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## Practice Matters: Adult Vaccination Recommendations

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## **Practice Matters: Adult Vaccination Recommendations**

Vaccines are one of the most important primary prevention services to help combat infectious disease and improve health throughout the lifespan (U.S. Department of Health and Human Services [HHS], 2021a). Since most vaccines are recommended and scheduled for the pediatric population, adult vaccinations for those over the age of 18 years are often a second thought. With the onset of the global 2019 coronavirus (COVID-19) pandemic, adult vaccination needs have reemerged in mainstream discussion. Faith Community Nurses (FCN) are an important resource for all those within their faith community. FCN promote care of the body, mind, and spirit while promoting health and wellness through education, screenings, and basic health services (Mock, 2017). FCN have successfully implemented various health promotion programs for diabetes, hypertension, obesity, injury prevention and have increased vaccination rates along with promotion of Healthy People 2020 initiatives (Bangurah et al., 2017; Copper et al., 2015; Long, 2020; Pappas, 2012; Pappas & King, 2014; Willis & Krichten, 2012). FNC can serve as an important resource for education, screening, and identification of adults not up to date on recommended vaccinations. Therefore, FCN must be aware of current recommendations and provide accurate information regarding vaccine safety and effectiveness for those in their community.

### **Objectives**

After reading this article, the FCN will:

1. Be aware of the importance of vaccinations for adults over the age of 18 years for primary prevention of infectious disease.

2. Be able to discuss the Centers for Disease and Prevention (CDC) vaccination recommendations for adults over the age of 18 years in the United States.
3. Be able to discuss vaccine contraindications and identify potential adverse effects.

## **Background**

Pre-existing health conditions, travel, personal lifestyle, and work environments along with waning protection received from childhood vaccinations can leave adults vulnerable to preventable diseases (CDC, 2021a). Even though adults are at risk for serious illness, hospitalization, and death from vaccine-preventable diseases, immunization rates in the United States (U.S.) remain low and are well below governmental targets (Lu et al., 2021). Significant disparities for vaccinations exist by race, ethnicity, age, and other social and geographical determinants increasing the risks of infectious disease to individuals, communities, and the nation (HHS, 2021a). In addition to existing disparities, increasing anti-vaccine ideals and mistrust have led to vaccination refusals furthering preventable disease outbreaks. The COVID-19 pandemic, along with the development of new vaccines and vaccine technology, has spotlighted the need for open discussion and education to improve public confidence and trust in vaccine safety (HHS, 2021a).

The Centers for Disease Control and Prevention (CDC) (2021a) recommends adult vaccinations based on several individual variables that are updated and published annually. Recommendations should include the considerations of age (see Figure 1), previous vaccination status, underlying medical conditions and review of special situations (see Figure 2) (CDC, 2021b). Best practice guidelines and recommendations for immunizations are updated approximately every three to five years by The Advisory Committee on Immunization Practices (ACIP) General Recommendations Work Group (GRWG) (CDC, 2019a). Recommendations are

based on the most current scientific and expert opinions from healthcare providers and public health officials (CDC, 2019a). The high safety standards established in the U.S. for vaccine approval and ongoing monitoring are rigorous with many legal protections in place to ensure the safety, quality, and effectiveness of vaccines (HHS, 2021b). Vaccines go through extensive testing and evaluation by the Food and Drug Administration (FDA) prior to receiving recommendation from the CDC.

**Figure 1**  
*Recommended Adult Vaccinations by Age*

Vaccine	19–26 years	27–49 years	50–64 years	≥65 years
Influenza inactivated (IV) or Influenza recombinant (RIV4) <b>or</b> Influenza live, attenuated (LAIV4)	1 dose annually			
Tetanus, diphtheria, pertussis (Tdap or Td)	1 dose Tdap each pregnancy; 1 dose Td/Tdap for wound management (see notes)			
Measles, mumps, rubella (MMR)	1 dose Tdap, then Td or Tdap booster every 10 years			
Varicella (VAR)	1 or 2 doses depending on indication (if born in 1957 or later)			
Zoster recombinant (RZV)	2 doses (if born in 1980 or later)			
Human papillomavirus (HPV)	2 or 3 doses depending on age at initial vaccination or condition	27 through 45 years		
Pneumococcal conjugate (PCV13)	1 dose			1 dose
Pneumococcal polysaccharide (PPSV23)	1 or 2 doses depending on indication			1 dose
Hepatitis A (HepA)	2 or 3 doses depending on vaccine			
Hepatitis B (HepB)	2 or 3 doses depending on vaccine			
Meningococcal A, C, W, Y (MenACWY)	1 or 2 doses depending on indication, see notes for booster recommendations			
Meningococcal B (MenB)	19 through 23 years	2 or 3 doses depending on vaccine and indication, see notes for booster recommendations		
Haemophilus influenzae type b (Hib)	1 or 3 doses depending on indication			

