

Prevention of pertussis through adult vaccination

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Abbreviations: Tdap, tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis; CDC, Centers for Disease Control and Prevention; ACIP, Advisory Committee on Immunization Practices

Pertussis is a vaccine preventable respiratory infection. Young infants are at high risk of developing severe complications from infection. Despite high rates of pediatric vaccine uptake, there continues to be increases in pertussis cases, likely due to waning immunity from childhood vaccine and increased transmission through adults. Currently, pertussis booster vaccine (Tdap) is recommended for unimmunized adults and for women in the third trimester of each pregnancy; yet adult Tdap coverage remains low. Administering Tdap vaccine at non-traditional vaccination clinics and at sites where adults are accessing care for their children are effective in improving adult Tdap uptake. While most are willing to receive vaccine when recommended by their provider, lack of provider recommendation is a major obstacle to immunization. Future studies to understand barriers to provider vaccine recommendations need to be undertaken to develop interventions to improve adult Tdap vaccine uptake and reduce pertussis infection in the susceptible population.

Background

Pertussis is a highly contagious, vaccine-preventable respiratory infection caused by the gram-negative bacilli, *Bordetella pertussis*. While symptoms of adult infection may range from asymptomatic disease to a protracted coughing illness with subconjunctival hemorrhages, weight loss, urinary incontinence, syncope, and rib fractures, young infants are at the highest risk of developing severe complications, such as apnea, pneumonia, seizures, and death.^{1,2} Despite widespread use of pertussis vaccine in US children, with 83% of children aged 19–35 months having received 4 doses of DTaP (diphtheria-tetanus-acellular pertussis) vaccine in 2013, outbreaks of pertussis infection continue to occur.³

Worldwide, there are approximately 16 million pertussis cases, and 195,000 pediatric pertussis deaths each year.⁴ In the pre-vaccine era, over 100,000 cases occurred in the United States annually, with most cases documented in children.⁵ Given the lack of sensitive diagnostic testing and reporting of infection at

this time, these numbers are likely a gross underestimate of true disease occurrence, which may have exceeded a million cases per year. During this period, children represented the major source of transmission of infection, while adults maintained immunity through regular exposure to pertussis from infected children in the community. Following the introduction and widespread use of whole cell pertussis vaccines in the pediatric population in the 1940s, cases of pertussis infection declined dramatically, with a nadir of 1,010 cases reported in 1976.^{5,6} As a result of the immunization program, vaccinated children were protected from infection, so there was less exposure to pertussis in the community, and therefore less boosting of adolescent and adult immunity through natural infection or natural re-exposure to the pathogen. As immunity from both natural infection and childhood vaccination waned, an increase in proportion of pertussis cases were seen in adults and adolescents, who have now become the major source of transmission of infection to susceptible young infants.^{7,8}

Since the 1980s, there has been a gradual increase in reported pertussis cases in the US, with cyclical peaks observed every 3–4 years, particularly among the adolescents and adults.^{9–14} In 2012, alone, 48,277 cases of pertussis were reported to the Centers for Disease Control and Prevention (CDC), the highest number of cases reported in one year since 1955.¹⁵

This resurgence in pertussis, with high pre-school pertussis vaccine coverage, is primarily thought to be due to waning immunity and persistent transmission of infection by adolescents and adults, confirming the need for booster vaccines for this population.^{11,12,16} Other factors that contribute to the increased rates of reported pertussis cases include better provider awareness of infection manifestations beyond infancy, improvement in diagnostic testing with the advent of PCR, and potential changes in antigenic and genotypic characteristics of circulating *B. pertussis* strains.^{5,7,11} The importance of pertussis prevention in adults is 2-fold: vaccination programs in this population are a cost effective method to reduce disease-associated morbidity and to decrease possible transmission of infection to young infants who are at risk for severe complications.^{13,17–20}

Vaccine Recommendations

In 2005, 2 tetanus-diphtheria-acellular pertussis (Tdap) booster vaccine formulations were licensed and recommended in the United States for adolescents. In 2006, the recommendation

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was expanded to include adults younger than 65 years, particularly for those in contact with infants younger than 12 months of age.^{21,22} Despite this recommendation, by 2008 only 5% of adults were estimated to have received a Tdap vaccine.²³ In 2010, the Advisory Committee on Immunization Practices (ACIP) recommended that unimmunized adults older than 65 years who have contact with infants younger than 12 months should also receive a Tdap booster, while those without infant contacts may receive vaccine.²⁴ Two years later, this recommendation for Tdap booster was modified to include all unimmunized adults over 65 years of age, regardless of infant contact.²⁵ Yet, in 2013, adult Tdap vaccine coverage rate was estimated to be only 17.2% overall, with coverage for adults 19–64 years living with an infant younger than 1 year at 29.4%.²⁶

As the majority of the infant pertussis cases are transmitted from a parent or sibling, the initial 2006 US ACIP recommendation also included immunizing women prior to pregnancy and immunizing all household contacts of newborn infants who have not yet received Tdap vaccine. The rationale for immediate postpartum vaccination is meant to indirectly protect the newborn from infection, a strategy known as ‘cocooning’.^{21,27} In 2011, the ACIP recommended that Tdap vaccine be administered to unvaccinated pregnant women, in addition to vaccinating household contacts who had not yet been immunized.²⁸ Subsequently, it was found that, in healthy non-pregnant adults, antipertussis antibodies peaked one month after vaccination and then declined over the course of 3 years.²⁹ Similarly, infants born to mothers who received Tdap vaccine pre-conception or early in pregnancy did not have sufficient antibody to protect against infection.³⁰ In an effort to optimize neonatal protection from pertussis, the ACIP modified the 2011 recommendation in 2012 to include administering Tdap vaccine to women during the third trimester of each pregnancy.¹⁵ In the 2 years following recommendation for Tdap vaccine administration during pregnancy, Tdap vaccine uptake in pregnant women ranged from 15 to 82%, depending on the study.^{31–33} Of note, the higher Tdap vaccination rates were seen at single center studies, and the study that showed 82% vaccine completion reported data from 5 months.

