate change to published guidelines, committee leadership will make recommendations and immediate updates and will invite full committee review as indicated.

Table S2: Recommendation Ratings and Definitions

Strength	Quality of Evidence	
A: Strong B: Moderate C: Optional	1	Based on published results of at least 1 randomized clinical trial with clinical outcomes or validated laboratory endpoints.
	*	Based on either a self-evident conclusion; conclusive, published, in vitro data; or well-established practice that cannot be tested because ethics would preclude a clinical trial.
	2	Based on published results of at least 1 well-designed, nonrandomized clinical trial or observational cohort study with long-term clinical outcomes.
	2†	Extrapolated from published results of well-designed studies (including nonrandomized clinical trials) conducted in populations other than those specifically addressed by a recommendation. The source(s) of the extrapolated evidence and the rationale for the extrapolation are provided in the guideline text. One example would be results of studies conducted predominantly in a subpopulation (e.g., one gender) that the committee determines to be generalizable to the population under consideration in the guideline.
	3	Based on committee expert opinion, with rationale provided in the guideline text.