Recommended vaccination for adults who meet age requirement, lack documentation of vaccination, or lack evidence of past infection.
  Recommended vaccination for adults with an additional risk factor or another indication.
  Recommended vaccination based on shared clinical decision-making.
  No recommendation/Not applicable.

*Note.* CDC, 2021b. Recommended adult immunization schedule by age group, United States, 2021.

<https://www.cdc.gov/vaccines/schedules/hcp/imz/adult.html>

**Figure 2**

*Recommended Adult Vaccinations by Medical Condition or Other Indications*

Vaccine	Pregnancy	Immuno-compromised (excluding HIV infection)	HIV infection CD4 count		Asplenia, complement deficiencies	End-stage renal disease; or on hemodialysis	Heart or lung disease, alcoholism <sup>1</sup>	Chronic liver disease	Diabetes	Health care personnel <sup>2</sup>	Men who have sex with men
			<200 mm <sup>3</sup>	≥200 mm <sup>3</sup>							
IIV or RIV4 or LAIV4	1 dose annually										
Tdap or Td	1 dose Tdap each pregnancy	1 dose Tdap, then Td or Tdap booster every 10 years									
MMR	Not Recommended*	Not Recommended	1 or 2 doses depending on indication								
VAR	Not Recommended*	Not Recommended	2 doses								
RZV	2 doses at age ≥50 years										
HPV	Not Recommended*	3 doses through age 26 years	2 or 3 doses through age 26 years depending on age at initial vaccination or condition								
PCV13	1 dose										
PPSV23	1, 2, or 3 doses depending on age and indication										
HepA	2 or 3 doses depending on vaccine										
HepB	2, 3, or 4 doses depending on vaccine or condition										
MenACWY	1 or 2 doses depending on indication, see notes for booster recommendations										
MenB	Precaution	2 or 3 doses depending on vaccine and indication, see notes for booster recommendations									
Hib	3 doses HSCT <sup>3</sup> recipients only										
	1 dose										

  Recommended vaccination for adults who meet age requirement, lack documentation of vaccination, or lack evidence of past infection  
  Recommended vaccination for adults with an additional risk factor or another indication  
  Precaution—vaccination might be indicated if benefit of protection outweighs risk of adverse reaction  
  Recommended vaccination based on shared clinical decision-making  
  Not recommended/contraindicated—vaccine should not be administered.  
  No recommendation/Not applicable  
 \*Vaccinate after pregnancy.

1. Precaution for LAIV4 does not apply to alcoholism. 2. See notes for influenza, hepatitis B, measles, mumps, and rubella; and varicella vaccinations. 3. Hematopoietic stem cell transplant.

*Note.* CDC, 2021b. Recommended adult immunization schedule by medical condition and other indications, United States, 2021.

<https://www.cdc.gov/vaccines/schedules/hcp/imz/adult-conditions.html>

Current general administration recommendations for adult vaccines include the following:

- (1) administer recommended vaccines even if vaccination status is unknown and
- (2) additional doses or restarts to series-based vaccines should not be administered even if there is an extended time between doses (CDC, 2021a). Severe allergic reaction to a previous dose of any vaccine is a contraindication to a second dose of the same vaccine, and the individual should consult with their health care provider. Severe allergic reactions can occur with any vaccine regardless of prior

reaction; therefore, providers administering vaccines must be aware of signs of reaction and emergency treatment plans. In most cases, individuals with a mild illness, such as a cold, may be vaccinated. Individuals who are moderately or severely ill may need to wait until they are recovered from their illness before receiving vaccinations and should consult with their health care provider. Common side effects are generally mild, of short duration, and include redness or swelling at the injection site, headache, fatigue, low fever, or body aches (CDC, 2021a).