The cocooning strategy, promoted by the CDC to protect newborns from serious complications of pertussis infection, has been shown to be effective in some studies but difficult to implement nationwide.^{18,34–36} Major limitations to this strategy include the continued risk of transmission of infection to young infants from adolescents and adults outside the household who would not be included in the cocooning strategy, the lack of a platform for postpartum vaccination of newborn contacts including funding and determining who has the responsibility to gather and immunize the family members, and lastly, that vaccinated adults remain susceptible to infection for 2 weeks after immunization receipt.³⁷ On the other hand, vaccinating women during their third trimester of pregnancy results in efficient transplacental transfer of antibodies and significantly higher infant titers at 1 month of age when compared to those born before maternal immunization.³⁸ Immunizing pregnant women, in combination with the cocooning strategy is a cost-effective method to prevent pertussis in young infants.³⁹

Strategies to Improve Adult Tdap Vaccine Uptake

Different strategies have been explored to increase Tdap coverage in adults. In particular, interventions that reduce known barriers to adult vaccination, such as vaccine cost, lack of medical access, inconvenience of seeking medical care for vaccine, and lack of vaccine awareness, have proven effective in improving adult Tdap vaccine uptake.^{40,41}

Improving access to vaccine is one of the most widely studied interventions to increase vaccine coverage. Vaccination clinics outside of the traditional medical office, such as retail pharmacies, are a safe and increasingly common way to reach adults who may otherwise not be immunized.^{42–45} These clinics offer 2 big advantages: convenience and easy access to vaccine. Hospital-based programs with standing orders for Tdap vaccine improve vaccine uptake in previously unvaccinated post-partum women.^{36,45,46} Administration of Tdap vaccine to parents with newborns being cared for in the neonatal intensive care unit increased vaccine uptake for parents of infants in the unit.⁴⁷ Similarly offering Tdap vaccine to infant caregivers, free of charge, in the pediatrician’s office has been shown to be an effective method of immunizing adults, however, this may prove to be logistically difficult as pediatric providers consider the legal and financial burden of administering free vaccine to adults who are not their patients.^{48,49}

In addition to vaccine access, Tdap attitudes also contribute to vaccine uptake. In a 2014 study of underserved Hispanic infant contacts in Texas, the majority of surveyed participants expressed willingness to receive vaccine. Participants noted that their lack of pertussis knowledge and vaccine cost were major barriers to immunization.⁵⁰

Studies clearly demonstrate the positive impact of physician vaccine recommendations, including Tdap vaccine.^{51–53} In one study of postpartum women, while most women expressed willingness to receive vaccine during pregnancy if recommended by their health care provider, only 5% and 10% report actually discussing Tdap vaccine and vaccinating household contacts, respectively, with their health care provider during their pregnancy.⁵⁴

The strong association between provider recommendation and vaccine uptake is well known. Even women with negative vaccine attitudes who had a health care provider recommendation for influenza vaccine were more likely to be immunized than those women with positive vaccine attitudes who did not have a health care provider vaccine recommendation.⁵⁵ Yet, Silvaggio found that only half of surveyed providers, practicing in areas of pertussis epidemics, routinely asked adult patients about the pertussis vaccine.⁵⁶ Similarly, 2 years after the routine recommendation for Tdap vaccine during pregnancy, while 80% of surveyed obstetric providers in New York reported that they recommend Tdap vaccine to their pregnant patients, one-third of the providers did not administer the vaccine in their practice.⁵⁷ Kao et al. found that obstetricians who believed that the incidence of pertussis in adults was increased, that pertussis disease in young infants was severe, and who understood the current recommendations for disease prevention in the young infants were more likely to intend to recommend Tdap in their obstetric practice.⁵⁸

While not administering Tdap vaccine in obstetric practices may act as a barrier to vaccine receipt, obstetric providers in these practices should encourage and guide patients as to where to receive vaccine during their pregnancy.

The evidence of waning immunity to pertussis vaccine suggests the potential need to replace Td booster vaccine with Tdap to maintain protective antibodies against infection and to reduce pertussis burden community-wide. Given the rapid decrease of antipertussis antibodies during the 3 years post-booster vaccine, such a strategy will require much higher adult immunization rates, as current rates are estimated at only 17%, and perhaps rethinking the time frame for which routine Tdap booster intervals would provide the broadest public health impact.

Improved understanding of barriers to provider vaccine recommendations and administration may lead to interventions that improve adult Tdap vaccine coverage. Academic detailing by

peer educators has been shown to improve provider immunization knowledge and practice in small pediatric practices.⁵⁹ Future studies should evaluate the effectiveness of similar interventions in adult health care providers in an effort to increase adult Tdap vaccine uptake, and reduce pertussis morbidity and mortality.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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