## **Vaccination Considerations**

### **Influenza**

Inactivated (IIV) or recombinant (RIV4) influenza (flu) vaccine is recommended annually as a one-time injection for all adults without contraindications with any licensed, age-appropriate flu vaccine (CDC, 2021a). Live attenuated (LAIV4) vaccines are recommended for those less than 50 years of age, and high dose formulation is recommended for those 65 years or older. In addition to preventing the flu, the vaccine decreases the risk of severe illness, hospitalization, and illness-induced heart and lung problems. Individuals who developed Guillain-Barré syndrome within six weeks following a previous dose of influenza vaccine should not be vaccinated unless benefits outweigh risks. Egg allergy is no longer considered an absolute contraindication to flu vaccine. Individuals with mild egg allergy, including hives, may receive an annual flu vaccine. Individuals with severe egg allergy, including anaphylaxis or angioedema, may receive a flu vaccine administered in a medical setting with personnel capable of identifying and treating severe allergic reactions. Live attenuated vaccines should not be administered to individuals who are immunocompromised or are a close contact/caregiver for individuals who are severely immunocompromised, pregnant, or have asplenia, cranial cerebrospinal fluid/oropharyngeal

communications, or cochlear implant. Additionally, individuals who have taken oseltamivir or zanamivir within 48 hours, peramivir within 5 days, or baloxavir within 17 days should not receive live attenuated flu vaccine. The preferred route is intramuscular (IM) in the deltoid muscle; however, the vastus lateralis muscle is an alternative site (CDC, 2021a).

### **Tetanus, Diphtheria, Pertussis**

Following receipt of one dose of tetanus, diphtheria, pertussis (Tdap) at age 11 years or older, Tdap or tetanus and diphtheria (Td) vaccination is recommended every 10 years or when indicated for wound management or pregnancy (Havers et al, 2020). Vaccination prevents the spread of life-threatening illnesses to children and in the case of tetanus, a disease that causes muscle spasms throughout the body sometimes leading to respiratory arrest. Tdap should be administered during gestational weeks 27-36 of each pregnancy. For minor wound management, administer Tdap or Td if more than 10 years since the last vaccination. For all other wounds, administer Tdap or Td if more than five years since the last vaccination (Havers et al., 2020). The preferred route is IM in the deltoid (CDC, 2021a).

### **Measles, Mumps, Rubella**

All adults who do not have evidence of immunity should receive at least one dose of the measles, mumps, and rubella (MMR) vaccine (CDC, 2021a). Vaccination prevents the spread of highly contagious infections, which can be especially harmful when spread to children. Students attending postsecondary schools, health care workers, and international travelers should ensure receipt of at least two doses of MMR. Human Immunodeficiency virus (HIV) positive individuals with no evidence of immunity and cluster of differentiation 4 (CD4) count of 200 cells/mm<sup>3</sup> or

greater for at least six months should also receive the two-dose series. If the second dose is indicated, a minimum of 28 days is required between the two-dose series. Evidence of immunity includes written documentation of appropriate vaccination, laboratory evidence of immunity, or birth before the year 1957. Verbal report of vaccination or disease is not acceptable evidence of immunity. Individuals who have been exposed to measles and do not have evidence of immunity should be offered post-exposure prophylaxis by administration of MMR vaccine within 72 hours of exposure or immunoglobulin (IG) within 6 days of exposure. Contraindications to MMR vaccination include pregnancy and severely immunocompromised individuals including HIV infection with CD4 count less than 200 cells/mm<sup>3</sup>. The preferred route is subcutaneous in the posterior triceps of the upper arm (CDC, 2021a).

### **Varicella**

The CDC (2021a) recommends all adults receive 2 doses of the varicella (chickenpox) vaccine approximately 4-8 weeks apart. While usually mild in children, unvaccinated adults exposed to varicella are more likely to experience serious complications. Contraindications to the varicella vaccine include pregnancy and other severely immunocompromised individuals including HIV positive with a CD4 count less than 200 cells/mm<sup>3</sup>. HIV positive individuals with CD4 count greater than 200 cells/mm<sup>3</sup> may consider vaccination with 2 doses scheduled 3 months apart after discussion with their health care provider. The preferred route is IM in the deltoid muscle (CDC, 2021a).



## **Zoster**

Herpes zoster (shingles) vaccination is recommended for adults 50 years and older including those with a history of herpes zoster or previous live zoster vaccine with VZL (Zostavax) (CDC, 2021a). RZV (Shingrix) is the only zoster vaccine currently being sold and administered in the U.S. and is a non-live, recombinant vaccine consisting of 2 doses scheduled 2-6 months apart. Herpes zoster can lead to permanent problems including continued nerve-pain at the site of the rash, vision loss, skin infections, and other neurologic problems (Mayo Clinic, 2021). Pregnant women should consult with their health care provider and consider delaying vaccination until after pregnancy. Severely compromised individuals including those with HIV and CD4 count less than 200 cells/mm<sup>3</sup> should consult with their health care provider as there are currently no vaccination recommendations for this population. The preferred route is IM in the deltoid muscle (CDC, 2021a).

## **Human Papillomavirus**

Human papillomavirus (HPV) vaccination is recommended for all adults through age 26 years and includes a three-dose series for persons receiving their initial vaccination (Meites et al., 2019). The first dose is followed by a second dose at 1-2 months with the 3rd dose scheduled 6 months later. Individuals who have less than 5 months between dose one and three, should repeat the 3rd dose. If interrupted, the series does not need to be restarted but can safely be resumed with no additional doses recommended. The vaccine is designed to prevent new infections and cancers such as cervical, anal, penile, vaginal, vulvar, and oropharyngeal (Meites et al., 2019). Administration of the HPV vaccine series for adults ages 27-45 years is determined through shared decision making between the individual and their health care provider. Vaccination with HPV is

contraindicated during pregnancy; however, breastfeeding women may receive the vaccine (Meites et al., 2019). The preferred route is IM in the deltoid muscle (CDC, 2021a).

### **Pneumococcal**

Vaccination against pneumococcal disease, or pneumonia, is recommended for all adults 65 years and older (Matanock et al., 2019). Pneumonia is a leading cause of hospital admissions, meningitis, blood infections, and sepsis (CDC, 2020). In the U.S., 13-valent pneumococcal conjugate vaccine (PCV13) and 23-valent pneumococcal polysaccharide vaccine (PPSV23) are the only two pneumonia vaccines available. For adults 65 years and over, ACIP recommends a one-time dose of PPSV23. Administration of PCV13 is no longer routinely recommended for this age group. Shared clinical decision making by the health care provider and individuals 65 years and older who are immunocompromised, have cerebrospinal fluid leak, or cochlear implant and have never received PCV13, can be utilized to determine if PCV13 should be administered prior to PPSV23. At least 1 year should be allowed between administration of PCV13 and PPSV23. Adults 65 years and older who received PPSV23 before the age of 65, should receive another single dose of PPSV23 at least 5 years from the prior vaccination (Matanock et al., 2019). Adults ages 19-64 who smoke cigarettes or have chronic medical conditions such as heart disease, diabetes, lung disease, or alcoholism, should receive one dose of PPSV23 (CDC, 2021a). Immunocompromised adults 19 years and older should receive one dose of PCV13, followed by one dose of PPSV23 a minimum of eight weeks later and then repeated at 5 years. PCV13 or PPSV23 can be administered during the same visit of influenza vaccination with different injection sites preferred. The favored method of administration of pneumococcal vaccination is IM in the deltoid muscle (CDC, 2021a).

## **Hepatitis A**

Hepatitis A (HepA) vaccination is recommended by the ACIP for any adult at increased risk for hepatitis A viral (HAV) infection, at risk for developing severe illness from HAV infection, or any adult who would like protection from this disease regardless of risk (Nelson et al., 2020). HepA vaccination is a 2 or 3-dose series administered over 6 to 12 months depending upon the specific vaccine. Illegal drug abusers or those in rehabilitation facilities, developmentally delayed persons attending day care facilities, persons experiencing homelessness, those with increased occupational risk, and international travelers to areas with elevated HAV transmission are considered at increased risk for contracting HAV. Severely immunocompromised individuals with HIV or chronic liver disease, such as cirrhosis, hepatitis B or C viral infection, or fatty liver disease, are considered at risk for development of severe illness from HAV infection and should be vaccinated. Severely immunosuppressed individuals should have serologic testing at least 4 weeks following completion of the vaccination series to confirm seroconversion and protection. In addition, vaccination is recommended for pregnant women who have increased risks of contracting HAV or severe outcomes. HepA vaccination is recommended by ACIP for postexposure prophylaxis for those with increased risks (Nelson et al, 2020). IM in the deltoid is the preferred administration route and site (CDC, 2021a).

## **Hepatitis B**

Hepatitis B (HepB) vaccination is recommended for all adults at risk for Hepatitis B viral (HBV) infection, severe outcomes from HBV infection, or anyone who wishes to be protected from HBV. The HepB vaccine is administered as a 2 or 3-dose series with dosing intervals varying by manufacturer. HepB vaccination is an important tool for primary prevention of HBV which can

become a chronic disease resulting in decreased liver function (Schillie et al., 2018). Chronic liver disease, intravenous (IV) drug abuse, close contact with someone infected with HBV, hemodialysis, international travel to areas with high HBV transmission, immunosuppression, risk for exposure to blood, and diabetes are all considered risks for HBV infection. Pregnant women considered at risk for HBV infection should be vaccinated and educated on methods to avoid HBV exposure. Postexposure prophylaxis for individuals exposed to HBV through contact with blood depend upon HepB vaccination status. Individuals who have completed a HepB series without serological testing postvaccination should receive one dose of HepB vaccine. Persons who have incomplete vaccination series should receive one dose of hepatitis B immune globulin (HBIG) and complete the HepB vaccine series. Completely unvaccinated persons should receive both HBIG and HepB vaccine as soon as possible (Schillie et al, 2018). The preferred administration is IM in the deltoid muscle (CDC, 2021a).

### **Meningococcal**

Adults at increased risk for meningococcal disease are recommended to receive vaccination against this illness which is caused by the *Neisseria meningitidis* bacteria (Mbaeyi et al., 2020). *N. meningitidis* can progress to death in a matter of hours or leave survivors with serious long-term effects such as loss of limb(s), loss of hearing, or damage to the nervous system (CDC, 2019b). There are currently two types of meningococcal vaccines approved for use in the U.S. including quadrivalent (serogroup A,C,W, and Y) meningococcal conjugate (MenACWY) and monovalent serogroup B meningococcal (MenB) (Mbaeyi et al., 2020). Specific vaccine type and the number of doses to administer depends upon which serogroups are most predominant in the location, age, and risk factors. For most healthy young adults up to age 23, routine vaccination with MenB is

recommended. Adults at risk due to asplenia or complement component deficiency receiving a complement inhibitor, such as eculizumab or ravulizumab, should receive vaccination with both MenACWY and MenB. Individuals with HIV are recommended to receive MenACWY and would only receive MenB if indicated (age 16-23 years with shared decision making). Persons traveling in areas with high rates of meningococcal disease, first year college students living in a residence hall if not previously vaccinated at age 16 or older, and military recruits should receive a single dose of the MenACWY vaccine. ACIP recommends meningococcal boosters every five years for previously vaccinated individuals who remain at risk (Mbaeyi et al., 2020). Pregnant women who are at increased risk for meningococcal disease may receive either MenACWY or MenB following consultation with their health care provider (CDC, 2021a). The preferred site of administration is IM in the deltoid muscle (CDC, 2021a).

### **Haemophilus Influenzae type b**

Haemophilus Influenzae type b (Hib) vaccination is only recommended for adults with certain health conditions to prevent infections leading to problems such as pneumonia, meningitis, and sepsis (CDC, 2021a). Adults with asplenia should receive one dose if they previously did not receive the Hib vaccine. All individuals who have undergone bone marrow transplant should receive a 3-dose series separated by 4 weeks beginning 6-12 months post-transplant. The preferred administration is IM in the deltoid muscle (CDC, 2021a).

### **COVID-19**

In addition to the vaccinations in Figure 1 and Figure 2, COVID-19 vaccination is currently recommended for all adults within the scope of Emergency Use Authorization (EUA) for each

specific vaccine (CDC, 2021b). There are three vaccine products available in the U.S. including Moderna, Pfizer-BioNTech, and Johnson & Johnson (J&J) (CDC, 2021c). Johnson & Johnson (J&J) is a single dose vaccine while Moderna and Pfizer-BioNTech are mRNA products and require 2 doses recommended at 28 days apart for Moderna and 21 days apart for Pfizer-BioNTech. Moderna and Pfizer vaccines allow for a 4-day early vaccination grace period and a delay of up to 6 weeks for the second dose. If the second dose is administered after 6 weeks, do not restart the series. COVID-19 vaccines are not interchangeable, and the product received for the first dose should be determined. However, if the first dose product cannot be identified, any available mRNA vaccine may be given with a minimum of 28 days between the first and second dose. If an individual is unable to receive the second dose of an mRNA product due to a reaction or contraindication, a single dose of the J&J vaccine may be administered at a minimum of 28 days following the first injection (CDC, 2021c).

After a short pause on the use of the J&J vaccine in April 2021 due to reports of thrombosis with thrombocytopenia syndrome (TTS) in some recipients, the AICP reaffirmed its recommendation for use and concluded the benefits of the vaccine outweighed the risks (MacNeil et al., 2021). The J&J vaccine now carries a warning for rare thrombotic events primarily among women ages 18-49 years. Patient and health care provider education regarding risks, availability of alternative vaccine products, and recognition of clinical presentation of TTS symptoms are important to guide decision making and treatment. TTS involves acute venous or arterial thrombosis along with thrombocytopenia in individuals who have not recently received Heparin. Patients should be educated to monitor for and seek immediate medical care for symptoms of blood clots with development of thrombocytopenia for approximately 3 weeks following the J&J vaccination. Treatment and presentation of TTS is similar to the rare Heparin allergy of Heparin

Induced Thrombocytopenia (HIT). Individuals presenting with TTS symptoms should not be treated with Heparin, a traditional treatment for thrombotic events, and a hematology specialist should be consulted. The resumption of the J&J single dose vaccine provides flexibility and improved access for many Americans (MacNeil et al., 2021).

In June 2021, the ACIP met to review reported cases of myocarditis in primarily young males aged 12-29 years occurring a few days after receiving the second dose of the mRNA Moderna or Pfizer COVID-19 vaccine (Gargano et al., 2021). The AICP concluded the benefits of decreased morbidity and mortality from the vaccines far outweighed the risks of myocarditis and continue to recommend the use of mRNA vaccinations. The EUA for mRNA vaccinations has been updated with additional information on myocarditis. Patients and health care providers should be educated regarding the risks and symptoms of myocarditis to improve early recognition and treatment. Symptoms may include dyspnea, angina, palpitations, or syncope. Troponin levels may be elevated, and there could be abnormal findings on electrocardiogram or echocardiogram consistent with myocarditis. Supportive therapy and exercise restriction are the primary treatment recommendations with the need for additional cardiac medications determined on an individual basis. Data regarding the incidence of myocarditis will continue to be closely monitored and evaluated for any changes in vaccination recommendations. The mRNA vaccines are important and safe instruments for the prevention of COVID-19 and associated hospitalizations, disease sequela, and deaths for all ages.

Intramuscular injection in the deltoid muscle is the recommended site and route for all COVID-19 vaccine products (CDC, 2021c). COVID-19 vaccines may be administered on the same day as other recommended vaccinations. If administering additional vaccines in the deltoid, separate injection sites by at least 1 inch. Separate limbs are recommended if additional

vaccinations frequently result in local reaction. If the deltoid muscle cannot be used, the vastus lateralis muscle is an alternate location for injection (CDC, 2021c).

### **Educational Resources**

Detailed vaccination schedules and recommendations for all ages, underlying conditions, travel, and special situations can be found on the CDC website for vaccinations and immunizations at:

<https://www.cdc.gov/vaccines/index.html>.

Additional resources for adult immunizations can be found on the U.S. Health and Human Services website at:

<https://www.hhs.gov/vaccines/national-adult-immunization-plan/index.html>.

This site contains adult immunization plans and goals for improved physical and organization structures and facilities along with access to vaccinations.

### **Conclusion**

Vaccinations play an important role in lifelong health and wellness by providing protection from preventable and potentially deadly infectious diseases such as COVID-19 or influenza. Vaccines in the U.S. undergo thorough and ongoing safety and efficacy evaluation before being recommended for use by the CDC. This transparent process includes information on contraindications, potential adverse effects, and special considerations to help adults and their health care providers make informed, best-practice decisions together. As trusted community members, FCN can provide accurate and understandable information regarding the safety and importance of adult vaccinations leading to improved immunization rates and outcomes.



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